

**TOOTHBRUSHING AS A DYADIC PROCESS:
INSIGHTS FROM NOVICE CAREGIVERS AND
FIRSTBORN INFANTS**

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ACRONYM GLOSSARY

AAP- American Academy of Pediatrics

AAPD – American Academy of Pediatric Dentistry

ASD – Autistic Spectrum Disorder

BDA – British Dental Association

BDHF – British Dental Health Foundation

CDI – Communicative Development Inventory

EAPD – European Academy of Paediatric Dentistry

ECC – Early Childhood Caries

IMD – Indices of Multiple Deprivation

LEDCs – Less Economically Developed Countries

LoC – Locus of Control

MEDCs – More Economically Developed Countries

MRC – Medical Research Council

NHS – National Health Service

PSE – Parental Self-Efficacy

RCT – Randomised Controlled Trial

SES – Socio-Economic Status

UN – United Nations

VLBW – Very Low Birth Weight

WHO – World Health Organisation

ABSTRACT

AIMS: The thesis explored influences on emergence of toothbrushing as a dyadic process through infancy with influences conceptualised throughout using Bronfenbrenner's ecological model. Influences were used to develop methods to support novice mothers to establish and maintain toothbrushing routines with infants. **METHODS: Study One:** Qualitative interview study with novice mothers of infants exploring influences on emergence of dyadic toothbrushing routines (n=16). **Study Two:** Using collected qualitative data to develop and standardise a psychometric scale measuring parental self-efficacy (PSE) for enforcing toothbrushing routines with infants (n=91). **Study Three:** Cross-sectional observational study of dyadic interactions during toothbrushing episodes, using three age groups of infant, 12-months, 18-months and 24-months (each n=12). **Study Four:** Development and evaluation of an intervention to increase maternal control of the brush dyadic toothbrushing using three study groups (each n=11). **RESULTS: Study One:** A total of 25 influences on emergence of dyadic toothbrushing were identified. Many of these influences were identified as lying within the mother-infant dyad. **Study Two:** Scale items were generated from the 25 sub-themes identified from the qualitative study. Overall reliability of the scale was $\alpha = .934$ and it was found to contain five components. **Study Three:** Significant differences ($p < .001$) were found between the three groups in frequency and duration of maternal and infant control of holding and using the toothbrush during observed episodes. **Study Four:** The picture book intervention did not significantly affect frequency and duration of either maternal or infant control of holding and using the toothbrush

during observed episodes. **Conclusion:** Many influences on emergence of dyadic toothbrushing come from the mother-infant dyad. Some may pose challenges, such as infant drive for self-toothbrushing. However, some influences such as PSE may facilitate the routine. Further work should focus on supporting caregivers to maintain control of holding and using the toothbrush during dyadic toothbrushing.

CHAPTER ONE: GENERAL INTRODUCTION TO THE THESIS

1.1 Introduction

In humans, the practice of using tools to remove food debris from between teeth is traceable back perhaps as far as 1.8 million years ago, as fossilised teeth have been discovered with apparent interdental erosion caused by repeated rubbing with grass stalks between the teeth (Hlusko, 2003). Such evidence could indicate that ancient hominids may have picked their teeth to try to alleviate discomfort from impacted food. Adoption of a tool to pick teeth, in addition to rubbing and cleaning of tooth surfaces, are all behaviours known to be consistently present across human history.

However, these behaviours are not uniquely human, as non-human primates also appear to use a range of behavioural repertoires around the removal of food debris from teeth. Social biology research has demonstrated that adult macaques use their own hair to remove impacted food in a similar way to humans using dental floss (Leca et al., 2010; Masataka et al., 2009; Watanabe et al., 2007). There is even emerging evidence to suggest that adult macaques may show or demonstrate this activity to their off-spring. Figure 1.1 shows a female adult macaque sat in front of her off-spring using her own hair in a manner similar to a way that a human may use dental floss. There is evidence that this is not just coincidental. Masataka et al. (2009) established evidence of adult female macaques varying their repertoire of behaviours involving the 'floss' depending on whether the infant macaque was present or not.

Specifically, when the infant was present, the maternal macaque's use of the hair-like 'tool' was of a longer duration, punctuated with more pauses and was more frequently in a given episode (Masataka et al., 2009). This outcome could be interpreted as a more 'deliberate' use of the hair-like tool in the presence of an infant macaque. In turn, this may indicate that adult macaques may play an instrumental role in the transmission of oral self-care behaviours across multiple generations. In particular, 'social modelling' may be one mechanism that facilitates uptake, with young macaques visually observing a familiar adult use a tool. Social modelling is a key component of 'social learning theory' (Bandura, 1977b) which describes how individuals learn from one another, via observation, imitation, and 'modelling'. The theory describes how individuals learn how new behaviours are performed from observing others enacting them and then later performing the new behaviour themselves.



Figure 1.1- Female macaque using her own hair in the manner of dental floss in front of her off-spring

More generally, although this non-human primate behaviour is likely to relieve the discomfort experienced from food debris impacted between teeth, its presence may indicate that the drive to keep the mouth and teeth free of food debris is one that could confer some kind of evolutionary advantage. Indeed, theorists in the evolution of behaviour have argued that such hygiene behaviours may be exhibited by animals because they are adaptive, being important in infection avoidance and therefore contribute to increased chance of survival (Curtis, 2007).

Along with a low sugar diet and regular visits to the dentist, tooth cleaning twice-daily with a toothbrushing and fluoride toothpaste with at least 1000 parts per million (ppm) fluoride is recommended as a key caries-preventive behaviour (Marinho, 2009). Indeed, World Health Organisation (WHO) recommendations for the prevention of dental caries stipulate that effective daily toothbrushing with a fluoride toothpaste is one of the most effective ways of preventing dental caries (Levy, 1993; Petersen, 2003; Twetman et al., 2003). Toothbrushing with fluoride toothpaste fulfils two purposes, firstly to balance the exposure of teeth to acidic sugars in the diet through exposure to alkaline fluoride, and secondly to mechanically remove food debris from teeth surfaces. A review of national and international guidelines around establishment of toothbrushing routines is now provided.

1.2 The Importance of Dental Health-Care Routines from Infancy

Toothbrushing is recommended by dental and general health bodies (American Association for Pediatric Dentistry, 2011; BDHF, 2010; NHS, 2009) to begin in *infancy* at around the time of the eruption of the first of the primary teeth. Importantly, by establishing effective toothbrushing in infancy, later dental health may also be assured. This is due to indications that these behaviours, once established, are more likely to endure throughout adulthood (Aunger, 2007; Marinho et al., 2003) providing lifelong protection against caries (Ramos-Gomez et al., 2002). Additionally, toothbrushing conducted in infancy is also crucial for preventing dental caries during this developmental period (Arora et al., 2011; Pine et al., 2004b). When dental caries are found in infancy, this condition is referred to as 'early childhood caries' (ECC). ECC is a significant worldwide health problem, with the World Health Organisation (WHO) estimating that globally, between 60-90% of school age children may be affected (Petersen et al., 2005; World Health Organisation, 2012).

Social inequalities in children's dental health status have also been identified as a worldwide problem (Pine et al., 2004a), with 'globally the greatest burden of dental diseases [being] on the disadvantaged and poor population groups' (Petersen et al., 2005). The problem is not confined to the United Nations (UN) defined 'less economically developed countries' (LEDCs), but is even more marked in 'more economically developed countries' (MEDCs), where there are significant disparities (Shaw et al., 2009).

In order to prevent ECC, organisations such as the American Academy of Pediatric Dentistry (AAPD), British Dental Association (BDA) and British Dental Health Foundation (BDHF) recommend that caregivers should brush young children’s teeth for them, and then be closely supervised during toothbrushing until the age of seven-years (AAPD, 2011b; BDHF, 2010; NHS, 2009). Other reports recommend that from the age of 2 – 3 years, children should be encouraged to start to clean their own teeth, but that caregivers should still closely supervise this (Sgan-Cohen, 2005). The principal source of health advice for families living in the UK, the National Health Service (NHS), states;

“Brush your child's teeth for at least two minutes twice a day...supervise tooth brushing until your child is seven or eight years old, either by brushing their teeth yourself or, if they brush their own teeth, by watching how they do it. You will need to help your child brush their teeth until they are at least seven years of age. It is important to help them up until this time to ensure they are brushing their teeth correctly.” (NHS, 2009)

Caregivers brushing of the teeth and caregiver supervision are recommended to ensure teeth are cleaned effectively to prevent caries, and also to prevent oral trauma and damage to the mouth from impalement of the toothbrush in the oral tissue (Matusue et al., 2011; Younessi and Alcaino, 2007). Figure 1.2 depicts a case of oral trauma reported in Matusue et al. (2011).



Figure 1.2- Case of oral trauma caused by impalement of a toothbrush into cheek

In particular, caregiver supervised/ conducted toothbrushing before *bedtime* is important as children will often have significant food debris in the mouth by bedtime. Additionally, reduced saliva during the night increases acidity of the oral cavity, increasing the likelihood of the process of dental caries (Hodosy and Celec, 2005). It is therefore important that food debris be adequately removed before bed in order to avoid the development of dental caries. Indeed, intervention studies have demonstrated that absence of nocturnal toothbrushing may be significantly associated with development of carious lesions in infants (Siqueira et al., 2010).

Insufficient or ineffective toothbrushing in *early childhood* has been suggested to be responsible for children requiring hospital admissions for dental extractions under general anaesthetic (Olley et al., 2011a). In the longer term, such traumatic early dental experiences may lead to later dental anxiety (Townend et al., 2000). However, not removing decayed teeth may result in problems in growth and cognitive development by interfering with mastication and nutrition (Sheiham, 2006) and also

school participation due to pain (Jackson et al., 2011). Finally, if rampant untreated dental caries is found to be present in a child, this has been recommended by dental health and social care professionals as a key indicator of more serious child neglect (Gussy et al., 2006).

It would appear then that there are several negative consequences of ineffective toothbrushing to infants and children. Therefore, it may be important to understand the various barriers and facilitators of the establishment and maintenance of effective toothbrushing routines with infants from the time of the eruption of the first of the primary dentition when toothbrushing should first begin. Specifically, it may be informative to examine how reciprocal behaviours from each member of the caregiver-infant dyad contribute to toothbrushing emerging as a '*dyadic*' process in which each member contributes to the specific features and nature of the activity. 'Dyadic' toothbrushing in which both members of the caregiver-infant dyad play an integral part in the behaviour being enacted, may then emerge through infancy and into childhood as a routine behaviour that children enact by themselves, alone, in an automatic manner. Research into influences on the emergence of dyadic processes such as toothbrushing routines would be fruitfully informed by the theories and methods employed within the discipline of developmental psychology.

1.3 The Value of the Contribution of Developmental Psychology to Understanding Toothbrushing as a Dyadic Process

Although toothbrushing as a routine behaviour is one most commonly associated with the disciplines of Dentistry and Dental Public Health, social scientists have also turned their attention to exploring this activity. Research methodologies commonly employed by social scientists have in recent years been used fruitfully by both dental researchers and social scientists with an interest in dental health behaviour. Specifically, examination of potential influences on toothbrushing as a dyadic process when they may be first established in infancy, may be aided by methods commonly employed in *developmental psychology* research.

Developmental psychology is concerned with describing and explaining “the changes that occur over time in the thought, behaviour, reasoning, and functioning of a person due to biological, individual, and environmental influences” (Slater and Bremner, 2011, pg 5). These influences may range from economic and political structures, to those more immediate including the family environment including social and emotional processes, and also those influences located at the level of the individual human including cognitive and biological processes. In particular, theory and knowledge from the discipline may contribute to understanding how toothbrushing as a dyadic process is first established and potential influences on the behaviour as it is maintained through infancy, via what has already been discovered in the field about infant development, and the multiple influences on infant developmental outcomes.

Methodologies commonly employed in developmental psychology research may already be proving to be highly appropriate for examining influences on early dyadic toothbrushing routines. For example, qualitative interviews have been employed to explore in detail caregiver's self-reported perceptions of influences on the establishment of dyadic toothbrushing in community child-care centres (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010). These studies revealed that sometimes difficult child temperament and behaviour may make enforcing toothbrushing routines with young children to be challenging. Such qualitative interview studies may provide a greater depth of insight into such influences on dental health behaviours than quantitative methods such as questionnaires and allow greater exploration of potential perceived influences. However, the published qualitative research that has examined in detail early toothbrushing routines (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Riedy et al., 2001) has only included children over the age of 3-years, an age at which toothbrushing routines may have already been in place for some time. To date, there does not appear to have been any published qualitative studies that have examined emergence of toothbrushing routines in children *under the age of three years*.

In addition to qualitative interviews, observational research has also examined dyadic toothbrushing in both dental clinic settings (Martins et al., 2011) and also family homes (Zeedyk et al., 2005). These observational studies have revealed that infants may be engaging in autonomous self-toothbrushing with very little parental input from as young an age as two and a half years. This is a considerably younger

age than the seven-years recommended by a number of national and international dental health advisory bodies (AAPD, 2011b; BDHF, 2010; NHS, 2009). What the consequence is of such early autonomous self-toothbrushing is on child dental health is not known, but the fact that independent studies have demonstrated that such early autonomous self-toothbrushing does occur, may indicate that this issue merits further exploration. However, the previous observational studies (Martins et al., 2011; Zeedyk et al., 2005) have included children aged 2.5 years and older, so these studies include dyads in which children are at an age when toothbrushing may have been in place for some time. Therefore, it may be useful to conduct similar observational research with infants than 2.5 years in order to examine influences on dyadic toothbrushing from the time when the routine first emerges.

The models and theories from within developmental psychology may also be useful in understanding influences on early toothbrushing in infancy. For example, by using a model such as Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), potential influences on the emergence of toothbrushing as a dyadic process through infancy may be conceptualised. Some influences may be more 'distal' or remote from the caregiver-child dyad, and lie outside of the immediate home environment and come from health care professionals. Other influences may be more 'proximal' or immediate to the caregiver-child dyad, and include caregiver and child behaviours.

What is already known more generally about behavioural development within the caregiver-child dyad during infancy, may also contribute to understanding the emergence of toothbrushing as a dyadic process through infancy. For example the findings related to early autonomous self-toothbrushing (Martins et al., 2011; Zeedyk et al., 2005) and potential temperamental and behavioural difficulties in young children (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010) may be understood via the developmental psychology literature.

The period of development in which the first teeth of the primary dentition erupt (6 – 12 months) is characterised by multiple other developmental processes, including changes in executive functions such as working memory, attention and problem solving skills (van de Weijer-Bergsma et al., 2008). These changes also occur alongside changes in social, emotional and behavioural functioning (Riggs et al., 2006). An increasing sense of self-agency and drive for autonomy characterises this period of development (Dix et al., 2007; Erikson, 1968; Newman and Newman, 2008), as do developments in infant fine motor skills, including object manipulation skills and also gross motor skills including crawling and walking (Carruth et al., 2004; WHO, 2006).

It is at around this age that infants exhibit object grasping behaviours and first manipulate objects (Cox and Smitsman, 2006), using them as tools (Barrett et al., 2007; Claxton et al., 2009). Self-care behaviours such as self-feeding with spoons start to develop in infancy (Carruth and Skinner, 2002; Carruth et al., 2004; Koda et

al., 2006). The period of development from around 12-months is characterised by the emergence of infant grasping of toothbrushes and attempts to manipulate toothbrushes as with other tools. Indeed, specially designed toothbrushes are available on the market, with handles designed to make them easier for infant hands to grasp. This would indicate that companies designing and producing toothbrushes realise that infants may engage in toothbrush grasping behaviours. Indeed, the two previous observational studies (Martins et al., 2011; Zeedyk et al., 2005) in which direct observations of dyadic toothbrushing episodes have been conducted have revealed that by 2.5 years many infants are holding and using the toothbrush to engage in autonomous self-toothbrushing.

1.4 Aims of the Thesis

Although establishing effective toothbrushing routines in the early years of life is vital for preventing ECC (Aunger, 2007), there is very little research examining *influences on the emergence of toothbrushing as a dyadic process in infancy*. Additionally, virtually nothing is known about how the roles of the caregiver and infant during toothbrushing episodes may change, from the time of establishment of the behaviour at the time of the eruption of the first primary dentition, through to the end of the second year of life. Therefore, the thesis aims to explore the potential influences on the emergence of toothbrushing as a dyadic process throughout infancy to the end of the second year of life.

Specifically, dyads containing novice mothers and first-born infants from a UK sample are identified for the studies reported in the thesis. This is due to the fact that as yet, there have not been any studies in which emergence of the routine in *first-born infants* has been examined. This is important, as novice caregivers of first-born infants may potentially find the task of establishing and maintaining early dyadic toothbrushing routines with first-born infants to be more challenging than experienced caregivers of multiple children might. First-time parenting poses quite unique challenges to caregivers as they navigate through the sometimes stressful aspects of encountering infant-care responsibilities as novice caregivers (Rodriguez and Adamsons, 2012).

Additionally, mothers are included in the studies presented in the thesis as the mother-infant dyad has been suggested to be the most fundamentally important relationship during infant development to a number of developmental outcomes (Kochanska et al., 2009). Studies demonstrate that during infancy, mothers still play a larger part in infant-care tasks than fathers (Ahnert, 2006; Scher and Sharabany, 2005), with many fathers perceiving themselves as being available to provide respite to mothers rather than being principal caregiver to their child (Premberg et al., 2008).

Influences on dyadic toothbrushing in infancy are conceptualised throughout the thesis using Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). The mother-infant dyad,

which is the main focus of the thesis studies, may be conceptualised as lying at the level of the 'microsystem' of the ecological model, which is defined as an infant's immediate environment and encompasses the relationships and interactions an infant has with their immediate surroundings. This level of the model may also interact with other levels of the model that represent such influences as socio-economic and cultural influences. The microsystem has been suggested as being particularly important to development in the early years (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), so would be expected to also be important to the establishment of toothbrushing as a dyadic process in infancy.

How caregiver and infant roles during toothbrushing episodes may change from the time of establishment of toothbrushing as a dyadic process at the time of the eruption of the first primary dentition, through the second year of life as the routine is maintained, are also examined. Therefore, dyads containing first-born infants aged between the ages of 12 and 30 months have been identified for the studies presented in the thesis as it is from the age of 12-months that dyadic toothbrushing is recommended to be first established, as by this age most infants will have experienced the eruption of the first teeth of their primary dentition (NHS, 2009; American Academy of Pediatric Dentistry, 2011b). By including a 12 to 30 month age range of infants, the experiences of mothers at the very start of the process of establishing the behaviour, and also those of mothers who are coming to the end of

the process of establishing and maintaining early dyadic routines with infants, will be captured.

The influences on early dyadic toothbrushing routines identified within the thesis are utilised in two ways. Firstly, they are used to develop means of measuring novice mother's perceptions of their ability to cope with such difficulties when establishing toothbrushing as a dyadic process through infancy. Secondly, they are used to develop ways to support mothers having such difficulties, to align their dyadic toothbrushing with the guidelines.

1.5 Overview of Thesis Structure

The thesis is formed of three main sections, which include;

Literature review: The literature review includes a general overview of the multiple influences on the emergence of toothbrushing as a dyadic process in infancy, with specific attention paid to toothbrushing in childhood. Influences on toothbrushing as a dyadic process discussed in Chapter Two are conceptualised via Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) as this model is also used in empirical chapters to conceptualise new data around influences on the emergence of toothbrushing as a dyadic process in infancy. Chapter Two also contains a more specific focus on caregiver and infant dyadic influences on infant developmental and health outcomes, and explores the roles of caregiver behavioural and cognitive influences and infant behavioural

influences. Chapter Two includes discussion of the literature surrounding theories on the emergence of tool use and self-care skills through infancy, as toothbrushing could be conceptualised as a self-care task utilising a tool.

Empirical studies: The empirical studies section contains reports of each methodology used in the thesis and findings from each of four separate studies. Each of these reports contains a review of literature specific to each separate study, including seminal published research findings that have informed each of the studies and literature around the specific methodologies used in study are overviewed and critiqued. The methodology employed in each study is described and the findings derived from the data collected. Findings from the studies are discussed in relation to previous research findings, and any limitations to the studies are outlined.

- **Study One:** A qualitative interview study exploring perceived barriers to and facilitators of the establishment of toothbrushing as a dyadic process in infancy in dyads containing novice mothers and first-born infants.
- **Study Two:** A psychometric scale development and standardisation study of a scale designed to measure novice mother's perceptions of their abilities to establish toothbrushing as a dyadic process with first-born infants. Items included in this scale are developed using the qualitative data collected in Study 1.
- **Study Three:** A cross-sectional observational study of age related differences of dyadic toothbrushing episodes during infancy, which includes dyads containing novice mothers and 12, 18 and 24 month old infants.

- **Study Four:** A study to develop an intervention to support mothers to align dyadic toothbrushing with infants with dental expert guidelines by increasing the frequency and duration of maternal control of the toothbrush during dyadic toothbrushing episodes. This intervention is evaluated using the psychometric scale developed in Study 2 and the observational data coding schedule used in Study 3.

Overall Discussions and Conclusions: This section includes a discussion of the findings taken from the data collected in the separate studies of the thesis and the thesis as a whole, along with the key conclusions drawn. This section also provides a discussion of how the key findings from the thesis contribute to the main aims of the thesis and the field more generally. Finally, implications of the research for clinical practice and recommendations for future research and health policy are provided.

CHAPTER TWO: DISCUSSION OF INFLUENCES ON DYADIC TOOTHBRUSHING ROUTINES: EVIDENCE FROM THE PUBLISHED LITERATURE

2.1 Introduction

The focus of the thesis is to understand influences on the emergence of toothbrushing as a dyadic process in infancy in dyads containing novice mothers and first-born infants. In order to achieve this, the philosophical and methodological underpinning for the thesis comes from the discipline of *developmental psychology*, which is concerned with describing multiple influences on “age-related changes in experience and behaviour” (Butterworth and Harris, 1994, pg 3). Therefore, a key step towards understanding potential influences is to first *describe* them and then go on to examine how they may interplay with one another to influence the emergence of toothbrushing as a dyadic process in infancy.

Explanatory models of child dental health behaviours, such as toothbrushing routines, have been generated via research conducted in collaboration with the World Health Organisation (WHO) (e.g. Pine et al., 2004b). Although these models have identified a number of influences on child dental health outcomes, very little is known about how influences located at the level of the mother-infant dyad may be associated with the emergence of toothbrushing as a dyadic process through infancy. Additionally, never before have dyads containing specifically novice mothers

and first-born infants been identified for such research. Therefore, the thesis seeks to use multiple methods to explore these potential caregiver-infant influences on the emergence of toothbrushing as a dyadic process in infancy in dyads containing novice mothers and first-born infants. Previously, broad systems approaches have been used to conceptualise influences on such public health issues as early childhood overweight (Hawkins et al., 2009). Therefore, it may be an important first step to take a systems or 'ecological' approach when attempting to understand the various influences on the emergence of toothbrushing as a dyadic process in infancy.

A number of ecological approaches have been used within the field of public health research in order to conceptualise the aetiologies behind health behaviours and also pathways to health behaviour change. Conceptualisation of multiple influences on health outcomes using ecological approaches may be important for several reasons. Models aid understanding of complex, multiple systems of influences which otherwise may be confusing and difficult to unpack. They may also allow predictions of outcomes to be made based on understanding the relative contributions of identified influences on a given outcome. Additionally, identification of components of a given model that may be lacking in empirical evidence may direct future research. Specifically with regards to behaviour change, models also allow the identification of potential targets for interventions, and also the design of interventions and decisions of most appropriate intervention strategies (Kok et al., 2004; Michie et al., 2008).

A number of health behaviour ecological models have been used within the field of public health over the past several decades. Although these models have been useful within public health research, they may not be so appropriate for conceptualising caregiver-infant *dyadic* influences on the emergence of toothbrushing as a dyadic process in infancy. Well known ecological models in public health research are the PRECEDE-PROCEED Planning Model (Green and Kreuter, 2005), Theory of Triadic Influence (Flay et al., 2009) and the Social Model of Health (Whitehead and Dahlgren, 1991). Each of these models have been used to identify influences on health behaviours that lie at various spheres including those lying in the wider culture, social and economic environment, and those lying in the more immediate community and also some influences from within the individual, such as age and gender.

Some of these models have been employed in research regarding *dental health* behaviours but have largely been used when examining *adult or adolescent* dental health behaviours (e.g. Ostberg et al., 2003). Additionally, previous attempts to take an ecological approach in exploring influences on child dental health outcomes have not focussed in detail on influences from the *caregiver-infant dyad* specifically, but instead have examined wider influences such as those coming from the wider family and community (Fisher-Owens et al., 2007). Essentially, when examining influences on the emergence of toothbrushing as a dyadic process in infancy, what is being examined is the emergence of reciprocal caregiver-infant interaction during a health care task. Therefore, it may be more appropriate to utilise an ecological model that

has been used extensively in infant developmental outcomes research, as opposed to the public health ecological models available in the literature.

Therefore, a model cited in much of the previous developmental psychology literature is used to aid conceptualisation of influences on the emergence of toothbrushing as a dyadic process in infancy. This model is Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Bronfenbrenner's ecological model has previously been used to conceptualise the various potential influences on infant developmental and health behaviours by researchers in the respective fields of developmental psychology and health psychology. Indeed, previous research into influences on child dental health outcomes more generally has taken similar ecological approaches in conceptualising these influences (Fisher-Owens et al., 2007), although the authors of this work do not use the Bronfenbrenner model specifically.

Although alternative systems models exist, the Bronfenbrenner model appears to have the widest range of applications, with other models focussing on more specific aspects of child development. For example, within developmental psychology, the 'ecological model of maternal role development' (Rubin, 1984) is concerned with the multiple influences on caregiver's actual and perceived roles in childcare, and the 'ecological model of child growth' (Reifsnider, 1998) which examines specifically influences on child growth. It would appear then that these ecological models may

be concerned with too specific an aspect of human development to be useful in exploring influences on toothbrushing as a dyadic process with infants.

It would appear then that Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) may be most appropriate for exploring potential influences on the emergence of toothbrushing as a dyadic process through infancy. This is because it may be applied to a wide range of infant developmental outcomes, including dyadic toothbrushing with infants, but is specific enough to take into account the full range of influences in infancy, including more specifically those located at the level of the caregiver-infant dyad. However, since its development, Bronfenbrenner's ecological model has undergone some development (Bronfenbrenner, 2005), so care should perhaps be made when using the model to ensure to employ the most recent version of the model.

In this Chapter of the thesis the literature is reviewed to explore multiple possible sources of influences on the emergence of toothbrushing as a dyadic process in infancy, in dyads containing novice mothers and first-born infants. This chapter provides an introduction to Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), before exploring specific influences on the emergence of toothbrushing as a dyadic process in infancy, and where they might lie on the ecological model. Wider potential influences such as culture are discussed first, before exploring those potential influences located closer to the caregiver-infant dyad. These influences are discussed in relation to cultural

transmission of toothbrushing practices, social and health policy and community influences on toothbrushing and possible caregiver-infant dyadic influences on the emergence of toothbrushing as a dyadic process in infancy. All potential influences on toothbrushing as a dyadic process with infants are conceptualised using Bronfenbrenner's ecological model, which is now described and discussed.

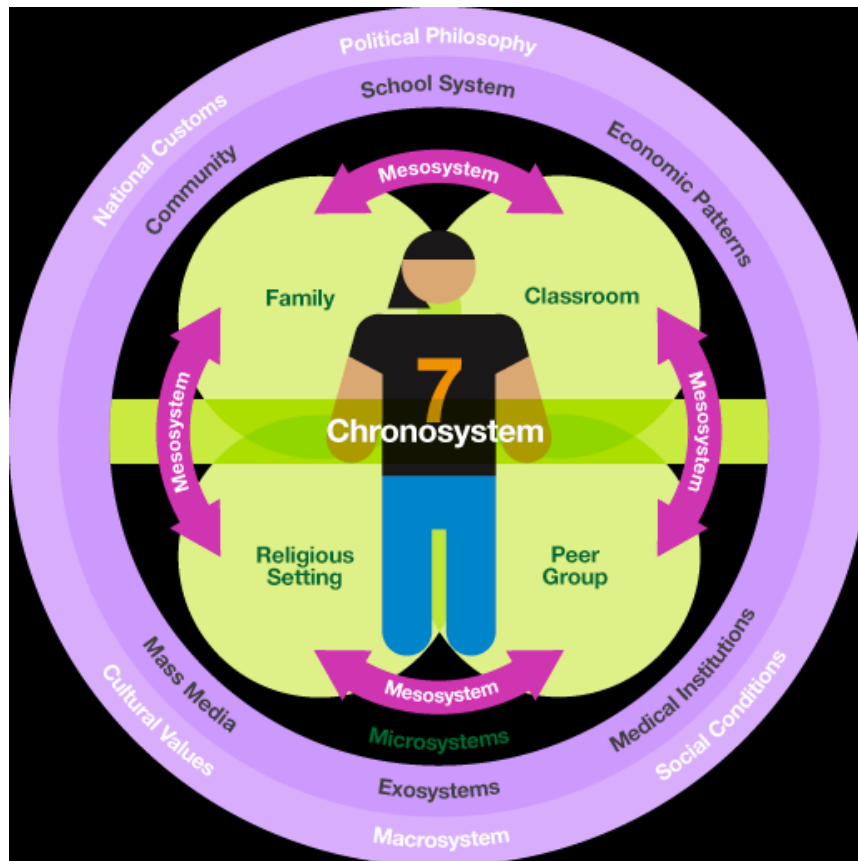
2.1.1 Using Bronfenbrenner's Ecological Model to Conceptualise Influences on Emergence of Toothbrushing as a Dyadic Process in Infancy

When attempting to understand multiple influences, at multiple levels, on the emergence of toothbrushing as a dyadic process in infancy, taking an ecological approach may aid conceptualisation of these influences. The term 'ecology' is borrowed from biological science and is used to describe the ways in which organisms interact with their natural environment (Krebs, 2008). Therefore, in behavioural sciences, ecological approaches seek to describe the ways in which *human* development and behaviour interact with environmental factors. These environmental factors are conceptualised as lying at various levels, with interactions occurring between the various levels of influence (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). These influences usually lie at the intrapersonal, interpersonal, organisational, community and public policy levels. Despite the focus on the influence of environment on human development and behaviour, modern ecological and systems approaches also emphasise the importance of the agency of the 'active person', and the role the developing person takes in shaping their environment (Bronfenbrenner, 2005).

Ecological models provide key frameworks that facilitate conceptualisation of multiple influences on human developmental outcomes within the field of developmental psychology. Arguably the most influential of the ecological models is Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Although alternative ecological or systems have been used within the discipline of health behaviour research (Grzywacz and Fuqua, 2000), many of these models do not allow close examination of developmental processes at the level of the individual. Wider systems models such as those employed in public health research are usually more appropriate for examining influences on the health behaviour of adults, usually at the whole population level (Green, 2006), and do not incorporate a caregiver-infant dyad as a level of explanation of influence. Therefore, when exploring influences on the emergence of toothbrushing as a dyadic process in infancy, Bronfenbrenner's ecological model is the most appropriate model, as this takes into account a dyadic level of influence, and is therefore appropriate for use in infancy research.

Although Bronfenbrenner's ecological model has undergone some changes over the years, the fundamental features of the model have remained relatively unchanged. The model identifies both the immediate proximal influences, and also the distant distal influences on child developmental outcomes, locating these within concentric, bi-directionally interacting levels. This means that influences lying at one level of the model may impact on and affect influences lying at other levels. At the core of the model is the notion that the individual interacts with the various levels of

environmental influences to create an inter-relational process of development. The ecological model, which is depicted below in Figure 2.1 illustrates the child as being at the centre of each of these spheres of influence (C4EO, 2011).



**Figure 2.1- Bronfenbrenner's ecological model of child development
(Bronfenbrenner, 1979b; Bronfenbrenner and Morris, 2006)**

The model takes into account the more distal influences on child developmental outcomes which are located within the wider 'exosystem' and encapsulate the influences relating to wider influences of society, community and availability of resources on individual development. The 'mesosystem' operates between the microsystem and exosystem and refers to the ways in which the influences of these two systems interact with one another. The 'macrosystem' refers to the yet more distal impact of the culture in which a child is embedded. The linear influence of time

on development is also represented by the model within the '*chronosystem*', and takes into account such influences as intergenerational transmission of parenting practices.

The ecological model contains within its centre the '*microsystem*', which contains within it more proximal influences on developmental outcomes. The microsystem corresponds to the immediate environment in which a child develops and incorporates in a wider sense, the local neighbourhood, family, religious and cultural affiliations and peer groups. In a more immediate sense, at the very centre of the microsystem is the home environment and influences lying at the level of the caregiver-infant dyad. These may include caregiver cognitions, especially self-efficacy, caregiver behaviours and also caregiver affect (e.g. Coleman and Karraker, 2003; Kuhn and Carter, 2006). Microsystem influences lying at the level of the child may include gender, sibship, birth order, neurodevelopment and behaviour (Gallagher, 2002).

Influences at the level at which the caregiver and child interact with one another to create the dyadic relationship, provide a dynamic context for development and learning. One key feature of the ecological model is that each of the levels described do not exert their influences on development in isolation from one another. Rather, the influences located on each level interact in a dynamic, synergistic manner with influences on other levels (Bronfenbrenner & Morris, 2006). For example, influences from wider society, which would lie at the level of the macrosystem, may potentially

impact on a caregiver's attitudes and behaviours to caring for their child, with these caregiver attitudes and behaviours lying at the level of the microsystem. Additionally, an influence may be conceptualised as lying at multiple levels, so for example, the influence on family may be located at the level of the immediate microsystem, or could be located at the wider level of the mesosystem. The interactions between the various levels of the model mean that one level cannot be examined in isolation from others. Therefore, in examining *microsystem* influences on toothbrushing as a dyadic process in infancy, how these microsystem influences may interact with influences that predominantly lie at wider levels of the model should be considered.

Although the ecological model has been influential within the developmental psychology field, it has been criticised on a number of grounds, and so before employing it in a line of enquiry, it may be expedient to give some consideration to the model's potential limitations. Bronfenbrenner added biological and genetic influences to the model in recent years (Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), which went some way to addressing criticisms that the model did not take these influences into account. Although this revision of the model was termed the 'bioecological' model (Bronfenbrenner and Morris, 2006) for the sake of brevity, throughout the thesis the 'ecological' model is referred to, as opposed to the bioecological model. Because the 'bioecological' version of the model was in a state of development until Uri Bronfenbrenner's death in 2005, it remains, to some extent, only partially complete.

Another criticism of the model, provided by Bronfenbrenner himself, is that it focuses too heavily on *context*; the external influences that impact on development, and does not pay enough credence to the *person* and the role they take in shaping their environmental context and therefore their own development. Additionally, because there have been so many versions of the model, usage of it by researchers may be inconsistent (Tudge et al., 2009). This means that it can sometimes be difficult to draw comparisons between findings from different studies that have been guided by the model if they have used different forms of it.

The following section discusses not only potential influences on toothbrushing as a dyadic process that lie specifically at the level of the caregiver-infant dyad within the microsystem, but also influences from wider levels of the model that may interact with the influences located within the dyad. Influences at levels of the ecological model that are more distal to the caregiver-infant dyad are discussed first, followed by those influences more proximal to the dyad and then influences located *within* the caregiver-infant dyad.

2.2 Conceptualising Potential Influences on the Emergence of Toothbrushing as a Dyadic Process in Infancy

When conceptualising influences on the emergence of toothbrushing as a dyadic process in infancy, it may be useful first to fully explicate what is meant by ‘emergence’, and additionally, precisely what aspects of development are of interest.

In this context emergence could refer to questions regarding when the routine may first start, what instruments or tools may be used during the enactment of toothbrushing, and the member of the caregiver-infant dyad who conducts the toothbrushing. Additionally, how the routine may change across the period of infancy, and how observed early dyadic toothbrushing routines compare with dental guidelines about toothbrushing routines may also be salient aspects of the behaviour to describe.

The specific aspects of emergence of toothbrushing as a dyadic process that are of interest within the empirical chapters of the thesis relate to those social-cognitive aspects of dyadic toothbrushing around dyadic social interactions around the use of the toothbrush and the cognitions underlying these, including caregiver cognitions. Additionally, some aspects of socio-emotional development may be of interest, including infant emotion and behaviour development. Therefore, exploring influences on the emergence of toothbrushing as a dyadic process in infancy entails examining how influences from the caregiver-infant dyad itself influences each of these key elements of the routine and how it develops.

Studies of influences on wider childhood dental health behaviours and outcomes have revealed *some* potential dyadic influences on toothbrushing such as caregiver attitudes and child behaviours (e.g. Adair et al., 2004; Huebner and Riedy, 2010) and these will be examined later in this chapter. However, much of the research has concentrated on wider influences lying at the levels of cultural, social and economic

influences (Fisher-Owens et al., 2007; Mouradian et al., 2007; Pine et al., 2004b). Therefore, more fine-grained, focussed exploration of those influences lying at the level of the caregiver-infant dyad is required in order to explain more fully these dyadic influences on the emergence of toothbrushing as a dyadic process in infancy.

Although some published studies have indirectly revealed information about dyadic influences on the routine, findings from the studies have mainly been associated with wider influences on toothbrushing routines. For example, the studies have explored wider ecological influences on dental health behaviours, such as media and social influences (Amin and Harrison, 2009), wider family issues (Huebner and Riedy, 2010), beliefs found in specific cultural groups (Nations et al., 2008; Riedy et al., 2001) and specific practices during tooth-cleaning, such as whether a toothbrush was used (Hoeft et al., 2009). As yet, no previous research has specifically aimed to examine *influences on the emergence of toothbrushing as a dyadic process in infancy*, and more specifically, in dyads containing *novice mothers and first-born infants*.

Exploration of a number of potential influences on the emergence of toothbrushing as a dyadic process in infancy, with reference to the literature, is now provided. The available research has examined cultural, socio-economic and health policy influences on childhood dental health outcomes. These spheres of influence are explored, as has been previously done in published reviews of ecological influences on children's dental health behaviours and status (Fisher-Owens et al., 2007).

Additionally, the scant literature on *dyadic* influences on child dental outcomes is also discussed. Although influences on child dental health outcomes are discussed by locating each on a corresponding level of the ecological model, some influences may be conceptualised as lying at more than one level of the model. Or, influences located on one level may interact with influences lying at other levels. Where relevant, such issues are also discussed in the following section.

2.2.1 Potential Influences from the Chronosystem on the Emergence of Toothbrushing as a Dyadic Process

Cultural practices, including child rearing practices, are perpetuated via intergenerational transmission across time (Conger et al., 2009). Although cultural practices may be located on the macrosystem and exosystem of the ecological model, the *transmission of such practices over time* could be conceived as being located on the chronosystem of the ecological model. This would indicate that at the widest level, the transmission of cultural traditions influence the nature of the dental health behaviours that develop within a caregiver-infant dyad, and the beliefs underpinning the enactment of such behaviours. How cultural traditions may influence the age at which toothbrushing as a dyadic process starts, what kind of tool is used to brush teeth, how many times a day it is conducted and the location toothbrushing takes place may be important in determining how the behaviour emerges as a routine across infancy. Indeed, research has revealed that cultural ideas about the relevance and importance of toothbrushing may be associated with

some of these features of the routine. Such cultural influences may be considered as lying at the level of the chronosystem of the ecological model.

2.2.2 Potential Influences from the Macrosystem on the Emergence of Toothbrushing as a Dyadic Process

Culture, or the shared beliefs and behaviours of a group of people living within a defined social context, provides guidelines for the most significant and meaningful aspects of life including birth, childrearing, aging and death (Sobo and Loustanaunau, 2010). When examining culture and health behaviours recent research has used the Damon (1987) definition of “culture [as the] learned and shared human patterns or models for living; day-to-day living patterns; these patterns and models pervade all aspects of human social interaction” (Damen, 1987, pg 367; cited in Rudell and Diefenbach, 2008, pg 388). This would indicate that across different cultural groups within society, there may be some differences in the ideas, customs and behaviours exhibited by specific cultural groups. Indeed, even with fairly universal behaviours, such as tooth-cleaning, there may be important cultural variations in the beliefs about the behaviour and the ways in which the behaviour should be enacted (Butani et al., 2008).

A published review of the literature (Butani et al., 2008) has suggested some of the ways in which cultural beliefs and values may contribute to *adult* dental health behaviours status and dental health status. This review revealed that within a total of 60 relevant published articles, data reported were mainly epidemiologic in nature

and described the identified dental health inequalities, rather than the dental health beliefs and behaviours of different cultural groups that might underpin these inequalities. However, the data on cultural differences in dental health beliefs and behaviours revealed a number of culturally specific practices. For example, Chinese populations were found to engage in more widespread preventive dental practices, such as using tooth-picks after meals, than other groups. African-American caregivers with fatalistic beliefs about childhood dental caries, i.e. that most children would develop caries at some point, were found to be less likely to brush their children's teeth than other groups. Additionally, it was found that in some Latino communities, elders of the community believe that the principal purpose of toothbrushing is to freshen the breath, rather than to prevent caries.

Although the Butani et al. (2008) review has revealed cultural differences in beliefs and behaviours around tooth-cleaning, the literature searched for the review did not relate to specifically *childhood dyadic toothbrushing*. The literature reported in the Butani et al. review related primarily to adult toothbrushing behaviours. However, as the authors report, there is a paucity in the literature of good quality research on specific cultural beliefs and behaviours around dental health more generally (Butani et al., 2008, pg 11).

At the most basic level, cultural variations have been found in how common daily toothbrushing with infants and preschoolers is, with several studies using parental self-report of toothbrushing frequency finding cultural variations. For example, 25%

of Brazilian 12-month olds have been found to have their teeth brushed each day (Dini et al., 2000), whereas the estimate for 6 – 36 months olds living in the United States (US) is around 63% (Douglass et al., 2001). Further work in the US has revealed that around 78% of Mexican-American mothers engage in daily toothbrushing with their child. The UK has some of the highest rates of daily toothbrushing in the world, with 90% of 12-month olds having their teeth brushed every day (Habibian et al., 2002). One key criticism of studies that rely on caregiver self-report however, is that it can be unreliable, and indeed the two dyadic toothbrushing observational studies already discussed (Martins et al., 2011; Zeedyk et al., 2005) have found that parents can tend to inflate reports around frequency.

The age at which toothbrushing routines should be first established has also been found to vary according to caregiver cultural group. For example, a focus group study with 41 mothers of children aged between 3 months – 20 years on the island of Saipan, USA, found that most mothers established toothbrushing routines with their child when they were 2 – 3 years old (Riedy et al., 2001). This is in contrast to findings from an interview study conducted with 45 Caucasian-American caregivers of children aged between 3 – 5 years in Washington State (Huebner and Riedy, 2010). This interview study found that 85% of caregivers interviewed reported having established toothbrushing routines with their child by their first birthday. Though how reliable this self-report data is, is unknown, as caregivers may have wanted to portray a socially desirable image of themselves by demonstrating they were following the USA dental guidelines around infant toothbrushing (AAP, 2007).

It is not only enacted dental health *behaviours*, such as toothbrushing behaviours, that may vary from culture to culture. There may also be significant variations in dental health *beliefs* that may underlie these behaviours. Explanatory models have identified that cultural beliefs and behaviours may be associated with dental health outcomes (Pine et al., 2004b). For example, in the focus group study referred to above (Riedy et al., 2001), it was found that mothers in Saipan placed very low value on 'baby' teeth, or 'primary' teeth, and did not think it important to protect or repair decayed primary teeth. This is in contrast to an anthropological study of 27 low-income mothers residing in Northeast Brazil (Nations et al., 2008), of malnourished children age 2 – 72 months old. Ethnographic interviews found that these Brazilian mothers placed a very high value on primary teeth, and regularly inspected their child's teeth for signs of caries, seeking help from folk healers and conventional dentists when caries was present.

Within this culture, 'tooth worms' are believed to cause dental caries in primary teeth, with the 'worm' not only passing caries from one tooth to another, but also passing into the gut where it lies in wait to pass caries onto the permanent teeth. This folk theory relating to the importance of primary teeth health to permanent teeth health motivates these mothers to value their child's primary teeth. It is these kinds of variations in beliefs about dental health issues in infancy that could contribute to cultural variations in early dental health behaviours, such as toothbrushing behaviours.

Other international work has been identified as exploring cultural variations in caregiver attitudes and beliefs around dyadic dental health behaviours, and also in caregiver self-reports of the nature of dyadic dental health behaviours (Adair et al., 2004). A survey was carried out with 2822 caregivers of children aged 3 – 4 years from the UK, Europe, China, Africa, Asia and both North and South America, using a standardised psychometric measure of caregiver attitudes and beliefs towards dyadic toothbrushing varied according to country of residence and ethnicity.

Within the psychometric measure, caregiver attitudinal items relating to two dental health behaviours were developed from a number of health behaviour theories, including the Theory of Planned Behaviour (Ajzen, 1991), Health Belief Model (Rosenstock et al., 1988) and the Health Locus of Control (Wallston et al., 1978) model. Standard psychometric measure standardisation techniques from psychological research (Frazer and Lawley, 2000) were used to assess which items should be included in the measure in order for it to be valid and reliable. Total item means, standard deviations and item-total correlations were used to establish internal reliability of items and also the measure as a whole. Items that were found to have low internal reliability were excluded and Cronbach's alpha coefficients were used to test internal reliability. Additionally, exploratory factor analyses (EFA) using the Principal Components method and varimax rotation were used to establish underlying factors within the measure.

Once the measure had been standardised, it was used to explore cultural differences in attitudes and beliefs about child dental health. Scandinavian caregivers believed it was important to preserve their child's dental health, whereas caregivers in China had a more neutral attitude. Additionally, even caregivers residing in the same country had different attitudes towards toothbrushing depending on their ethnicity. For example, Mexican-American caregivers also believed in the importance of toothbrushing for their child's dental health, but were less likely to believe in their ability to implement this behaviour than African-American or white-American caregivers.

This belief in ability to establish toothbrushing routines relates to parental self-efficacy (PSE) to carry out this child-care task. Indeed, as Adair et al. (2004) developed the psychometric measure used for the survey, they included a number of items that specifically measured PSE for enacting dyadic dental health behaviours. In their study Adair et al. found that PSE was the strongest predictor for whether caregivers were engaging in dyadic toothbrushing routines with their child. Throughout the thesis empirical chapters, the association of PSE with dyadic toothbrushing behaviours and means of measuring PSE for dyadic toothbrushing are explored using both qualitative and quantitative methods.

One of the key limitations that were reported by Adair et al. (2004) in relation to their study was the fact that they relied solely on self-report data. They indicate in their discussion of the study that self-reports may be subject to socially desirable

answers from participants, which may impact quite significantly on study findings. However, the authors collected, in addition to the self-report data already discussed, objective proxy measures of dental health behaviours i.e. dental data on each child, including their caries status. This provides an indirect measure of enacted behaviours, although the term 'indirect' is important in assessing the reliability of using such a proxy measure of behaviour. More direct assessment of behaviour using an observational methodology may provide more robust data regarding enacted behaviours. Indeed, observational studies of dyadic toothbrushing have indicated that caregiver self-reports of this important dental health behaviour can be unreliable (Martins et al., 2011; Zeedyk et al., 2005). Therefore, within the thesis empirical chapters, associations between psychometrically measured PSE and observed dyadic toothbrushing behaviours are explored.

The international work cited so far in this section provides insights into differences in dental health beliefs and practices around the world. However, recent work has revealed that even within the UK population, there may be some distinct differences amongst cultural groups living within close proximity of one another. Interviews and focus groups conducted with 33 Orthodox Jewish mothers living in Hackney, East London, revealed that they saw little worth in toothbrushing as a caries preventive behaviour (Scambler et al., 2010). These mothers believed that dental health was primarily genetic and that dental health behaviours had little impact on how healthy their child's teeth would be. They also reported that they did not believe that it was important to preserve the health of the primary teeth as they would be replaced by

the adult teeth, and did not understand the importance of the health of the primary teeth to the health of the adult teeth.

Many Orthodox Jewish families are larger than British families, and mothers in this study were found to have between one and nine children. Therefore, many of the mothers reported that due to family size, it was difficult to coordinate all child care duties, and that often tasks like toothbrushing, which were seen as secondary child care tasks, were delegated to older siblings. This raises questions as to how effectively the teeth of younger siblings were being brushed if it was tasked to their older siblings to ensure they carried out this hygiene behaviour. This lack of understanding of the important role caregivers need to take in their child's dental health may be evidenced further by mother's opinion that schools should instil toothbrushing routines in children, rather than caregivers. Scambler et al. (2010) interpreted their findings as Orthodox mothers having low self-efficacy, or confidence, in their abilities to establish effective toothbrushing routines and then maintain them with their young children.

For Orthodox Jewish families, their beliefs are very much embedded within a set of traditions that is provided by their religious observances, and their community provides a framework for all aspects of life. Evidently the mothers interviewed held distinct beliefs about their child's dental health, which may have been inter-generationally transmitted through their membership of their close cultural group. However, the authors do not provide specific data that explains *how* the religious

and cultural beliefs of these mothers resulted in their beliefs around their children's dental health. What Scambler et al. (2010) do demonstrate however, is that a distinct cultural group, although residing in a very culturally diverse area, have specific beliefs and behaviours around toothbrushing.

What the authors do not explore however, are the dental health beliefs and behaviours of other cultural groups living in Hackney. Hackney is culturally diverse, and also the second most socially deprived borough in the UK (Jack, 2011). Additionally, clear links have been found between social deprivation and poor dental health (Marmot and Bell, 2011). Therefore it could be argued that the lack of understanding of the importance of toothbrushing reported by the mothers interviewed was due to the fact they lived in a socially deprived environment, rather than specifically because of their cultural group.

In addition to cultural practices, another potentially important macrosystem influence on dental health behaviours and outcomes may be social deprivation. Social deprivation has been suggested to be a key determinant in dental health (Marmot and Bell, 2011), with global social inequalities in dental health being a priority on the international public health research agenda (Pitts et al., 2011). It is known that social and economic influences, in addition to culture, may influence dental health behaviours, and perhaps the emergence of dental health behaviours, such as toothbrushing routines, in the early years. Such socio-economic influences can be located on the macrosystem of the ecological model, and may be associated

with how often dyadic toothbrushing is conducted each day and the age at which dyadic toothbrushing is first established in infancy, for example.

There is a growing body of work that has investigated the associations between socio-economic status (SES) and dental health beliefs, behaviours and status (Fisher-Owens et al., 2007; Petersen et al., 2005; Pine et al., 2004b; Sisson, 2007). Caregivers of lower educational and income levels have been found to both report lower frequency of toothbrushing with their child than their higher SES counterparts (Maes et al., 2006) and also have children with higher rates of dental caries (Finlayson et al., 2007b). The potential reasons for the association between SES and toothbrushing behaviours relate to the psychosocial stress experienced by families living in more socially deprived environments, and the effect this may have on PSE and parenting skills (Adair et al., 2004; Finlayson et al., 2007b; Finlayson et al., 2007c).

The main limitation with the research that has already been conducted within the field is that although influences on toothbrushing have been identified, these influences predominately relate to toothbrushing practices in later childhood, rather than from their emergence in infancy. There are virtually no data in the literature that have identified significant influences on the emergence of toothbrushing as a dyadic process in infancy, and specifically in dyads containing novice mothers and first-born infants. Additionally, many of the studies that have assessed the associations between SES and toothbrushing behaviours have relied on caregiver self-reports of toothbrushing behaviours, which have been found to be unreliable

(Martins et al., 2011; Zeedyk et al., 2005). Although some studies have reported caries data, through assessing the number of *decayed, missing and filled teeth* (DMFT) as a means of assessing the effect of SES on toothbrushing, this provides only a proxy measure of toothbrushing behaviours.

2.2.3 Potential Influences from the Exosystem on the Emergence of Toothbrushing as a Dyadic Process

In addition to culturally specific advice transmitted through generations of individuals living in the same cultural groups, national and international guidelines also provide caregivers with recommendations about how they could best care for their child's dental health through effective toothbrushing. These guidelines can be located on the exosystem of the ecological model and may be associated with the age at which dyadic toothbrushing routines are first established in infancy and then maintained as they emerge through infancy. For example, these guidelines may be associated with how often each day it is conducted and whether the caregiver or infant conducts the toothbrushing. The guidelines provide recommendations on each of these features of the routine and come from organisations that may be directly associated with higher level government, such as the National Health Service (NHS), which states;

“Start brushing your baby's teeth as soon as they begin to appear”.

(NHS, 2009)

As the quote above illustrates, these guidelines may outline to caregivers how early toothbrushing routines should best be established in infancy, so might, if caregivers adhere to these guidelines, provide some insight into how early toothbrushing routines may emerge. The British Dental Association (BDA), which does not have direct links with the government, but is the professional association and trade union for dentists, echoes the NHS recommendations above;

“Good dental health from an early age will set your child up for life. As soon as the teeth start to come through, you should start brushing them.” (BDA, 2010)

Internationally, advice from other organisations such as the American Academy of Pediatric Dentistry (AAPD), demonstrate that guidelines for dyadic toothbrushing routines in infancy are consistent;

“Daily dental cleaning should start as soon as your infant's first tooth appears. Wipe the teeth with a piece of gauze or a damp cloth. Switch to a toothbrush with a fluoride toothpaste as your child gets older.” (AAP, 2007)

These organisations also recommended that caregivers should brush their infant's teeth at least once a day, preferably twice, (AAP, 2007; NHS, 2009) and that this be done for a period of at least 2-minutes (NHS, 2009). However, a firm evidence-base

for the precise length of time that an infant's teeth should be brushed does not really exist, with the 2-minute rule coming from the adult dental health guidelines.

A recent review of guidelines on infant and child dental care was conducted (Dos Santos et al., 2011), which compared infant and child dental care guidelines from countries that generate significant scientific output in terms of academic publications. National dental health organisations from the UK, United States of America (USA), Canada, Denmark, Finland, Norway, Sweden, Australia, Japan and Brazil were contacted by a Brazilian research group in order to obtain materials developed by each organisation that advised on infant and child dental care. Additionally, the guidelines published on the websites of each of these organisations were obtained for analyses.

In total, 25 organisations from 10 countries were included in the analyses. When guidelines from these organisations were compared it was found that there were some differences in the guidelines from country to country, with many of these differences relating to toothbrushing guidelines. Although all organisations agreed that supervised toothbrushing throughout infancy and childhood was important, there were variations in the guidelines in terms of frequency of toothbrushing per day and at what age dyadic brushing should start. Additionally, there were variations in the guidance in terms of the length of time dyadic brushing should be conducted for, and the age up to which children need to be supervised during toothbrushing by an adult.

In terms of age at which brushing should start, around half of organisations recommended that this should be the time of the eruption of the first primary dentition between 8 – 12 months (American Dental Association, 2005) (52%), with the remaining either not providing guidance on this (16%) or stating that brushing should start between the age of the first primary molar between 13 – 19 months (American Dental Association, 2005) and 24-months (32%). With regards to the frequency of toothbrushing, only just over half of the organisations (56%) recommended twice-daily brushing, with the remainder either not mentioning frequency of brushing in their materials (28%) or recommending that one-daily brushing was sufficient (16%).

There was least guidance was the length of time that toothbrushing should last for, with the vast majority of the 25 organisations included in the study (84%) not providing any advice about this. In terms of the age at which children needed to be supervised during toothbrushing, there was virtually no agreement between the organisations, with recommendations ranging from 2-years to 12-years, and other organisations stating that supervision should continue until children are skilled in brushing. Age related comparisons in advice were not conducted in the study.

The lack of standardisation of the guidelines found in the Dos Santos et al. (2011) study mean that caregivers in different parts of the world may be establishing toothbrushing as a dyadic process with infants in different ways, which may result in variations in how the behaviour emerges as a routine in different cultures. This issue

could be considered to be a chronosystem cultural issue in addition to an exosystem health policy issue. However, one of the limitations on the Dos Santos study is that the authors did not provide specific information about the guidance provided from each of the 25 organisations. It was therefore difficult to see whether there was at least some consistency within each country, and therefore simply differences between countries, or whether there was also inconsistency between organisations from the same country. Therefore, how far the inconsistencies in the guidelines identified by Dos Santos et al. might contribute to differences in child dental health outcomes between the countries included in the study is unknown, so replication of the Dos Santos study would be necessary.

The most significant difficulties that Dos Santos et al. highlighted however, was the lack of clear guidance around the length of time dyadic toothbrushing should be conducted for and also the age at which adult supervision during toothbrushing can stop. The best-practice guidelines available in the UK are built on the assumption that children under the age of seven-years need to be “supervised” during toothbrushing by an adult (BDHF, 2010; NHS, 2009). However, there is some inconsistency in the guidelines as to what “supervision” of a child’s toothbrushing should be. The clearest recommendations come from the NHS, which states that caregivers should watch their child brushing their teeth, and help them to brush their teeth properly, until the age of seven-years.

In the guidance from other bodies such as the British Dental Health Foundation (BDHF, 2010a), it is unclear whether it is sufficient for a caregiver to be present when their child brushes their teeth, or whether they should take a more active role. A more active role may involve demonstrating to a child how to brush their teeth properly, or may involve a caregiver checking their child has brushed their teeth properly. There is also a lack of guidance about how caregivers should make the transition from brushing their infant's teeth for them to allowing them to brush their own teeth. The lack of evidence-base around the emergence of dyadic toothbrushing as a routine through childhood, and at what age children have the abilities to effectively clean their own teeth, may explain in part the lack of clarity in the guidelines.

The only indirect evidence reported in the literature comes from three systematic reviews of the effectiveness of fluoride toothpaste in preventing caries in children (Marinho et al., 2003; Twetman et al., 2003). The main aim of each of these reviews was to assess how effectively fluoride toothpaste prevents caries in children of various ages. A second aim of these reviews was to assess whether differences in caries-preventive effectiveness might be associated with whether child toothbrushing was supervised or unsupervised by an adult. Although meta-analyses from these reviews found that adult supervision does increase the caries-preventive effectiveness of fluoride toothpaste, both included studies that resulted in very wide age ranges of children and no analyses using age as a factor were included.

For example, in the Twetman et al. (2003) review of 54 outcome studies, the ages of children included in the studies in the review ranged from 1-year to 14-years. As Twetman et al. included all 54 studies in the meta-analysis it is difficult to understand from the review how adult supervision may impact on caries-preventive effectiveness of fluoride toothpaste as a function of child age. Additionally, in the Marinho et al. (2003) review, similar findings were generated from their meta-analyses of 70 clinical outcome studies, with caries-preventive effectiveness being associated with adult supervision of toothbrushing. The age range of children in the Marinho et al. review was also wide, from 5-years to 16-years, so similarly it is difficult to comment on how child age may be associated with effectiveness of fluoride toothpaste.

It is interesting however that 49 of the 70 (70%) studies Marinho et al. included in their review included children aged 12-years at baseline. This would suggest that even when a sample of children is predominantly 12-years old or over, adult supervision during toothbrushing increases the effectiveness of fluoride toothpaste in preventing dental caries. This is a total of 5-years older than the seven-years of age recommended as being appropriate an age for children being able to brush unsupervised (NHS, 2009). Before children are approximately seven-years old they may not have the manual dexterity to be able to brush the lingual (tongue-side) surfaces of their teeth (Livny et al., 2008), which is one of the reasons why adult supervision is recommended until this age.

The findings from these two systematic reviews (Marinho et al., 2003; Twetman et al., 2003) are in contrast to research which has demonstrated that at the age of 2.5 year, many children may be engaging in autonomous self-toothbrushing with little caregiver supervision (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). However, as yet no focused research has attempted to identify the age at which infant's first start to exhibit this behaviour, nor has any research been published to identify the age at which children have the necessary fine motor skills to be able to brush their teeth effectively. This issue is explored in detail within the thesis empirical chapters through using an observational methodology to cross-sectionally compare different age groups of infants.

2.3 Potential Influences from the Microsystem on the Emergence of Toothbrushing as a Dyadic Process- The Caregiver-Infant Dyad

So far, the influences on the emergence of toothbrushing as a dyadic process through infancy that have been discussed and located on the ecological model, are more distal than proximal to the caregiver-infant dyad (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). However, microsystem influences, and particularly *dyadic* influences located within the microsystem, have been suggested to be some of the most important influences on development, especially during the early years of life (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). These dyadic influences may be most

important in explaining why many young children may be engaging in autonomous self-toothbrushing at a younger age than the dental guidelines recommend (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). Therefore, a detailed exploration and discussion of potential dyadic influences located at the level of the microsystem is now provided.

The microsystem is a dynamic system composed of influences from the immediate home environment, with possibly the most influential of these to developmental outcomes being located at the level of the caregiver-infant dyad (Crockenberg and Leerkes, 2004; Rosenblum et al., 2002). These caregiver and infant influences are implicated in the features of the dyadic relationship and the nature of the social interactions between an infant and their caregiver. These dyadic microsystem influences may be examined in relation to how they may be perceived by caregivers as barriers or facilitators of the emergence of toothbrushing as a dyadic process through infancy. Effective dyadic toothbrushing routines in infancy may be conceptualised as conforming to the dental guidelines outlined in the previous section, that is, being conducted primarily by the caregiver, and being conducted for an appropriate length of time (NHS, 2009).

What would appear to be the key feature of the microsystem that may make it so important to human development, especially in the early years of life, is that it contains within it some of the most important human dyadic systems related to human *relationships*. In infancy the most important of these would be the infant-

principal-caregiver dyad, as infants are primarily dependent on the principal caregiver, usually the mother, to provide all their care needs. In a wider sense, the family system incorporates the co-caregivers, siblings and extended family members with whom the infant comes into regular contact with, may also provide some important influences on development.

More specifically, in the Bronfenbrenner definition of the microsystem, he proposes that it is the subjective *experience* of the microsystem environment that results in it being a powerful source of influence during the process of development, rather than concrete, objective properties such as structures within the location and setting. How an individual *perceives* their environment and the relationships they have within it, and the resulting motivations and affective and behavioural responses that result from an individual's perceptions, are, Bronfenbrenner hypothesises, central to the microsystem (Bronfenbrenner, 1979b). The microsystem represents those influences on the developing person that lie within their immediate environment, which during infancy and early childhood would likely be the family home. Bronfenbrenner defines a microsystem as;

“A microsystem is a pattern of activities, roles and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics.”

(Bronfenbrenner, 1979b pg 22)

An individual caregiver's level of experience in child-rearing may also play a role in how the behaviour emerges as a routine, with novice, first-time caregivers perhaps having less experience of establishing and maintaining dyadic toothbrushing routines with infants than caregivers who have more than one child. Additionally, other caregiver influences on the emergence of the behaviour as a routine may include caregiver cognitions, behaviours and affective state. Infant influences on the emergence of the behaviour as a routine may include their age, dental development, gender, and level of development, including gross motor skills such as crawling and walking and also fine motor skills, such as object manipulation. Some of these multiple sources of potential microsystem influences on the emergence of toothbrushing as a dyadic process through infancy are summarised in Figure 2.2 and are explored in more detail in this section.

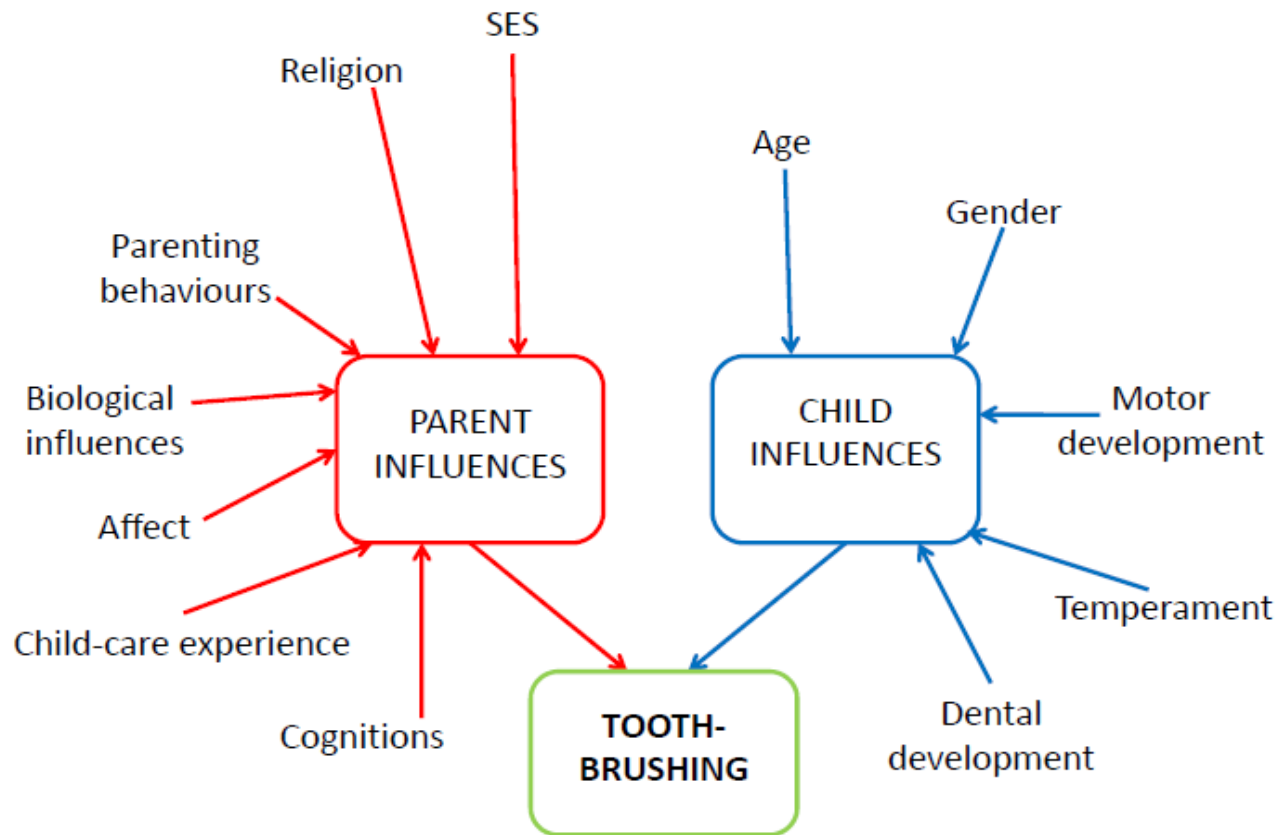


Figure 2.2- Dyadic influences on early toothbrushing routines

There is a growing body of literature around the role some microsystem influences may play on the emergence of toothbrushing as a dyadic process through infancy. For example, infant behaviour (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006), and caregiver cognitions such as parental self-efficacy (PSE) (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010) have been associated with dyadic toothbrushing.

As previously outlined, the available dental guidelines recommend that caregivers should be in control of the toothbrush during dyadic toothbrushing up to the age of seven-years (NHS, 2009). However, the available literature indicates that for caregivers, being in control of the toothbrush during dyadic toothbrushing may be a more difficult parenting task than it may at first seem. Infant behavioural difficulties, such as non-compliance and dislike of toothbrushing may act as significant barriers to the routine being enforced (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006). Therefore infant behaviours, and the parenting practices used to try to overcome difficult infant behaviours, may influence how effectively the behaviour emerges as a routine and how well it is established and maintained. Underpinning these parenting practices may be a range of cognitions, and indeed there is evidence in the literature that cognitions such as PSE may be associated with how successfully caregivers establish and maintain toothbrushing as a routine with

their child (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010).

Although this previous work has explored how infant behaviour and caregiver cognitions may influence dyadic toothbrushing routines, it has not specifically explored how these may act as influences on the emergence of toothbrushing as a dyadic process through *infancy*. Additionally, no previous work has focussed on dyads containing specifically novice mothers and first-born infants. All the research conducted so far, has included children over the age of 2-years, at which point toothbrushing routines should have been established and maintained for some time.

Despite the limitations to the sparse available literature regarding microsystem influences on dyadic toothbrushing routines, the findings from this research would indicate that the microsystem may provide a useful environment from which to elucidate possible influences on the emergence of toothbrushing as a dyadic process in infancy. This toothbrushing research may also be supported by the general developmental psychology literature that has explored microsystem influences on a range of child developmental outcomes.

Before the following discussion of potential dyadic influences located at the level of the microsystem on early toothbrushing routines, a number of caveats should be provided. Although located within the microsystem there are many important influences on developmental outcomes, not all influences may be located within the

microsystem. Indeed Bronfenbrenner himself noted that although the interpersonal processes that take place within the microsystem are important, they are not the only influences on development.

Microsystem influences may have interactions with wider influences that could be conceptualised as lying at wider levels of the ecological model, including family influences such as socio-demographic and religious status of caregivers. Therefore social processes of reinforcement, modelling and social learning that occur within the microsystem paint only half a picture. The influences of non-social processes and processes outside of the immediate microsystem environment are also important to developmental outcomes (Bronfenbrenner, 1979 pg 18). Bronfenbrenner also noted that investigation into influences from the wider ecological environment often lie within the purviews of disciplines such as anthropology and sociology. However, as this is a developmental psychology thesis, microsystem influences that lie within the immediate home environment, and the caregiver-infant dyad more specifically, are more appropriate area of investigation for the scope of the discipline underpinning the thesis.

Additionally, a limitation of much of the research that has explored microsystem *influences on the emergence of toothbrushing as a dyadic process through infancy specifically*, is that they have in the main relied on caregiver self-report of home toothbrushing behaviours (Adair et al., 2004; Finlayson et al., 2005; Finlayson et al., 2007b). However, as already stated in several parts of this literature review,

observational studies of dyadic toothbrushing episodes have found that caregiver self-reports can often be unreliable. Studies have found that caregivers may report dyadic toothbrushing as being conducted for longer than observed, and also being conducted by the caregiver rather than the child more frequently than the observational data would indicate (Martins et al., 2011; Zeedyk et al., 2005).

Irrespective of the limitations to the existing research, to examine potential microsystem influences from the caregiver-infant dyad toothbrushing could potentially be important in understanding the emergence of the behaviour as a dyadic process. Therefore, these dyadic influences are explored and described throughout the thesis empirical chapters through the use of qualitative interview and observational methods and additionally through the development of a psychometric measure. Potential influences on toothbrushing as a dyadic process that lie at the level of the caregiver are now discussed, followed by potential influences that lie at the level of the infant.

2.4 Potential Caregiver Influences on the Emergence of Toothbrushing as a Dyadic Process through Infancy

Although there are a number of potential infant influences that may be associated with emergence of toothbrushing as a dyadic process in infancy, the extent to which these infant influences may exert their effect may be moderated by a number of important caregiver influences. How successfully caregivers might establish dyadic

toothbrushing in the face of challenges from an infant, may rely on caregiver behaviours and the cognitions underlying those behaviours. A number of influences may underpin caregiver behaviours during the emergence of dyadic toothbrushing specifically. Indeed, caregiver behaviours (e.g. Gardner and Klimes, 2006) and caregiver affective responses (e.g. Gerdes et al., 2007) have been suggested to be associated with a range of infant developmental outcomes more generally, so how these influences may be associated with the emergence of dyadic toothbrushing routines is discussed in this section. Other caregiver influences have been suggested to be associated with the emergence of dyadic toothbrushing routines more specifically, such as caregiver knowledge about the importance of establishing and maintaining dyadic toothbrushing routines with infants (e.g. Akpabio et al., 2008).

In addition to caregiver behaviour, affective responses and knowledge, caregiver cognitions such as self-efficacy have been suggested to be particularly associated with success in general parenting (Coleman and Karraker, 2000; Coleman and Karraker, 2003) and also success in establishing and maintaining dyadic toothbrushing routines (e.g. Adair et al., 2004; Huebner and Riedy, 2010). The cognition of PSE is derived from research around the cognition of general self-efficacy, first proposed by Albert Bandura in his 'social learning' (Bandura, 1977b) and then 'social cognitive' (Bandura, 1986, 2001) theories. General self-efficacy, and specifically PSE are key cognition underpinning success in many areas of functioning (Bandura and Locke, 2003). In this section, firstly social learning and cognitive theories are discussed, followed by the literature around general self-efficacy. Then

PSE is discussed in relation to how it may influence on the emergence of toothbrushing as a dyadic process in infancy, followed by the additional potential caregiver level influences briefly referred to in this introduction to this section.

2.4.1 Bandura's Social Learning and Social Cognitive Theories

In the previous section, the use of ecological and systems approaches such as Bronfenbrenner's ecological model (Bronfenbrenner, 1979a, 2005; Bronfenbrenner and Morris, 2006) in relation to examining influences on child developmental outcomes was discussed. However, the Bronfenbrenner model is useful in conceptualising multiple influences, it is less of a *theory* and more of an *approach* that may help in the conceptualisation of the development and emergence of behaviours. It does not provide a structured account of the various influences on development, with indications as to how these influences may interact with one another. Therefore, Bronfenbrenner's ecological model does not necessarily allow specific predictions to be made about the various influences on development and cannot therefore be termed a 'theory'.

However, Social Learning Theory (SLT) (Bandura, 1977b) and Social Cognitive Theory (SCT) (Bandura, 1986, 2004) are two associated theories that are informed by ecological and systems approaches, but are more structured and may be more testable. These theories may therefore also provide useful frameworks for understanding the development and emergence of dyadic tooth-brush holding and use in tooth-brushing routines from infancy to toddlerhood. These theories may also

allow predictions to be made as to how the various potential barriers and facilitators on the development and emergence of dyadic tooth-brush holding and use in tooth-brushing routines may influence how far parents can ensure these routines are aligned with dental expert guidelines.

SLT has been influential within child developmental research and SCT has been a key theory used to understand the various influences on health behaviours. Central to these theories is the cognition of self-efficacy, and in the case of the development of *child* health behaviours, PSE. A number of studies (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Huebner and Riedy, 2010) have also identified PSE as also being implicated in the development and emergence of child dental health routines, such as tooth-brushing routines.

The later SCT (Bandura, 1986, 2001) evolved from general SLT (Bandura, 1977b) and has been used within the context of child developmental and health behaviour research. It is composed of a number of components that have causal effects on one another that take into account human motivation, action and well-being. It allows predictions about health behaviour change to be made and also provides guidance on specific cognitive and behavioural change techniques that can be used in intervention design, with discrete cognitive targets for change also outlined. The basic tenet of the theory is that human beings are in a constant state of 'triadic reciprocal determinism' with their environment and behaviour; i) personal factors

associated with an individual (cognitive, affective and biological events) interact with
ii) the environment the individual is in and iii) the individual's behaviour.

The theory takes into account the possible barriers to and facilitators of behaviour change and how these barriers and facilitators can be manipulated and altered to increase (or decrease) the chances of health behaviour change from occurring. This means that when an individual expects to achieve behaviour change successfully (have positive outcome expectations), has few external barriers that may prevent them from changing their behaviour (and a number of facilitators of behaviour change) they are more likely to succeed in making positive changes to their behaviours. And as previously stated, central to SLT and SCT is self-efficacy, which has been identified as a key cognition that is relevant to both child developmental (Bandura, 1977b) and health behaviour outcomes (Bandura, 1977a, 2004). General self-efficacy and PSE are now both discussed.

2.4.2 An Introduction to Self-Efficacy

'Self-efficacy' is defined as an individual's belief that they have the 'capabilities to organise and execute the courses of action required to produce given attainments' (Bandura, 1997, pg 2). Consequently, as already noted, '*parental* self-efficacy' (PSE) has been found to be an important predictor of a caregiver's ability to fulfil the role of being an effective caregiver (Coleman and Karraker, 2003). Therefore, a caregiver that has good self-efficacy has confidence in their ability to cope with their role as a caregiver, and therefore may be more likely to cope with the demands of child

rearing tasks. The role of self-efficacy, and PSE specifically, has also been suggested to be implicated in establishing effective dyadic toothbrushing routines (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010).

Three main levels of self-efficacy have been postulated (Bandura, 1997). 'General' self-efficacy related to global levels of self-efficacy transferable to a number of different domains and tasks, 'domain-specific' self-efficacy related to one particular domain of functioning (e.g. general child-care) and 'task-specific' self-efficacy related to functioning on any particular task (e.g. brushing a child's teeth).

Numerous studies have identified self-efficacy as a key caregiver cognition that may mediate the effects of a number of caregiver, child and environmental variables (Coleman and Karraker, 2003; Jones and Prinz, 2005; Teti and Gelfand, 1991). When caregivers experience difficulties, self-efficacious beliefs may act as a protective factor enabling them to cope with the task of raising their child (Jones and Prinz, 2005). Conversely, some studies have found that influences such as caregiver stress and child behavioural difficulties may have a deleterious effect on PSE (Bornstein et al., 2003). Consequently, it has been suggested that PSE may act as a useful indicator of caregivers who may be at risk of requiring additional support in their parenting role (Barnes and Adamson-Macedo, 2007). Self-efficacy has also been suggested to be a useful outcome variable when assessing the effectiveness of early intervention programmes (Kendall and Bloomfield, 2005; Rutter, 2006).

Self-efficacy is not a static entity but dynamic, and may be altered over time by behavioural, cognitive, affective, biological and environmental events (Bandura, 1997). For example, a study of European American caregiver's found that their level of self-efficacy increased when they experienced success at parenting tasks or received verbal support of their abilities from others (Bornstein et al., 2007). Research literature that reports on the developmental trajectories of PSE is scant, although most recent data indicates that caregiver self-efficacy may remain relatively stable when children are between the ages of 4.5 - 28.5 months (Pierce et al., 2010). However, other studies have suggested that PSE significantly increases as an infant's age increases from one - two years of age but then remains stable between two - three years of age (Gross et al., 1994).

This may mean that when infants are between the ages of one and two years, caregivers may cope well with each of the tasks associated with caring for their child due in part to their naturally increasing levels of self-efficacy (in addition to experiencing increased mastery of infant care tasks). However, when their child is between the ages of 2 and 3 years, caregivers may begin to find coping with child care tasks more difficult due in part to their perceptions of their PSE reaching a plateau (Gross et al., 1994) (in addition to other factors such as increasingly difficult child behaviours following infancy). Additionally, a more recent study has found that PSE continues to increase between 2 to 4 years of age, but only in the absence of caregiver depression (Weaver et al., 2008).

Although the construct of PSE has provided some crucial insights into caregiver behaviour and motivation, it does appear to have its limitations. Firstly, the notion that PSE is highly implicated in developmental outcomes is primarily cognitive-behavioural in nature, and does not refer sufficiently to developmental processes. For example, a caregiver may have experienced profoundly traumatic events in childhood or adolescence, which have contributed to her developing feelings of inadequacy and limited self-efficacy. The classic model of PSE does not take into account how this kind of developmental process may contribute to low levels of PSE, or suggest ways in which such (understandably) low levels of PSE may be improved.

In addition to being unable to fully take into account complex *past histories* that may contribute to low levels of PSE, the theory also does not fully appreciate the detrimental effect that particularly challenging *present* circumstances might have on PSE (and any attempts to improve PSE). While Bandura does acknowledge that adversity can have an important role to play in the development of feelings of futility (low PSE), this is not the focus of the theory. It is not a theory of how *environment impacts* upon an individual's self-efficacy, but rather a theory of *meta-cognitive processes* and therefore seeks to understand the cognitive processes underpinning an individual's beliefs about their abilities. The theory does not incorporate the effect of current life circumstances or current environmental influences on the cognitive processes that underpin and individual's beliefs about their abilities.

2.4.3 Research Findings Related to the Role of Parental Self-Efficacy on Child Dental Health Outcomes

A source of influence on a range of child developmental outcomes that may be conceptualised as lying at the level of the microsystem of Bronfenbrenner's ecological model, are caregiver cognitions, such as PSE. Qualitative interview studies (Amin and Harrison, 2009; Huebner and Riedy, 2010) have suggested that PSE may also be implicated in how caregivers cope with challenges to dyadic toothbrushing. In addition, an international study of dental health behaviours conducted by the World Health Organisation (WHO) identified that caregivers of young children from lower SES groups felt less confident in their abilities to establish toothbrushing routines with their children than those from higher SES groups (Adair et al., 2004).

Caregivers of 3- and 4-year old children were assessed in the study, with low SES caregivers reporting lower levels of PSE to control their children's toothbrushing behaviours than higher SES caregivers. This was suggested by Adair et al. (2004) to account, at least in part, for the social disparities identified in children's dental health status. This finding has been corroborated by work conducted in the USA, in which PSE was found to be significantly associated with children's toothbrushing frequency (Finlayson et al., 2005; Finlayson et al., 2007b) which was measured in this study via caregiver self-report. As the purpose of this chapter of the thesis is to provide an overview of the more general PSE literature, these child dental health PSE studies are critiqued in more detail in the thesis in Chapters Four. Chapter Four

reports on findings from a study to develop a psychometric scale to measure PSE for establishing and maintain early dyadic toothbrushing routines with infant.

2.4.4 Methods of Measuring Parental Self-Efficacy when Researching its Association with Child Dental Health Outcomes

The past three decades has seen the publication of a substantial body of work around PSE. In order to research PSE and evaluate interventions to increase PSE, a number of standardised psychometric scales have been designed to measure it since 1977, when Albert Bandura first postulated the construct of 'self-efficacy'. Within the thesis empirical chapters, work is reported in which methods of measuring PSE specific to establishing and maintaining dyadic toothbrushing routines are developed. However, literature around the development of general PSE scales is now discussed.

Using combinations of the search terms 'parent*'/ 'maternal', 'self-efficacy' and 'scale'/ 'measure'/ 'instrument', to search the PsycINFO, Web of Science, MedLine and PubMed databases, twelve studies were identified in the literature in which PSE scales (based upon the classic Bandurian definition of 'self-efficacy') for use with parents of children in early childhood (age range neonates - children age 6 years) had been developed between the years 1977-2012.

When constructing these scales, developers have intended them to measure different levels of PSE. Some PSE scales are 'domain-specific' and relate to *specific*

areas of parenting skills such as caring for a child's health, e.g. the Perceived Maternal Self-Efficacy Scale (Barnes and Adamson-Macedo, 2007). However, these kinds of PSE scales are not designed to accurately measure PSE related to a *specific task* in parenting, e.g. establishing toothbrushing as a dyadic process with infants. Such 'task-specific' measures of PSE have been suggested to have greater predictive validity and sensitivity (Crncec et al., 2008), but as yet only one PSE scale has been developed that contains task-specific items, the Maternal Efficacy Questionnaire (Teti and Gelfand, 1991).

The development of such scales is often a technically challenging process, and several methodologies are cited in the literature as being appropriate for developing scale items (DeVellis, 2003; Frei et al., 2009). Chapter Four of the thesis provides a more detailed overview of the technical issues associated with developing items for inclusion in such scales and constructing and validating such scales. Chapter Four also critiques a number of scales specifically developed to measure PSE for establishing early childhood toothbrushing routines (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010).

In addition to PSE potentially influencing the emergence of toothbrushing as a dyadic process through infancy, a number of additional caregiver level influences may be important to the emergence of the routine. For example, having positive outcome expectancies and understanding the value of toothbrushing to maintaining child dental health, may be associated with a greater level of caregiver motivation to

establish such routines (Adair et al., 2004; Huebner and Riedy, 2010). Additionally, more authoritative, positive parenting behaviours, rather than authoritarian, punitive behaviours, may be more associated with success in coping with these difficulties with non-compliance and subsequently dyadic toothbrushing (Amin and Harrison, 2009; Huebner and Riedy, 2010).

Another key caregiver factor that may be associated with how successfully caregivers cope with the demands of parenting tasks, such as establishing toothbrushing as a dyadic process, is affect and mental health. It has been suggested that children of caregiver's with mental health difficulties may have poor dental health (Kenney et al., 2005). Maternal depression has also been found to be associated with low PSE (Haslam et al., 2006; Weaver et al., 2008) which may cause some difficulties in caregiver-infant interactional styles and attachment (Campbell et al., 2004; McMahon et al., 2006).

There does however appear to be some variability in findings regarding the associations between caregiver cognitions, mental health, behaviour and attachment (Toth et al., 2009). Additionally, the exact mechanisms by which these influences may contribute to child developmental outcomes are as yet not fully understood, and additionally, there may be protective effects from such factors as social support (Herwig et al., 2004). These other caregiver influences located within the microsystem may be important to child development, being associated with parenting practices and quality of attachment within the caregiver-child dyad. In

examining how caregiver influences on the emergence of toothbrushing as a dyadic process through infancy, it may be informative to consider these additional caregiver-related influences. These additional caregiver influences are explored and described throughout the empirical chapters of the thesis using qualitative interview and observational methodologies. Published literature around these potential caregiver influences is now discussed.

2.4.5 The Role of Caregiver Biological Influences on the Emergence of Toothbrushing as a Dyadic Process through Infancy

In-keeping with the most recent conception of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), in which biological influences are examined in relation to human development, parental biological influences have been suggested to be implicated in child developmental processes. Heritability and genetic vulnerability to conditions such as autistic spectrum disorder (ASD) may predispose both caregivers and their children to having intellectual and behavioural difficulties that may result in non-optimal developmental outcomes (Hallmayer et al., 2011; Rommelse et al., 2010).

2.4.6 The Role of Caregiver Knowledge on the Emergence of Toothbrushing as a Dyadic Process through Infancy

There are infant dental health guidelines that relate basic information about what age to establish toothbrushing routines in infancy, how often teeth should be

brushed and what kind of toothbrush and toothpaste should be used (AAPD, 2011a; BDHF, 2010; NHS, 2009). However, even when these guidelines are made available to caregivers, there may still be a lack of understanding amongst them as to what the best-practices around infant toothbrushing are, evidenced by findings from a recent focus group study conducted in the USA with 22 mothers and 13 expectant mothers (Mofidi et al., 2009). The authors found that although many of the mothers and expectant mothers interviewed understood the importance of brushing infant teeth twice a day, some did not. Some of the mothers and expectant mothers interviewed did not understand the importance of the primary teeth to the health of future adult teeth, and therefore did not understand the importance of brushing infant teeth every day.

An additional study conducted with 105 mothers in the USA included a questionnaire to test mothers knowledge of child dental health and preventive behaviours (Akpabio et al., 2008). Akpabio et al. found that only 32.4% of mothers knew that infant toothbrushing routines should begin before the age of 2-years old. The authors also found that mothers who were more highly educated gave more correct responses, as did mothers who had more than one child. The authors suggested that first-time mothers who are less well educated may not have the skills necessary to seek out information about how to best care for their infant's teeth than more well-educated mothers. Additionally, first-time mothers may not benefit from the experience gained from having cared for several children. The authors therefore conclude that infant dental health educational programmes need to be developed

and provided to less well educated, young mothers with one child, in order to provide guidance to them on caring for their infants teeth.

2.4.7 The Role of Caregiver Parenting Practices on the Emergence of Toothbrushing as a Dyadic Process through Infancy

Robust findings have been generated from large scale parenting skills intervention studies in both the United Kingdom (UK) and the United States (US) that demonstrate the importance of using positive, non-punitive parenting behaviours to positive child developmental outcomes (Sanders et al., 2000; Webster-Stratton and Reid, 2003; Webster-Stratton and Reid, 2008). These interventions support caregivers to increase their use of techniques such as praise, encouragement, reinforcement and reward in order to foster positive attachment and prevent later childhood behavioural difficulties (Sanders et al., 2000; Webster-Stratton and Reid, 2008). The use of these more positive parenting practices may be associated with better child adjustment and lower rates of externalising behaviours (Gardner et al., 2006). Use of more punitive parenting behaviours however, may be associated with a range of more negative child developmental outcomes including aggression and other externalising behaviours (Snyder et al., 2005), and also internalising behaviours (Laskey and Cartwright-Hatton, 2009).

An increasing body of research had also documented the effects of social and economic deprivation on parenting practices (Belsky et al., 2007; Webster-Stratton and Reid, 2008) through its mediating effects on mental health and PSE (Jennings

and Abrew, 2004; Jones and Prinz, 2005; Sanders and Woolley, 2005a; Teti et al., 1996; Weaver et al., 2008). Vulnerable caregivers residing in areas of social deprivation that have to cope with multiple environmental stressors, such as financial insecurity and neighbourhoods with high levels of crime, may often experience lower levels of PSE than their more affluent counter-parts (Jones and Prinz, 2005; Jones et al., 2005; Webster-Stratton and Reid, 2008). This compromised PSE has been demonstrated to be associated with more punitive, authoritarian parenting practices (Bor and Sanders, 2004) which in turn can be associated with the development of behavioural difficulties in children.

As yet there are very limited guidelines for caregivers in terms of the kinds of parenting practices that may facilitate the emergence of toothbrushing as a dyadic process through infancy, specifically in dyads containing novice mothers and first-born infants. This kind of guidance may be particularly useful given the suggested difficulties caregivers face in terms of infant non-compliance during toothbrushing (AAPD, 2011b; Amin and Harrison, 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006).

There is some basic advice and guidance available to caregivers about how to establish toothbrushing as a dyadic process, in terms of the age at which dyadic toothbrushing should start and how frequently per day infant teeth should be brushed (AAPD, 2011a; BDHF, 2010; NHS, 2009). However, there is a real paucity in the literature with regards the best parenting practices to employ when first

establishing early dyadic toothbrushing and then maintaining it through the second year of life. The little information available to caregivers is that they make toothbrushing an enjoyable experience for their child, by providing positive reinforcement through praise and verbal encouragement for compliant behaviour and opportunities for children to practice brushing their own teeth (AAPD, 2011b). Additionally, a qualitative study conducted in Canada with 15 parents has reported that parents in this study did receive some guidance from dental professionals as to the specific parenting practices to employ when brushing infant teeth, such as how to hold an infant and how to hold the brush (Amin and Harrison, 2009).

Another aspect of parenting practices that may be associated with how toothbrushing emerges as a dyadic process through infancy is caregiver's abilities to establish and use daily dyadic routines more generally. Literature around other child hygiene practices, such as hand-washing (Curtis et al., 2009) demonstrate that when hygiene practices are started early in life and are maintained in a routine fashion at the same time each day, these practices are more likely to become habitual and automatic. This has also been suggested as a potential pathway for the habituation of toothbrushing (Aunger, 2007), with NHS guidelines suggesting that toothbrushing, if conducted at the same time as other hygiene routines such as bath time, is more likely to become a regular, automatic routine behaviour in childhood through to adulthood (NHS, 2009).

Despite the importance of routines to a range of child developmental outcomes including physical health outcomes such as asthma regulation (Fiese et al., 2008) general child and family wellbeing (Fiese et al., 2006) and child learning outcomes (Spagnola and Fiese, 2007), some caregivers may struggle to establish such routines. Low caregiver SES and education (e.g. Evans et al., 2005) and caregiver mental health difficulties (Calam et al., 2012) have all been suggested as associated with fewer family routines and more 'chaotic' households, which are all related to poorer pre-schooler developmental outcomes (e.g. Martin et al., 2011).

2.4.8 The Role of Caregiver Affective Influences on the Emergence of Toothbrushing as a Dyadic Process through Infancy

It may also be important to consider the various caregiver affective influences that may mediate parenting behaviours and therefore child developmental outcomes. The most commonly problematic caregiver affective factor that has been reported in the literature is that of caregiver, and in particular, maternal, depression. It has been documented that there may be a significant association between presence of maternal depression and maternal behavioural competence in the parenting role (Gerdes et al., 2007; Teti and Gelfand, 1991; Weaver et al., 2008). For example, depressed mothers have been suggested to have difficulties with developing secure attachment following the birth of their child, instead developing insecure and avoidant attachment styles (Bifulco et al., 2004). Depressed mothers have also been suggested to engage in more punitive, physical discipline than their non-depressed

counter-parts (Shay and Knutson, 2008). However, the potentially damaging effects of caregiver depression may be moderated by social support (Cairney et al., 2003; Herwig et al., 2004) and key caregiver cognitions such as PSE (Teti and Gelfand, 1991).

2.5 Potential Infant Influences on the Emergence of Toothbrushing as a Dyadic Process through Infancy

Although caregiver level influences may be important in the emergence of toothbrushing as a dyadic process through infancy, a number of infant level influences may also need to be taken into account. A number of aspects of infant development which may cause this period of development to be challenging for caregivers are now discussed in relation to how they could potentially be associated with the establishment of the behaviour and its emergence as a routine. These aspects of development mainly relate to infant behaviour and how this may act as potential challenges to the routine being enforced, and also the emergence of early object grasping as fine motor skills development.

Additional aspects of development in this important period may also act as barriers to caregiver controlled dyadic toothbrushing during infancy. These aspects of infant development may primarily relate to infant object grasping or 'prehension skills' which have been observed in infants as young as 4-months old (Sgandurra et al., 2012; van Hof et al., 2002). Prehension skills are important to performing many kinds

of routine task, and involve reaching, grasping and object manipulation. These skills start to develop in the first six-months of life, and allow infants to explore their environment and learn more about the world. Prehension skills develop alongside an increasing drive towards autonomous object grasping and tool use (e.g. Biringen et al., 2008) and in particular, the drive towards autonomous use of tools in self-care tasks such as self-feeding using a spoon (e.g. Carruth et al., 2004).

Difficult infant behaviour during infancy may make this period challenging for many caregivers (e.g. Keenan and Wakschlag, 2000; Stacks, 2005), and enforcing healthcare routines with an infant who may have an increasing sense of 'self-agency' and drive towards autonomy may pose a particular challenge. Self-agency is defined as the conceptual understanding of self as an agent capable of shaping motives, behaviour, and future possibilities (Damon and Hart, 1991). Such autonomous behaviour has been demonstrated in the infant sleep routines (Moore et al., 2008) and feeding routines (Bruns and Thompson, 2010) literature, and there are tentative indications from the dental literature that this may also be an issue in infant toothbrushing (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006).

These aspects of infant development that may pose a challenge to dyadic toothbrushing as during infancy and up until the age of around seven-years, caregivers should retain principal control of the toothbrush during dyadic

toothbrushing (BDHF, 2010; NHS, 2009). However, it has been suggested in the literature that within some dyads, caregivers are not succeeding in this, and that many young children may in fact have significant control of holding and using the brush themselves to engage in self-toothbrushing (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005).

Potential infant influences on dyadic toothbrushing routines are explored and described throughout the thesis empirical chapters using both qualitative interview and observational methods. What now follows is a discussion of how these aspects of infant development may potentially be associated with emergence of toothbrushing as a dyadic process through infancy, with reference to the published literature. Infant behavioural development is discussed first, followed by literature on the development of prehension and tool use skills, with a specific focus on the use of tools to engage in self-care tasks in infancy.

2.5.1 The Role of Infant Behaviour in the Emergence of Toothbrushing as a Dyadic Process through Infancy

Infant behaviour may sometimes be associated with the relative ease or difficulty of a range of child-care tasks. Some behavioural difficulties may be common in infancy and early childhood, with many caregivers experiencing the problems associated with the “Terrible Two’s” (Keenan and Wakschlag, 2000; Stacks, 2005). However, recent reviews of the literature have suggested that serious behavioural and social-

emotional difficulties may develop in a significant number of very young children, and that these difficulties may persist into later childhood and perhaps adulthood (Carter et al., 2004; Keenan and Wakschlag, 2000). This is also suggested to be particularly relevant to infants born with neurodevelopmental disabilities such as ASD and cerebral palsy (Baker et al., 2003; Eisenhower et al., 2005).

The most common early behavioural difficulties relate to externalising behaviours, including aggression and temper tantrums (Stacks, 2005). Externalising behaviours are in contrast to internalising behaviours, which are usually reflective of internal states such as anxiety, depression and withdrawal. A great deal of the research into early behavioural difficulties has focussed on externalising behaviours as these behaviours may be most disruptive to family functioning and may be associated with caregiver stress (Herring et al., 2006; Plant and Sanders, 2007; Williford et al., 2007).

Caregiver perceptions of infant behaviour may be associated with caregiver self-efficacy (Porter and Hsu, 2003), with caregivers perceiving their infant's behaviour as being more difficult having lower perceptions of self-efficacy in their role as a caregiver. However, the associations between infant behaviour, perceived level of difficulty of parenting tasks and parental self-efficacy are complex. The development of early behavioural difficulties may be associated with a range of other microsystem influences not necessarily located at the level of the infant, but rather at the level of the caregiver.

Behavioural difficulties during infancy may result in caregivers having some difficulties with parenting and child care tasks (Putnam and Stifter, 2005). For example, during the first year of life, difficult infant behaviour has been suggested to be associated with disrupted infant sleeping patterns (Spruyt et al., 2008) and feeding difficulties (Galler et al., 2004). There are also some tentative indications in the scarce dyadic dental health literature that behaviour in early childhood may also present challenges to dyadic toothbrushing (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006).

One of the major challenges of infant behavioural research however, has been the development of an acceptable definition of the construct, due to its multidimensional nature. There is some agreement within the literature that infant behaviour may in some part be biologically determined, has longitudinal stability and is cross-situationally consistent (Else-Quest et al., 2006). Additionally, some aspects of infant behaviour in the early years of life may also remain stable into later childhood (Komsis et al., 2006) and also may provide the basis for later adult personality (Caspi et al., 2003).

A recent meta-analysis of 189 previous studies assessing gender differences in behaviour between the ages of 3-months and 13-years, found some significant gender differences, with females exhibiting more effortful control than males (Else-Quest et al., 2006). Effortful control is the ability to suppress a dominant behavioural

response in favour of enacting a sub-dominant response (Kochanska and Knaack, 2003) and plays a role in behavioural regulation. Further to this, male infants have been suggested to exhibit higher rates of externalising disorders, including oppositional defiant and conduct disorder (Else-Quest et al., 2006). Oppositional Defiant Disorder is defined as “a persistent pattern of angry and irritable mood along with defiant and vindictive behaviour” (APA, 2012). Prematurity and very low birth weight (VLBW) (Hack et al., 2004) have been suggested to be associated with increased risk of externalising disorder and also increased risk of cognitive and socio-emotional problems, which may affect patterns of caregiver-infant dyadic interactions (Forcada-Guex et al., 2006).

2.5.2 The Emergence of Tool Use Skills in Infancy

As has already been discussed, there are indications from the literature that certain aspects of infant development may act as barriers to dyadic toothbrushing, mainly coming in the form of difficult infant behaviour during toothbrushing (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006). However, other aspects of infant development may also influence the emergence of toothbrushing as a dyadic process through infancy.

Towards the end of the first year of life, gross motor skills develop in order to allow infants to walk unaided, and alongside this, fine motor skills including object grasping and manipulation also develop. An international study conducted by the WHO

examined windows for achievement of six gross motor skills in infants from Ghana, India, Norway, Oman and the USA (WHO, 2006). Between the ages of 4 – 24 months, 816 infants were examined bi-monthly by trained fieldworkers until each of six milestones was achieved in order to generate standard data of how infants should develop and allow identification of delayed development. Additionally, caregivers provided self-reported dates of when each infant was observed by them to have achieved each milestone. Table 2.1 provides this caregiver self-report data around infant gross motor skills milestones.

Table 2.1- Ages at which infants reach gross motor skills milestones

Gross motor skill	Mean age reached (months)	Range (months)	Confidence interval
Sitting unaided	6.0	3.8 – 9.2	1.1
Standing with assistance	7.6	4.8 – 11.4	1.4
Crawling on hands and knees	8.5	5.2 – 13.5	1.7
Walking with assistance	9.2	5.9 – 13.7	1.5
Standing alone	11.0	6.9 – 16.9	1.9
Walking alone	12.1	8.2 – 17.6	1.8

Although these data provide indications as to when most infants should reach each of these developmental milestones, the data should be interpreted with some caution. This is because caregiver self-reports were taken as the ‘exact’ date when each infant reached each milestone if a trained fieldworker had not examined an

infant on the day that the milestone was reached or a fieldworker had not been available to conduct an examination that month. As caregivers may be reassured by their infant reaching milestones either early or on time, caregiver provided dates may have over-inflated the precocity of milestone achievement for their infant. Additionally, these data come from outside of the UK, so it is unknown whether the ages of milestone achievement identified in the WHO (2006) study provide reliable comparisons for infants residing in the UK.

Unfortunately, the WHO Growth Reference Study Group that collected the international *gross* motor skills data (WHO, 2006) have not as yet collected similar data for *fine* motor skills. However, standardised assessments such as the Bayley Scales of Infant Development (Bayley, 2006), and reviews by the American Academy of Pediatrics (AAP- Gerber et al., 2010) have provided norms for ages at which a number of fine motor skills milestones are expected to be reached. The Bayley Scales assess fine motor skills such as grasps, with scores for fine motor skills increasing as grasps become more complex. For example, the first grasp type infant's exhibit is a whole hand grasp, which allows infants to grasp objects like rattles and emerges at the age of around 2-months (Gerber et al., 2010).

As infants develop further, the 'inferior-palmer' followed quickly by the 'palmar' grasp emerge at around the age of 4 – 6 months (Gerber et al., 2010; Law et al., 2010) and is assessed with the Bayley Scales via the infant being required to grasp a crayon without using the thumb. Following this, the 'transitional' or 'radial-palmar'

grasp emerges around the age of 6 – 7 months (Gerber et al., 2010), which is a palmar grasp that incorporates the use of the thumb and is assessed by the infant grasping a crayon. This is then followed by the yet more complex ‘radial-digital grasp’, which emerges at the age of around 8 – 9 months (Gerber et al., 2010) and allows the infant to pick up objects such as blocks using the pad of the thumb and the other fingertips. Soon after the emergence of the radial-digital emergence comes the ‘inferior pincer’, and then the ‘pincer’ grasp at the age of around 8 – 10 months (Gerber et al., 2010), which is similar to the radial-digital grasp, but allows grasping of smaller objects such as pellets.

Further in infant development, the yet more complex ‘tripod grasp’ emerges which allows fine control of objects such as crayons. The final grasp assessed by the Bayley Scales is the ‘dynamic’ grasp which is essential for the fine control of objects such as pencils when engaging in writing. If this final grasp type is exhibited between the ages of 3 – 3.5 years, this would indicate typical development. See Figure 2.3 for photographs depicting each of the grasps that emerge throughout infancy.



Crude palmer grasp (4 – 5 months) and palmer grasp (5 – 6 months)



Radial-palmer grasp (6 – 7 months) and radial-digital grasp (8 – 9 months)



Inferior pincer grasp (8 – 9 months) and pincer grasp (10 – 12 months)

Figure 2.3- Grasp types that emerge through the first 12-months of life

The onset of walking unaided frees up an infant's hands allowing them to develop these fine motor skills (Biringen et al., 2008; Karasik et al., 2011; Wijnhoven et al., 2004) and is facilitated via caregiver encouragement (Karasik et al., 2008), in addition to caregiver direction and teaching and infant persistence (Banerjee and Tamis-LeMonda, 2007; Bober et al., 2001). Once infants are able to grasp objects a key

motor skill emerges, in which objects are manipulated and used as tools. Developmental psychologist Rachel Keen recently defined tool use as “using an object to act on the environment to accomplish a goal” (Keen, 2011), which would imply that when tool use emerges in infancy, infants purposefully grasp objects and manipulate them, using them as a tool in a conscious planned way to achieve a goal. As infants develop and they are able to grasp tools in more sophisticated ways, they can achieve increasingly complex environmental change using tools (Cox and Smitsman, 2006). One of the first tools infants use to exert their will to change their environment is a spoon, which they use to engage in an important self-care task, that of self-feeding (Claxton et al., 2009; McCarty et al., 2001).

2.5.3 The Emergence of Self-Care Skills in Infancy

The emergence of self-care skills through infancy is, like the emergence of tool use, a key part of development. Self-care skills, which are a feature of ‘daily living skills’ (Sparrow et al., 2005) describe skills that are required in order for an individual to attend to their personal needs, such as feeding, toileting, dressing and grooming. In infancy one of the early self-care skills to emerge is that of self-toileting (Joinson et al., 2009) and also self-feeding (Bober et al., 2001; Carruth and Skinner, 2002; Carruth et al., 2004).

Aspects of the rearing environment, most specifically those lying at the level of the caregiver-infant dyad located within the microsystem of the Bronfenbrenner Ecological Model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), may be associated with individual differences in the emergence of self-care skills. For example, one of the most immediate influences on the emergence of self-care skills through infancy is the presence of biological risk of neurological sequelae. Children born either pre-term or with neurodevelopmental disorders such as ASD (Jasmin et al., 2009), Down's syndrome (Dolva et al., 2004) or Williams syndrome (Mervis and John, 2010) are more likely to experience delay in the emergence of self-care skills when compared to their typically developed counterparts.

Another dyadic influence on self-care skills emergence comes from parenting practices and attitudes. For example, caregiver expectations about learning and development of skills during the first two years of life may be associated with caregivers being motivated to provide the necessary encouragement to aid self-care skills emergence (Dieterich et al., 2004). Additionally, learning occurs within the context of social interactions with a competent other (Vygotsky, 1978a) so opportunities to observe the competent other engaging in the self-care task of interest may be important (Landry et al., 2001), along with instruction on the nature of the task.

One of the most important self-care tasks that emerge in infancy is self-feeding using utensils such as spoons (Carruth and Skinner, 2002; Carruth et al., 2004; Connolly and Dalgleish, 1989; Koda et al., 2006), and belongs to a class of behaviours during infancy in which objects are placed inside the mouth in order to facilitate exploration (McCarty and Keen, 2005). Self-feeding emerges as a self-care behaviour as infants develop a sense of self and their desire to autonomously carry out tasks themselves increases (Dix et al., 2007; Erikson, 1968; Helwig, 2006; Newman and Newman, 2008).

The drive for autonomy is an important aspect of development that enables infants to develop new skills, through providing them with opportunities to try out new activities for themselves (Keller et al., 2004). However, this developing drive for autonomy may be associated with difficult behaviours, such as defiance and non-compliance, that may make this period of development problematic for care-givers to navigate through (Briggs-Gowan et al., 2006; Kochanska, 2002). There are also indications from the literature that this may be particularly problematic in health care tasks that require the use of tools, specifically in feeding using spoons (Aboud et al., 2009; Ammaniti et al., 2004). So striking a balance between caregivers being sufficiently involved with the process in order to ensure positive health outcomes for their infant, and negotiating control in order to manage behavioural difficulties and support their infant's natural drive for autonomy in using tools in self-care tasks, may be important. The issues around adult supervision of toothbrushing in childhood are now discussed.

2.5.4 The Importance of Adult Supervision during Early Dyadic

Toothbrushing

Dental guidelines recommend that toothbrushing should be conducted or closely supervised by an adult until a child is around seven-years old (BDHF, 2010; NHS, 2009). The literature indicates that there may be some cultural variations in age of eruption of first primary dentition which may mean there are some cultural variations in when the routine might first be established.

Infants in Iceland are some of the youngest at 6.89 months (sd 2.16), infants in Nigeria 8.39 months (sd 2.93), Iraq 8.40 months (sd 2.20) and in Saudi Arabia 8.49 months (sd 2.81) (Folayan et al., 2007). Additionally, as has already been discussed earlier in the chapter there is no real firm evidence-base to support the age of seven-years as being the age at which adult supervision can stop, so there may also be some variation between different countries with regards to what age is considered appropriate for autonomous self-toothbrushing (Dos Santos et al., 2011). However, there does appear to be consensus that adult supervision during toothbrushing is important in the early years of life.

One potential reason why caregiver supervision may be necessary is that toothbrushes may pose a danger to young children if they are allowed to hold them unsupervised. There have been documented cases of toothbrushes causing serious oral trauma through becoming embedded in the tissues of the oral cavity (Belfer et al., 1995; Matsusue et al., 2011). Often these incidents happen because children are

allowed to walk around with the toothbrush in their mouth, but then fall over, causing serious impalement injuries (Younessi and Alcaino, 2007).

A further reason why it is not recommended that children engage in self-toothbrushing until the age of seven-years is that infants may not have the appropriate fine motor skills necessary to manipulate the toothbrush to ensure their teeth are brushed to an adequate level of hygiene prior to this age. If toothbrushing is broken down into a 'task-analysis' it becomes clear that as an activity, it is actually quite complex. Task analyses break down daily-living and other tasks into the constituent micro-behaviours in order to allow children and adults with ASD to learn these tasks.

A toothbrushing task-analysis developed by the Dr Samuel D Harris National Museum for Dentistry, USA, for the 'Healthy Smiles for Autism' campaign (Dr Samuel D Harris National Museum of Dentistry, 2010), demonstrates the series of micro-behaviours involved in toothbrushing. These include picking up the toothbrush, picking up the toothpaste, taking the cap off the toothpaste and squeezing a pea-sized amount of toothpaste onto the brush. This initial series of micro-behaviours is required even before the act of actually cleaning the teeth with the brush begins. The task-analysis goes on to describe how the toothbrush is then used to brush the front teeth using a circular motion, brushing the inside surfaces of the teeth, brushing the top surfaces of the teeth, brushing the tongue, and then spitting out the toothpaste. The task-analysis then finally describes the processes of rinsing the

brush, replacing the cap on the toothpaste, and placing the toothpaste and toothbrush back into their cup.

The task-analysis outlined demonstrates that toothbrushing is actually a complex task comprised of a series of micro-behaviours, some of which require relatively complex manipulation of the toothbrush in order to cover all tooth-surfaces adequately. This may explain in part, the fact that the dental expert guidelines recommend that children younger than seven-years should either have their teeth brushed for them by an adult, or be very closely supervised in order to ensure all teeth surfaces are cleaned adequately.

It is also recommended in the guidelines that caregivers should brush their infant's teeth at least once a day, preferably twice, (AAP, 2007; NHS, 2009) and that this be done for a period of at least 2 minutes (NHS, 2009). In particular, caregiver-conducted toothbrushing before *bedtime* is important as children may have food debris in the mouth by the evening due to the chewing and ingestion of food throughout the day. Reduced saliva flow during the night also increases acidity of the oral cavity, increasing the likelihood of the process of dental caries (Hodosy and Celec, 2005). It is therefore important that food debris be adequately removed before bedtime in order to avoid the development of dental caries. Indeed, intervention studies have demonstrated that absence of nocturnal toothbrushing may be significantly associated with development of carious lesions in infants (Siqueira et al., 2010).

Based on the literature, it could therefore be argued that during infancy, caregiver conducted dyadic toothbrushing in which the caregiver holds and uses the toothbrush to clean their infant's teeth is important for preventing oral trauma from toothbrush impalement injuries and also ensuring good dental health. However, the behavioural difficulties common in infants and young children may potentially make it quite difficult for caregivers to maintain full control of the toothbrush as their child develops through infancy. Indeed, the literature would suggest that this may potentially be the case.

Firstly, a recent telephone survey of 1000 parents by the British Dental Health Foundation (BDHF) found that up to a fifth of under-fives may be brushing their teeth themselves, completely unsupervised (BDHF, 2008). This finding appears to support the idea that children are engaging in significant self-toothbrushing, and perhaps more than the dental guidelines recommend. In addition, a quarter of parents surveyed did not realise that twice-daily toothbrushing was needed in order to maintain their child's dental health.

Findings from a qualitative interview study conducted with 48 Mexican-American mothers of young children (Hoeft et al., 2009) appear to confirm the findings from the BDHF (2008) survey. Mothers in this study did not establish toothbrushing routines with their children until they were on average 1.8 years old (sd .8 years), whereas American Dental Association (ADA) guidelines state that toothbrushing should be established at the time of the eruption of the first primary tooth. When

mothers in this study were asked who conducted their child's toothbrushing, many reported that their child did, despite their child being under the age of seven-years, which is the age at which it is recommended that children should be allowed to brush their own teeth (BDHF, 2010; NHS, 2009). A total of 87% of mothers from this study were found to be engaging in toothbrushing with their child that did not comply with ADA recommendations (ADA, 2002).

Additionally, a further qualitative interview study (Huebner and Riedy, 2010) conducted with 45 caregivers (44 mothers and 1 father) of children aged approximately 3 – 5 years living in a rural county of the United States, provides further support for these findings. When the authors asked participants to describe a typical toothbrushing episode, only 11/40 (28%) of parents reported that they brushed their child's teeth for them. This is in contrast to the 22/40 (55%) of parents who reported that they were simply physically present in the bathroom when their child brushed their own teeth, with the parent providing minimal supervision. An additional 7/40 (18%) of parents reported that their child brushed their own teeth completely unsupervised. The findings from these two qualitative interview studies (Hoeft et al., 2009; Huebner and Riedy, 2010) are discussed in more detail in Chapter Three of the thesis.

More robust data to support the findings from the BDHF (2008) survey data and the Hoeft et al. (2009) and Huebner & Riedy (2010) interview studies, are provided by two studies in which dyadic toothbrushing routines with infants were directly

observed (Martins et al., 2011; Zeedyk et al., 2005). Although the studies were conducted with different samples of dyads, Martins et al. with 201 Brazilian dyads with mean infant age 3.4 years and Zeedyk et al. (2005) with 18 Scottish dyads, with mean infant age 2.5 years, both studies generated similar findings. Martin et al. found that around 34% of dyads engaged in toothbrushing in which the parent did not brush the infant's teeth for them, with Zeedyk et al. (2005) finding this figure to be 33%.

Each of the studies previously discussed and summarised in Table 2.2 demonstrate that young children may be engaging in self-toothbrushing at a younger age than the seven-years that dental expert guidelines recommend (AAPD, 2011a; BDHF, 2010; NHS, 2009). Additionally, these two observational studies reveal that caregiver reports of dyadic toothbrushing may not be reliable when compared with observed toothbrushing practices. The two observational studies (Martins et al., 2011; Zeedyk et al., 2005) are discussed in more detail in Chapter Five of the thesis. Throughout the thesis empirical chapters, both qualitative interview and observational methodologies are used to explore and describe how infants begin to engage in self-toothbrushing, in addition to exploring and describing other caregiver-infant influences on dyadic toothbrushing.

Table 2.2- Summary of published studies reporting child self-toothbrushing as occurring at a younger age than general health (e.g. NHS, 2009) and dental health (e.g. BDHF, 2010a) guidelines recommend

Authors	Year	Sample Size	Population	Methodology	Main Findings
British Dental Health Foundation	2008	1000	British parents of children (child age not specified)	Survey study	20% of children under the age of 5-years are brushing without adult supervision.
Hoeft et al.	2009	48	Mexican-American dyads (child age 5.8 years)	Interview study	Mean age at which toothbrushing routines started in infancy was 1.8 years, with 87% of dyads parent not brushing child's teeth for them by mean age of 5.8 years.
Huebner & Reidy	2010	45	American dyads (child age 3 – 5 years)	Interview study	Toothbrushing routines started by age of 1-year in 78% of dyads and in 73% parent had minimal/no control over child's toothbrushing.
Zeedyk et al.	2005	18	Scottish dyads (infant mean age 2.5 years)	Observational study	33% of dyads parent not brushing infant's teeth for them by age of 2.5 years.
Martins et al.	2011	201	Brazilian dyads (infant mean age 3.4 years)	Observational study	34% of dyads parent not brushing infant's teeth for them.

If findings from these studies (BDHF, 2008; Hoefl et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005) are reliable, many infants and young children may be engaging in self-toothbrushing at a younger age than the seven-years recommended by dental professionals (AAPD, 2011a; NHS, 2009). Although there is no firm evidence-base to support the recommendation that children should not engage in self-toothbrushing until the age of seven-years, and also a lack of agreement internationally as to when self-toothbrushing should commence (Dos Santos et al., 2011), seven-years appears to be the age recommended in the UK (BDHF, 2010; NHS, 2009).

The complexity of toothbrushing, both as a tool use and self-care task, might mean that before the age of seven-years, children do not have the ability to hold a toothbrush using the kind of 'oblique' or 'distal oblique' grasps that develop in later childhood and are associated with better plaque removal. Indeed, observational research has shown that these more sophisticated tool grasps are associated with better plaque removal than the more simplistic grasps seen in earlier childhood.

In a recent observational study of children aged 10 years (sd 1.29 years) residing in India (Sharma et al., 2012) 100 school children attending a dental clinic were video recorded in order to analyse the kind of grasp they used to brush their teeth. On a first visit, the researchers took a baseline plaque sample (PS_1) using the Silness-Loe plaque index (Silness and Loe, 1964) and then instructed each child to brush their teeth using their usual method. Following brushing a second plaque sample was

collected (PS₂). All children were then provided with instruction of an optimal toothbrushing technique, which included using an oblique grasp, brushing each tooth surface with a circular motion for a total of 3-mins. They were then asked to use this optimal method of brushing for seven-days.

All children returned to the dental clinic and each child was asked to demonstrate toothbrushing a second time, with this again being video recorded. Finally, a third plaque sample (PS₃) was collected immediately after the second toothbrushing observation. Sharma et al. (2012) found that when although all children had been provided with toothbrushing instruction, 92% of them did not modify the grasp they used upon second toothbrushing observation. In terms of grasps used by the children at baseline, the most common grasp used was a distal oblique (67%) with an oblique grasp being used by just over a quarter (25%), and one child used a spoon grasp, whilst another used a precision grasp.

When Sharma et al. (2012) analysed the plaque samples, they found that at baseline (PS₁) and then immediately after brushing (PS₂), children using the distal oblique grasp had significantly lower mean plaque scores than children using the oblique grasp (both $p = .003$). However, following toothbrushing during the second visit to the dental clinic (PS₃), no differences were found between children using the distal oblique and oblique grasps, in terms of plaque score. Additionally, regardless of grasp type used, significant reduction in plaque scores were found between baseline plaque (PS₁) and immediately after brushing both during the first visit to the dental

clinic (PS₂) and the second visit (PS₃) (all $p < .0001$). This would indicate that although both grasps result in plaque reduction, immediately after brushing, for longer term, sustained plaque reduction, the distal oblique technique is more effective.

Although the findings from Sharma et al. (2012) are interesting, there are number of limitations to the study. Firstly, in any kind of observational research, when an observational coding schedule is used, it is good practice to check the reliability of the coding schedule between different observers. Sharma et al. do not report any such inter-coder reliability assessment so it is unclear how reliable the coding schedule used to categorise each child's grasp type was. Additionally, as children were filmed brushing their teeth in the dental clinic with a member of study staff present, the study may lack ecological validity and caused children to brush their teeth differently to how they would at home. It may have been preferable for caregivers to film their child in the natural home environment, in order to capture each child's most natural toothbrush grasping technique.

Despite the limitations however, Sharma et al. have provided some preliminary data that suggests that grasp type does indeed affect the level of plaque on children's teeth, and that therefore, how a child grasps the toothbrush may potentially affect their dental health. This may mean that if children are engaging in self-toothbrushing at an age when they are only able to use very simple grasp techniques, the effectiveness of toothbrushing in preventing caries may be compromised. Therefore, it may be important to examine the natural emergence of dyadic toothbrushing as a

routine behaviour and uncover the influences which may be contributing to children engaging in autonomous self-toothbrushing at a much younger age than is recommended.

2.6 Summary of Chapter Two

Chapter Two of the thesis has provided a discussion of the literature around some of the potential multiple influences on the establishment and maintenance of dyadic toothbrushing routines through infancy. These influences have been located within the various spheres of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), and relate to cultural, economic, societal and dyadic influences. Some of the more proximal influences on emergence of toothbrushing as a dyadic process have been located within the microsystem of the ecological model, which has been suggested to be "the centre of gravity" (Bronfenbrenner and Morris, 2006) of the model and the various influences on child developmental outcomes. Therefore, a discussion of microsystem influences that may be associated with emergence of toothbrushing as a dyadic process through infancy has also been provided. Specifically, those influences that lie at the level of the caregiver-infant dyad have been explored.

The complex interplay between caregiver and infant influences and how this interplay is associated with the quality of the dyadic relationship and interactions have also been examined. Of central interest to the thesis is the cognition of PSE, which has been suggested as being associated with emergence of toothbrushing as a

dyadic process through infancy. General self-efficacy and PSE more specifically, have been discussed, along with the methods used to measure PSE.

Chapter Two has also provided a discussion of literature regarding the emergence of tool use and self-care skills through infancy. These areas of development have been related to findings from the dental health literature that suggest young children may be holding and using toothbrushes in order to engage in self-toothbrushing at a younger age than dental guidelines would recommend. Literature around the potential health damaging effects of allowing very young children to use tools during health care tasks has been discussed. Finally, key findings from the dental health literature regarding the possible consequences of young children engaging in self-toothbrushing have also been summarised and related to the main focus of the thesis, which is to explore the emergence of dyadic toothbrush use as a routine behaviour through infancy.

The following chapters of the thesis now report a number of empirical studies, each utilising a different research methodology that explores and describes a range of caregiver-infant influences on the establishment and maintenance of dyadic toothbrushing routines as they emerge through infancy.

2.7 Aims of the Thesis

In order to provide a rationale for the aims of the thesis, it may be useful to provide a brief summary of the key literature that informs the thesis aims. Early childhood dental caries is a serious public health concern, especially in socially and economically deprived groups (Pine et al., 2004a). One of the principal causes of dental caries is a lack of effectively executed toothbrushing routines (Petersen, 2003). The dental literature indicates that caregivers may find it difficult to enforce effective toothbrushing routines in which the caregiver holds the brush to clean their child's teeth for them. This may in part be due to difficulties with behaviour often seen in infancy and early childhood (AAPD, 2011b; Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Olley et al., 2011b; Riedy et al., 2001; Spitz et al., 2006).

Additionally, from a young age children have an increasing drive for autonomous tool use, especially in self-care activities such as feeding (Ammaniti et al., 2004), and also potentially toothbrushing (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). However, the more primitive tool grasp techniques exhibited in early childhood may be less effective in removing dental plaque from teeth than tool grasps seen in later childhood (Sharma et al., 2012). These issues may potentially contribute to explaining some of the contributory factors underlying the high prevalence of early childhood dental caries. This possibility is explored in the thesis using a range of methodologies, in addition to exploring how other influences may play a role in shaping developing dyadic

toothbrushing as a routine behaviour from when it is established at the time the first tooth erupts from the gum.

Based upon the literature provided in this review, the research presented in the thesis aims to fulfil several aims that all share two common goals. These are firstly to explore influences on the emergence of toothbrushing as a dyadic process through infancy in dyads containing novice mothers and first-born infants, and locate these influences on Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Secondly, novel methods will be developed to identify and support caregivers at risk of needing support to align their dyadic toothbrushing routines with dental expert guidelines, by retaining principal control of the toothbrush whilst brushing their child's teeth for them.

The studies within the thesis have been designed so as to fulfil objectives laid out by Urie Bronfenbrenner (Bronfenbrenner and Morris, 2006) for the conduct of progressive developmental psychology research, namely to devise novel methods for researching existing questions about human development in order to generate new, more precise research findings. Additionally, guidelines for the development and evaluation of complex intervention laid out in recent MRC guidelines (Craig et al., 2008) will also be followed. The goals for the thesis will be fulfilled via four separate studies each employing a different methodology and having a different specific aim.

A qualitative interview study with first-time mothers of infants is reported in the first study reported in the thesis. This study has explored maternally perceived barriers to

and facilitators of the emergence of toothbrushing as a dyadic process through infancy in dyads containing novice mothers and first-born infants. This study is intended to increase the evidence-base around influences on the emergence of toothbrushing as a dyadic process through infancy, as there are as yet no studies published in the literature that have explored this, specifically in dyads containing novice mothers and first-born infants. Nor have any previous studies included first-time mothers with no previous experience of child-rearing, or mothers of infants. Previous studies have included mothers with multiple children, who have all developed beyond the infancy years. Additionally, Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) is used to conceptualise the perceived barriers and facilitators of the emergence of toothbrushing as a dyadic process through infancy, something that has not previously been attempted.

Data from the qualitative interview study is used to inform the development of a psychometric scale. This scale is designed to measure novice caregiver's PSE to establish toothbrushing as a dyadic process with infant's that align with dental expert guidelines, through caregiver control of holding and using the brush to clean their infant's teeth for them. This scale serves two purposes, firstly to identify novice caregivers who may at risk of having difficulties with barriers to establishing toothbrushing as a dyadic process with their first-born infant. Secondly, the scale is used to evaluate the efficacy of a picture book intervention to support caregivers to align their dyadic toothbrush toothbrushing routines with dental expert guidelines.

Although previous dental health PSE scales studies have been conducted, no previous studies have reported scales specifically intended to measure novice caregiver's PSE for *establishing* toothbrushing as a dyadic process with infants.

In order to further explore how dyadic toothbrushing comes to be characterised by significant infant control of holding and using the toothbrush to engage in self-toothbrushing, an observational study of dyadic interactions around toothbrush holding and use is reported. This study includes typical toothbrushing episodes for a cross-section of age groups (12, 18 and 24 month olds), that allow comparisons to be made between the age groups, in terms of the amounts of both caregiver and infant control of holding and using the toothbrush. This study is intended to increase the evidence-base around the emergence of early dyadic toothbrush holding and use in toothbrushing routines through infancy, as no previous studies have specifically explored changes in toothbrush holding and use from the inception of the routines in infancy.

The final study reported in the thesis is one in which a picture book intervention to increase caregiver frequency and duration of holding and use of the toothbrush, and decrease frequency and duration of infant holding and use, is developed and evaluated. No previous intervention development and evaluation study has attempted to specifically alter this aspect of dyadic toothbrushing, nor have any attempts previously been made to use a picture book format to achieve this behavioural change.

CHAPTER THREE: MATERNALLY PERCEIVED BARRIERS AND FACILITATORS OF ESTABLISHING AND MAINTAINING DYADIC TOOTHBRUSHING ROUTINES WITH INFANTS

3.1 Introduction

The literature review presented in the previous chapter has provided discussion of a number of studies that may provide some indications as to potential influences on the emergence of toothbrushing as a dyadic process through infancy. Some of the published research has focussed on those influences lying at the more distal levels of the ecological model, including cultural influences at the chronosystem level around the importance of the primary dentition (Nations et al., 2008) and when toothbrushing routines should first be established (Hoeft et al., 2009). Other research has examined socio-economic influences lying at the level of the macrosystem, with studies indicating significant social inequalities in dyadic toothbrushing (Pine et al., 2004a), and also dental health outcomes (Petersen, 2008).

However, despite the contributions made by the previous work exploring influences on dyadic toothbrushing, none of these studies have directly explored in detail *mother-infant dyadic* influences on the emergence of toothbrushing as a dyadic process through infancy. Nor have they specifically focussed on dyads containing *novice mothers and first-born infants*. Additionally, experiences of *novice mothers of first-born infants* have never previously been explored in any study in the published

literature. Including novice mothers of first-born infants in a qualitative study of their experiences of establishing toothbrushing as a dyadic process with their infant, may be most informative as novice mothers may have had no previous experience of engaging in this parenting task.

Although previously published studies of dyadic toothbrushing have not aimed to explore influence from *infancy* (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Nations et al., 2008; Riedy et al., 2001), they have fruitfully used qualitative interview methods to explore in detail potential influences on dyadic toothbrushing with children who have developed beyond the period of infancy. Therefore, using a similar qualitative interview methodology may also provide unique insights into mother's self-reported experiences of establishing toothbrushing as a dyadic process with *infants*, in dyads containing novice mothers and first-born infants.

Maternally perceived influences may be identified as acting as either barriers or facilitators to establishing dyadic toothbrushing with infants, and may be conceptualised by locating identified influences at each of the levels of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Such conceptualisation of influences on dyadic toothbrushing with novice mothers and first-born infants has never before been attempted within the published literature. Previous qualitative interview studies around dyadic toothbrushing (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Nations et al., 2008; Riedy et al., 2001) have previously included

dyads containing older children, and have also not aimed to focus specifically on novice mothers. Nor have these previously published studies conceptualised identified influences on dyadic toothbrushing using Bronfenbrenner's ecological model.

Findings from the published qualitative interview studies (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Nations et al., 2008; Riedy et al., 2001) are now discussed, with specific attention paid to what these studies may reveal about potential influences on the *emergence of toothbrushing as a dyadic process through infancy*. Additionally, the studies are critiqued, with a specific focus on how their methodologies may inform the present study. The sample characteristics, procedures and data analysis methods employed in these studies are discussed in terms of how these aspects of the studies may be altered in order to address the novel research questions and aims of the present study.

3.1.1 Influences on Dyadic Toothbrushing Routines- Findings from Qualitative Interview Studies

There are available in the literature a number of qualitative studies that may provide insights into potential influences on the emergence of toothbrushing as a dyadic process through infancy (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Nations et al., 2008; Riedy et al., 2001). These qualitative studies are now revisited to examine how the aims and methodologies of these studies can be altered to inform the present qualitative study reported in this chapter.

The present study aims to explore more specifically novice mother's perceptions of influences on the emergence of toothbrushing as a dyadic process through infancy. Specifically how these influences may be perceived as barriers to or facilitators of the establishment of the behaviour when it is first established and then maintained as a routine through infancy are explored. Additionally, this new study has used Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) to both structure questions within the qualitative interview schedule and also conceptualise themes identified from interview data. Tables 3.1 and 3.2 provide summaries of these qualitative studies, including sample characteristics, research questions and aims, methodologies employed and main findings. Information has been extracted from the published papers reporting the studies included in Tables 3.1 and 3.2, although the level of detail provided in the published papers regarding participant samples, methodologies and findings does not allow all the details of the studies to be accessed.

Table 3.1- Summary of Methodologies Employed in Qualitative Interview Studies Exploring Dyadic Toothbrushing

Authors	Sample Characteristics	Research Questions	Methodology
Riedy et al. (2001)	41 mothers and grandmothers, representing 5 Asian populations. Residing on the Island of Saipan.	To understand how cultural practices around children’s oral health, in order to provide guidance for a public health intervention.	Focus groups sessions using a semi-structured interview. Data were content analysed.
Nations et al. (2008)	27 low-literacy Brazilian mothers. Child mean age 36 months (range 2 – 72 months). All children malnourished.	To critically evaluate mothers opinions of the significance of their malnourished children’s teeth, and describe popular dental practices.	Ethnographic one-to-one interviews conducted and participant observations recorded in field notebook. Critical, interpretative, anthropological approach used to interpret data.
Amin & Harrison (2009)	14 mothers, 5 fathers, Chinese- and English-speaking, residing in Canada. Child mean age 3.9 years (range 2.5 – 6 years)	To understand processes that influence parental adoption of dentally healthy behaviours following their child having decayed teeth extracted under general anaesthetic (GA).	Semi-structured one-to-one interview protocol developed, and then modified as interviews progressed. Grounded theory approach used to analyse data and conceptual model developed.
Hoelt et al. (2009)	48 Mexican-American mothers. Child mean age 5 years	To investigate parental beliefs and behaviours around the establishment of home oral hygiene routines.	Semi-structured one-to-one interviews were conducted. ‘Standard qualitative procedures’ used to code data.
Huebner & Riedy (2010)	44 mothers, 1 father. Residing in rural area of USA. Child age range 3 – 5 years.	To identify parent’s motivations, supports and barriers to twice-daily toothbrushing with their infant and pre-school aged children.	Semi-structured one-to-one interview comprised of 9 open-ended questions. Data coding via a mixed-methods qualitative approach incorporating Grounded Theory techniques.

Table 3.2- Summary of Main Findings from Qualitative Interview Studies Exploring Dyadic Toothbrushing

Authors	Main Findings
Riedy et al. (2001)	Mothers past and current attitudes and health beliefs impacted on health behaviours. Negative past experiences and lack of value for primary teeth predicted poor dental health behaviours. However, some mothers were interested in learning about preventive strategies.
Nations et al. (2008)	Primary teeth are imbued with cultural significance, and mothers examine children’s mouths regularly to find signs of decay, and actively sought help when decay was present. However, access to dental services was poor, as was access. Mothers reported tooth cleaning from the time of the eruption of the first primary dentition as important.
Amin & Harrison (2009)	The GA experience had an immediate, but short-lived impact on parental dental behavioural change, e.g. toothbrushing and sugar consumption. Parents had difficulties maintaining behavioural changes. Parenting strategies, PSE, parental oral health perceptions, family context and media all influenced behaviour change.
Hoeft et al. (2009)	Toothbrushing routines were established at mean child age of 1.8 years. Toothbrushing routines did not conform to expert guidelines. Those mothers who engaged in oral hygiene routines with their child, they had to be prompted to by a health care professional. Not all mothers used a toothbrush and many children engaged in self-toothbrushing.
Huebner & Riedy (2010)	Parents who engaged in more frequent brushing described using specific skills to overcome barriers, including self-efficacy and holding high standards about toothbrushing. Parents who brushed less frequently described more barriers to toothbrushing and held lower standards about importance and had incorrect beliefs about importance toothbrushing.

The published studies presented in Tables 3.1 and 3.2 have explored such things as caregiver and child behavioural determinants of toothbrushing as a routine behaviour when toothbrushing routines are already in place (Huebner and Riedy, 2010). Additionally, they have examined why caregivers adopt certain behaviours when caring for their child's dental health (Amin and Harrison, 2009). Other purposes of these published studies have been to explore mothers understanding of the importance of tooth cleaning routines with their children and more operational issues such as whether a toothbrush is used (Hoeft et al., 2009) and cultural significance of the primary dentition (Nations et al., 2008). Therefore, none of these studies have specifically explored influences on the emergence of toothbrushing as a dyadic process through infancy, and how these influences may be perceived as *barriers to or facilitators of the establishment and maintenance* of the routine. Nor have any of the previously published studies sought to specifically explore in detail, microsystem influences on the emergence of toothbrushing as a dyadic process in that may come from the *mother-infant dyad* itself.

Additionally, these previously published studies have included both mother-infant and father-infant dyads, but given that mothers are usually principal care-givers when children are in the infancy stage (Scher and Sharabany, 2005), it would be advantageous to gain insight into solely *maternal* perceptions of their experiences establishing and maintaining the routine. Mothers and fathers may have quite different roles whilst parenting infants, with mothers primarily being the 'stay-at-home' parent fulfilling the majority of child-care tasks, and fathers being more responsible for evening care and play activities (Rubin and Wooten, 2007). The

studies have included mothers and grandmothers (Riedy et al., 2001), mothers and fathers (Amin and Harrison, 2009; Huebner and Riedy, 2010), with only two including only mothers (Hoeft et al., 2009; Nations et al., 2008). Additionally, and importantly, none of these studies included only first-time caregivers within their cohort, so only tentative conclusions can be drawn from the data collected from these studies regarding the difficulties novice caregivers, with no prior experience of child rearing, face during toothbrushing.

Additionally, the previously published studies include interviews with caregivers that have children who have had their full set of primary teeth for some time, so may not provide insights into influences on dyadic toothbrushing routines from the point at which they are first established at the eruption of the first primary dentition. For most children, the first primary teeth erupt at around eight-months old, with the last primary teeth erupting through the gum at around the age of 24-months (Folayan et al., 2007). It is during this time in which the full set of primary teeth that toothbrushing routines should first be established (AAPD, 2011a; NHS, 2009).

The ages of children included in these studies were generally older than the age at which dyadic toothbrushing routines are first established, which may mean that data obtained in the studies may not be relevant to exploring very early influences on the routine when they may be first established at the time of the eruption of the first primary dentition. For example, in the Hoeft et al. (2009) interview study with 48 low-income mothers, children had a mean age of five-years. The interview study conducted by Nations et al. (2008) included children closer to the age at which

toothbrushing routines are first established, at around three-years old, although this is still older than the one-year recommend by dental experts (American Association for Pediatric Dentistry, 2011; BDHF, 2010; NHS, 2009).

Further, in the Amin & Harrison (2009) interview study with 18 parents, children's mean age was 3.9 years, but with a relatively wide age range of 2.5 – 6 years. The Riedy et al. (2001) focus group study with 39 mothers and grandmothers also had a wide age range, with children being aged between 3 months and 20 years. And in Huebner & Riedy's interview study with 44 caregivers, it is not clear how old the children were, as it is only reported that 27 (61%) parents had children younger than three-years with the remainder having children up to the age of five-years. It would be informative therefore to contribute to the evidence-base provided by these published studies, by consulting mothers of *infants*.

One of the strengths of the published studies is that they have provided useful cross-cultural insights into the nature of early dyadic dental health cognitions, beliefs and behaviours around the world. However, although the data reported by the cited studies may potentially reveal cultural differences in influences on dental health cognitions, beliefs and behaviours, they do not necessarily contribute to understanding these within a UK population. Data has been provided by Mexican American (Hoeft et al., 2009), Chamorro, Filipino, Carolinian, Pohnpean, and Chuukes (Riedy et al., 2001), Northeast Brazilian (Nations et al., 2008), Canadian (Amin and Harrison, 2009) and American (Huebner and Riedy, 2010) families. Additionally,

international work examining cross-cultural differences in parental cognitions, beliefs and practices around their children's dental hygiene (Adair et al., 2004).

Of these qualitative studies, the one that has perhaps provided the most relevant insights into influences on the emergence of toothbrushing as a dyadic process, was conducted recently in the USA (Huebner and Riedy, 2010). The aim of this study was to explore sources of caregiver motivation, support, and barriers to twice daily toothbrushing with their infants and preschool-age children. More specifically the authors aimed to find out what the home toothbrushing practices of low-income rural parents of young children were. They also aimed to uncover potential determinants of the routine, and distinguish caregivers who brush their young children's teeth twice per-day from parents who brush less often. A further aim was to gain on caregivers experiences and reflections on what could support them to engage in twice-daily toothbrushing with their child.

The Huebner & Reidy (2010) interview study was conducted with 45 caregivers (44 mothers and one father) of children aged approximately three – five years living in a rural county of the United States. Semi-structured interviews containing none open-ended questions were carried out, with data then being analysed using a Ground Theory approach (Strauss and Corbin, 1998). As 40 of the 45 caregivers interviewed reported having established toothbrushing routines with their child, data is reported from those 40 caregivers that had established toothbrushing. Some of the findings from the Huebner & Riedy (2010) study concur with those from the Amin & Harrison (2009) Canadian study, such as highlighting the potential role of PSE to dyadic

toothbrushing routines and the importance of parenting strategies in overcoming child resistance to the routine. However, unlike the Amin & Harrison (2009) study, the authors of this American study explored *specifically toothbrushing*, as opposed to more general dental health routines. However, as in the Amin & Harrison (2009) study, where possible the authors of the American study attempted to divide the key influences on dental health routines into ‘facilitators’ and ‘barriers’.

Huebner & Riedy (2010) found the key facilitators of regular toothbrushing to be the following; ‘oral health beliefs’, ‘social norms’, ‘emotional reactions’, ‘self standards’, ‘self-efficacy’, ‘skills’, and ‘external supports’. Most of these facilitators identified within the Huebner & Riedy study could be conceptualised as lying at the level of the parent, and within the microsystem of Bronfenbrenner’s ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). ‘Oral health beliefs’ were facilitators when parents believed that toothbrushing routines in the home could effectively preserve their child’s dental health, and that it was their responsibility as parents to ensure these toothbrushing routines were established and maintained. ‘Social norms’ were perceived as facilitators when social support provided by the family (such as siblings) normalised toothbrushing and reinforced the importance of the routines. In addition to lying at the level of the microsystem, ‘social norms’ could be conceptualised as also lying at the level of the mesosystem of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

‘Emotional reactions’ to the consequences of not engaging in toothbrushing were cited as a facilitator by parents in this study, mainly regarding the negative reactions they felt when they imagined how ‘horrible’ dental caries was. ‘Self-standards’ were a facilitator in that parents reported that they themselves saw the importance of being dentally healthy through twice-daily toothbrushing and wanted to make sure that their preschoolers were dentally healthy also. These facilitators may also be conceptualised as lying at the level of the microsystem of Bronfenbrenner’s ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

The Huebner & Riedy (2010) study provides data related to influences on dyadic toothbrushing routines, and indicates that many of these influences may lie at the level of the microsystem of Bronfenbrenner’s ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). However, the aim of Huebner & Riedy’s study appears to be more related to *current* dyadic toothbrushing practices and the various barriers to and facilitators of these, as most of the themes reported by the authors relate to current influences on the routine in its present state, with children aged three – five years old. Minimal information can be gleaned from Huebner & Riedy’s study regarding early influences on dyadic toothbrushing when it first starts to emerge during the first year of life, as the authors perhaps did not aim to examine these very early influences.

However, data generated by Huebner & Reidy (2010) provides a useful starting point for more focussed research into these very early influences. Although the influences they describe relate to dyadic toothbrushing in the pre-school period, perhaps some of these influences could be relevant to the very early establishment of dyadic toothbrushing and its emergence as a routine behaviour, if extrapolated backwards to the start of the routine in the first year of life. Indeed, the influences identified by Huebner & Riedy may be relevant for informing an interview schedule designed to explore influences on the emergence of toothbrushing as a dyadic process through infancy. Additionally, the qualitative approach they used could be considered as appropriate when exploring in detail these potential early influences on dyadic toothbrushing routines. However, there are some practical and theoretical issues that should be considered when conducting qualitative research. These practical and theoretical issues are now discussed in relation to designing methodologically sound qualitative studies that are fit for the purpose of the research questions posed.

3.1.2 Practical and Theoretical Issues when Using Qualitative Methods to

Explore Perceived Influences on Toothbrushing as a Dyadic Process

Using qualitative methods to explore caregiver perceptions of barriers to and facilitators of emergence of toothbrushing as a dyadic process may yield data that provide in-depth insights into specific dyadic influences on dyadic toothbrushing routines. One of the strengths of qualitative research and the data it generates (e.g. from interviews) is that it can provide a greater depth of information than quantitative data (e.g. from questionnaires). However, there are some practical and

theoretical difficulties associated with using qualitative methods when exploring such issues. These issues are now summarised and discussed.

The difficulty with qualitative methods is that they are diverse, and there are several methods by which data can be analysed qualitative (Holloway and Todres, 2003). The most widely used method, and perhaps the method that has been considered the foundation of more complex forms of qualitative analyses, is that of 'thematic analysis'. It is essentially "a method for identifying, analysing and reporting patterns (themes) within data" (Braun and Clarke, 2006, pg 79). Whereas some forms of qualitative analyses, such as 'grounded theory' (Glaser, 1998) or 'interpretative phenomenological analysis' (IPA, e.g. Smith and Osborn, 2003) stem from a specific theoretical position and are applied in a standard manner across studies, thematic analysis is far more complex.

Due to the fact that thematic analysis does not have any specific theoretical underpinning, and due to its theoretical freedom, it is a useful research tool that can be applied in many diverse ways according to the kind of data that is collected and the kind of findings that need to be generated (Braun and Clarke, 2006). This flexibility also means that when thematic analysis is used, it can be used within any theoretical framework that is deemed to be appropriate. For example, when examining influences on infant developmental outcomes, thematic analysis can be used within the framework of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), which is a widely

used model within developmental psychology. This means that as data are analysed, key themes and sub-themes may be identified from the data and conceptualised using the framework of the ecological model. However, this lack of strict theoretical underpinning in thematic analysis has caused some researchers to criticise it on the grounds that the 'anything goes' ways in which it is used reduces the theoretical and methodological rigour of studies that use the method and the reliability of findings generated.

In order to overcome these criticisms and provide clear guidelines for how thematic analysis can be employed in qualitative psychology research, Braun & Clarke (2006) published a 6-phase guide to performing thematic analysis. They recommend that the flexibility of thematic analysis should not undermine the theoretical and methodological rigour of studies that employ it as long as specific steps are taken to ensure correct and transparent execution of thematic analyses.

The process involves firstly becoming familiar with the data through transcribing audio or video recordings, and then reading and re-reading transcripts. The second step involves generating initial themes by coding themes that may be of interest, usually through making notes on transcripts. After this, the third step, formal coding, begins which involves checking codes identified are consistent through the data, and then collating codes into potential themes. The fourth step involves reviewing of identified themes and generating a thematic 'map' in order to identify how specific themes may be related to one another, and how themes may be made up of sub-

themes. The fifth step involves further refining and naming of themes, until no new themes can be identified and the generation of clear definitions of each theme. Further refinements may be made, but Braun & Clarke (2006) state that refinements should not be made *ad infinitum* if further refinements do not add anything of interest to the findings, that the process of refinement of themes should be terminated. The final step involves the reporting of the findings from the thematic analysis, and the selection of extracts and quotes that facilitate the telling of the 'story' identified from the themes from data.

In addition to this 6-step process, Braun & Clarke (2006) also make some further recommendations when conducting qualitative research in psychology using thematic analysis. Firstly, they recommend that themes should not be seen to 'emerge' from the data with the researcher taking a passive role in this process. Rather, themes are 'identified', with the researcher always playing an active role in identifying patterns and themes, selecting those of interest and defining and reporting them. Although this would indicate that there is a huge degree of subjectivity involved in thematic analysis, Braun & Clarke see this as a strength of thematic analysis, as it allows a researcher to identify themes in the data that are relevant to the theoretical underpinning of their specific study and the aims that the study might have.

Further recommendations are provided by Braun & Clarke for the data analysis stage in order to ensure that the actual analyses are conducted thoroughly. For example, thematic analysis is not simply extracting a series of extracts or quotes from data that are not strung together via a theoretical or analytic narrative. The extracts and quotes selected should tell a coherent story that either may, or may not, be created within a theoretical framework, such as Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). It is also equally important to ensure that the data collection questions from an interview schedule are not used as the 'themes' that are reported. This issue of circularity between interview questions and identified themes may be resolved by using broad, open ended questions in interview schedules, that allow participants to report specific information as they see as relevant, rather than asking very specific questions. Additionally, a weak thematic analysis may have also been conducted if there is too much overlap between themes, or where themes may not be internally consistent or difficult to define.

Although the recommendations by Braun & Clarke (2006) provide a useful framework for maximising rigour of qualitative research in psychology, this form of research and data analysis is inherently subjective, leading to some difficulties with reliability of such data. Therefore, it has been suggested to be good practice to highlight possible sources of researcher bias during data collection and analyses through the use of a 'reflective journal' (Ortlipp, 2008), thereby ensuring these processes are as transparent as possible.

The traditional concept of 'reliability' relates to how consistently an instrument measures a construct of interest, which is less problematic when a quantitative measure is being used, such as a standardised psychometric test. However, when the measuring instrument is a *human being* (as is the case in qualitative research) the process of assessing reliability becomes more complex. An inherent part of qualitative research is the subjective manner in which a researcher interprets data collected, so the commonly employed method of 'inter-rater' reliability used in quantitative research becomes less appropriate. It would be unsurprising, indeed expected, that if two separate researchers analyse a set of qualitative data, that they would come to different conclusions based upon their previous experiences and knowledge and, the individual biases these bring to the process of interpretation of findings (Long and Johnson, 2000). It is therefore recommended that several techniques be used to assess reliability, or what is more appropriately termed 'dependability', of qualitative research findings.

Additionally, methods of checking reliability of qualitative data have been developed, such as inter-rater reliability checks (Marks and Yardley, 2004), reflection on possible sources of bias (Long and Johnson, 2000) and presenting findings to the population researched to gain their feedback on accuracy of findings (Creswell and Miller, 2000). In addition to using a traditional inter-rater technique, it is often appropriate in qualitative research to also check accuracy of interview transcripts (MacLean et al., 2004; McLellan et al., 2003). Several of these methods were reported as having being used to check reliability of data obtained from the Amin & Harrison (2009) and Huebner & Riedy (2010) studies described above.

Amin & Harrison (2009) reported that they used open-ended questions in order to elicit more truthful responses from the participants, and also used additional sources of information including observations and field notes, to validate their findings. However, they do not report in their published paper exactly *how* these extra sources of information were used to validate their interview findings. Additionally, Amin & Harrison (2009) also report that they used transcripts of interviews to confirm and clarify statements made by participating caregivers during the interviews. They also report that both authors compared all interview transcripts to audio-recordings to ensure accuracy of transcription and also both authors checked interpretation/coding of transcribed data. Again however, they do not systematically report in their published paper exactly how these processes were followed. For example, it is unclear whether they used statistical methods, such as Cohen's kappa statistics, to check degree of concordance between the two author's interpretations of the data.

In the Huebner & Riedy (2010) study there are similar difficulties with understanding from the published paper exactly *how* reliability assessments were carried out. Although like Amin & Harrison (2009) Huebner & Riedy also report that they included open-ended questions, they do not specifically state that this was to encourage the elicitation of truthful responses. Additionally, Huebner & Riedy (2010) also report comparing interview transcripts to audio-recording to ensure accuracy of transcription, although they provide no more information to detail how this process was followed. For example, they do not report whether authors checked each other's transcripts for accuracy, or just their own. Huebner & Riedy also do not report having

used any additional reliability check, such as checking reliability of data interpretation and coding.

3.1.3 Aims of the Study

In light of the current paucity of published data around the influences on the emergence of toothbrushing as a dyadic process through infancy, this study aims to gather mother's reflections on their experiences of establishing dyadic toothbrushing as a dyadic process with their infant. Specifically, the experiences of novice mothers residing in areas of high social deprivation in which there are high rates of childhood dental caries are the principal focus of the study. This might allow identification of a more complete range of the various potential challenges to the routines, as caregivers of multiple children may be better practiced at this particular infant-care task. Novice mothers of first-born infants have never been focussed on in such a study of dyadic toothbrushing before.

A semi-structured qualitative interview (see Appendix C) methodology is used, in order to gather detailed insights into mother's perceptions of their experiences engaging in this infant-care task. Some of the key themes identified within the Huebner & Riedy (2010) qualitative interview study with caregivers of pre-school aged children are used to inform items within the interview schedule used within the present study (see Appendix C). However, as the present study explores influences on the emergence of toothbrushing as a dyadic process through *infancy*, additional themes to those identified by Huebner & Riedy are included in the interview schedule.

This is to reflect that the focus of the study is influences on the emergence of toothbrushing as a dyadic process in infancy from the *first year of life*. Huebner & Riedy's study in contrast focused influences on current toothbrushing during the *pre-school years*. The present study makes an original contribution to the literature as for the first time mothers are asked to reflect back on when they very first started brushing their infant's teeth and describe how that infant-care task has changed and evolved over the first year of toothbrushing.

Qualitative data generated from the interviews are coded and analysed using thematic analysis guidelines for qualitative research in psychology as recommended by Braun & Clarke (2006). 'Thematic network analyses' (Sutton, 2008) are reported in order to identify themes and also sub-themes subsumed within them. Mother's reflections on their experiences of establishing toothbrushing as a dyadic process with their infant are used to identify themes from interview data. These themes are used to suggest maternally perceived barriers to and facilitators of the establishment and maintenance of toothbrushing, which are then located on the various levels of Bronfenbrenner's ecological model in order to allow conceptualisation (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

3.2 METHOD

3.2.1 Design

This was a qualitative, semi-structured interview study with first-time mothers in Salford, Greater Manchester to examine how mothers with no previous experience of child rearing coped with the task of establishing toothbrushing as a dyadic process through infancy.

3.2.2 Participants

Relevant ethical approval was gained to recruit 16 participating first-time mothers into the study. This number of participants was deemed to be a large enough sample size to reach data saturation given sample sizes in previous qualitative interview studies of child dental health behaviours (Amin and Harrison, 2009). Ethical permission to conduct this study was granted on 26/04/2010 by the University of Salford Research Ethics Committee Ref: REP10/036. Access to potential participants was provided by child-care professionals working in local Children's Centres and all were interviewed individually in their own homes. Participants were also offered the opportunity to be reimbursed for their time with 'high street' vouchers worth £5 that could be used in a number of well known stores.

The participants resided in either one of two wards in Salford, Greater Manchester associated with the worst rates of decayed, missing and filled teeth (DMFT) in children under 5-years old. These wards were selected as it was presumed that mothers

residing in them would have potentially encountered a significant number of difficulties when establishing dyadic toothbrushing and then maintaining through the period of infancy. This is due to the fact that in these two wards, the percentage of children with decayed, missing or filled teeth is 70-79% and 60-69% (Pretty et al., 2007). These wards in Salford fall within the 7% most deprived areas in the United Kingdom, as measured by the Multiple Indices of Deprivation (IMD) (ODPM, 2004). Detailed demographic information of the sample in the study was collected, such as type of occupation of mothers' and level of education was evaluated.

In order to evaluate employment types of mothers in the study the 'Registrar General's Scale of Social Class and Socio-economic Groups' was used. The scale has also been used in recent qualitative studies published in high impact journals regarding infant attention (Gaffan et al., 2010), mothers early life experiences and age at first pregnancy (Nettle et al., 2011) and psychological adjustment of mother-child dyads when children were conceived by gamete donation (Golombok et al., 2011). The scale is used to classify employment into the following categories; I) Professional, II) Managerial/Technical, IIIa) Skilled (non-manual), IIIb) Skilled (manual), IV) Partly Skilled, V) Unskilled, VI) Other. Table 3.2 summarises demographic characteristics of mothers in the sample.

Table 3.3- Demographic details of maternal caregiver (n= 16)

Maternal Age in years	Mean 30.66 (sd 3.53; range 22.83 – 35.00)
Infant Age in years	Mean 2.22 (sd .16; range 1.92 – 2.50)
Infant Gender	8 Female (50%), 8 male (50%)
Ethnicity	12 White-British (76%) 1 White-Irish (6%) 1 White-other (6%) 1 White/Afro-Caribbean (6%) 1 Pakistani (6%)
Marital status	8 Married (50%) 7 Cohabiting (44%) 1 Divorced (6%)
Current employment status	2 Full-time employment (13%) 6 Part-time employment (37%) 2 Part-time education (13%) 6 Full-time carers (37%)
Maternal employment type	7 Skilled (non-manual) (44%) 6 Unemployed/full-time carer (38%) 2 Partly skilled (12%) 1 Skilled (manual) (6%)
Educational record	8 Higher education (50%) 8 Further education (50%)

Although all mother’s resided in two of the most deprived wards of Salford, 8 mothers (50%) and 7 fathers (44%) had attended higher education and all but one were living with a co-caregiver (husband or partner). A total of 12 mothers were white-British (76%) with 1 mother being white-Irish (6%), 1 being white-other (6%), 1 being white-Afro-Caribbean (6%) and 1 being Pakistani (6%).

3.2.3 Materials

A participant information sheet (see Appendix A) was developed to inform participants about the study and a demographic details questionnaire (see Appendix B) was developed in order to allow information such as employment status and ethnicity to be gathered. This demographic information was collected in order to allow more precise assessment of socio-economic status and also identify whether the sample of participants was representative of Salford in terms of ethnicity. An interview schedule was also developed (see Appendix C). A digital Dictaphone was used to record all interviews (following agreement from participants). NVivo version 8.0 software was used for analysing qualitative data from the interviews.

3.2.4 Procedure

Following consent, participating mothers were contacted to organise a convenient date and time for their interview. Mothers were then visited at home where interviews were held and lasted approximately 30 minutes. All interviews were recorded using a digital Dictaphone and then fully transcribed verbatim.

3.2.5 Interview Schedule

The interview schedule was partly informed by themes identified from previous qualitative research around influences on dyadic toothbrushing during the pre-school period (Huebner and Riedy, 2010). However, additional appropriate items were added in order to explore establishment and maintenance of dyadic toothbrushing routines

earlier than the pre-school period in *infancy*. Within the interview schedule, questions were included that explored maternally perceived barriers and facilitators of dyadic toothbrushing that may be located at each of the levels of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

Interview schedules were semi-structured and composed of open ended questions that were designed in such a way that they did not ask about specific influences on the establishment of dyadic toothbrushing and its emergence as a routine behaviour through infancy. Rather, mothers were encouraged to talk around general topics in order to gain more accurate impressions of mother's true opinions and feelings around their experiences of influences on the emergence of toothbrushing as a dyadic process through infancy. Open-ended, general items were included to also ensure that at the data coding and analysis stage that identified themes did not just simply map onto the topics of the interview schedule items.

3.2.6 Data Coding and Analyses

During the process of preparing data for coding and analysis a series of 6-steps were followed, which have been recommended for use in qualitative research in psychology (Braun and Clarke, 2006):

i) Transcription and becoming familiar with the data

Once all data were collected interviews were transcribed verbatim (see Appendix D for an example interview transcript). Transcription was conducted by the researcher as this process was seen as an important means of becoming familiar with the data. Before data were analysed, transcription accuracy was checked in 20% (n=3) of the audio files and their corresponding transcripts by a second researcher not associated with the study. This is in accordance with recommendations regarding transcription accuracy checks that are usually conducted when a transcription service company is used instead of the researcher transcribing their own data (MacLean et al., 2004; McLellan et al., 2003). Additionally it was deemed to be appropriate for the second researcher to check transcription accuracy, as they were not directly associated with the study and therefore were considered to be adequately impartial.

ii) Generating initial codes

After all interviews were fully transcribed in Word, documents were imported into QSR NVivo 8 (NVivo, 2009). During the process of transcription sections of interviews were marked using the 'track changes' option in Microsoft Word in order to allow initial themes of interest to be identified and brief notes to be made alongside transcription text. Then, the formal process of thematic coding was carried out.

iii) Searching for themes

The steps taken to code data were based on those reported in the literature (e.g. Braun and Clarke, 2006) and a thematic network approach was taken to code interview data collected in the present study. A number of steps were taken when

coding the data in the present study. Data reduction started by devising a preliminary thematic framework and then codes were applied to the text, by dissecting the text into meaningful segments such as paragraphs, sentences or quotes and where appropriate coding each segment using one of the three themes in the thematic framework.

iv) Reviewing themes

Key sub-themes within each of these three main themes were identified and coded as nodes in QSR NVivo 8 (NVivo, 2009). Once data had been coded using the initial thematic framework, more specific themes were then identified within these themes. This was done by re-reading the sections of text that had been thematically coded and then refining these thematic codes into more specific, internally homogenous thematic codes that were specific enough to be externally heterogeneous and discrete from any others. This meant that what initially began as one theme was disaggregated into a number of separate sub-themes. Following this process of developing initial sub-themes, where appropriate, if a number of sub-themes were deemed to be sufficiently similar to one another, they were collapsed into one over-arching theme.

v) Defining and naming themes

Each identified theme and sub-theme was named and the concept each theme represented was accurately described and defined. A thematic network containing all identified themes and sub-themes was also constructed (see Figure 6), in order to allow the relationships between themes and sub-themes to be examined.

vi) Reporting on findings

Following naming and defining of sub-themes and themes, each were located upon Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) in preparation for conceptualisation of how each could be inferred as either a barrier to or facilitator of the establishment of dyadic toothbrushing and its maintenance as a routine with infants. Additionally, key extracts and quotes were selected based on how well they represented each theme and sub-theme, and told the 'story' of the data most vividly.

Then, all transcripts and their themes and sub-themes were checked three times in order to check accuracy of coding and search for possible further themes and sub-themes that had not originally been identified. This process was continued until no new themes or sub-themes were identified from the data and theoretical saturation had been reached.

3.2.7 Reliability Analyses

In addition to the main data coding and analyses, data were also checked for reliability. Two methods were utilised in this study to check reliability and dependability of study findings, these being inter-rater reliability checks and also keeping a reflective diary of experiences whilst collecting data and coding and analysing it. These were based upon recommendations in the literature and surpassed levels of methodological rigour employed in previous child toothbrushing interview studies (Amin and Harrison, 2009; Huebner and Riedy, 2010). The reflective diary can

be found in Appendix F and the outcomes from the inter-rater reliability analyses are now reported.

i) Inter-rater reliability

Once all data had been coded and themes and sub-themes identified, reliability of coding was checked by a second, impartial researcher who had not been directly associated with the research. In accordance with the recommendations in the instructions to authors of the journal 'Social Science and Medicine', the codings assigned to 20% (n=3) of data transcripts were checked for reliability. Although there is some disagreement in the literature as to the appropriateness of reliability checks in qualitative research, the decision was made to conduct a reliability check as this would demonstrate methodological rigor, provide greater confidence in study findings and improve the chances of publication of study findings. It was not possible for the second researcher to be completely blind to the aims of the study, as they had to know what the identified themes were in order for them to use the themes to check the reliability of the themes. However, they were blind to the locations within the transcribed interviews where the themes were identified during the main data analysis procedures.

Following inter-rater reliability analyses with a second researcher (TK) unaffiliated with the study, an Intra-Class Coefficient (ICC) was generated using Cohen's kappa (κ) statistics to derive level of agreement of sub-themes assigned to data collected by the first researcher (SE) from 20% of the sample of participating mothers. This is in accordance with best practice guidelines in the literature regarding the use of ICC

when ascertaining inter-rater reliability (Streiner, 2003). Before conducting inter-rater reliability analyses, the second researcher also checked accuracy of transcription of these data, by comparing audio data to transcripts. All transcripts were found to be accurate representations of audio data.

The initial ICC coefficient generated for all sub-theme codings was .76 ($p < .0001$), indicating overall substantial reliability across all sub-themes included in the analyses. Additionally, reliability co-efficients were generated for each of the main themes which contained a number of sub-themes. Reliability coefficients of the separate sub-themes were as follows;

- Maternal Cognitions: $\kappa = .33$ ($p = .22$)
- Maternal Behaviours: $\kappa = .69$ ($p = .01$)
- Infant Behaviours: $\kappa = .66$ ($p = .07$)
- Support and Advice: $\kappa = .89$ ($p = .02$)

As 'Family History' was comprised of only one theme, it was not possible to conduct a statistical analysis of inter-rater reliability of this. However, closer inspection of the data revealed perfect agreement between the first and second researcher on codings for this variable.

Reliability for each of the individual themes was found to be excellent for 'Support and Advice' and moderate for 'Maternal Behaviours' and 'Infant Behaviours'. However, the initial ICC for 'Maternal Cognitions' was found to be low. Further investigation discovered that discrepancies between first and second researcher codings for the

sub-theme of 'outcome expectancies' had occurred. Discussion between the two researchers revealed that the definition provided by the first researcher for this sub-theme had not been clear enough for the second researcher to be able to code the sub-theme accurately. The definition provided was as follows;

'Perceived expectancies of establishing toothbrushing routines: this was related to any statements made by mothers about their expectations of the outcomes of their attempts to establish toothbrushing routines with their infant.'

When coding transcripts for 'outcome expectancies', the second researcher had only coded sections for this sub-theme when statements in the transcript related to whether mothers thought they would be successful at establishing toothbrushing as a dyadic process with their infant. However, the second researcher had intended the definition for the 'outcome expectancies' sub-theme to have been broader and more in keeping with the classic definition of 'outcome expectancies', which is that they relate to a person's estimation that a given behavior will lead to certain outcomes (Bandura, 1977b). These outcomes need not necessarily be simply an individual's estimation of their level of success. Rather, 'outcome expectancies' may also relate to an individual's estimation of the *consequences* of enacting (or failing to enact) certain behaviours. Therefore, the first researcher coded the following statement by Participant 2 as being related to 'outcome expectancies' as she outlines her beliefs about what would happen to her infant's teeth if she did not successfully establish dyadic toothbrushing with her son;

“...I’ve heard a lot of horror stories about kids having to have their teeth pulled out and things like that. There’s absolutely no way at all I want to have that for (child)... ”

Participant 2

Whereas the second researcher did not code the above statement as reflecting ‘outcome expectancies’ due to the lack of clarity in the definition for this sub-theme. However, upon improving the definition for ‘outcome expectancies’ the second researcher agreed that she would actually code this statement from Participant 2 as reflecting ‘outcome expectancies’. The definition for the ‘outcome expectancies’ sub-theme was revised as follows;

***‘Perceived outcome expectancies of establishing toothbrushing routines:** this was related to any statements made by mothers about their expectations of how successful their attempts at establish toothbrushing routines with their infant would be. It was also related to their expectations of what would happen to their infant’s dental health if they were successful or unsuccessful at establishing toothbrushing routines.’*

Refining the definition in this way meant that the reliability for the ‘Maternal Cognitions’ theme improved significantly from ICC = .33 to ICC = .60 ($p = .10$), indicating moderate reliability for this theme. This also improved the overall reliability across all five themes included in the analyses to ICC = .77 ($p < .0001$), which can be considered to reflect substantial reliability.

- **Other Areas of Discrepancy:**

More detailed qualitative reliability analyses were then conducted to uncover other possible areas of discrepancy between the two researcher's coding of the data for the 'Maternal Behaviours', 'Infant Behaviours' and 'Support and Advice' themes. This revealed that in some cases sections of text could potentially be coded as either one of two different sub-themes. As it is considered to be better practice to code a section of text as describing only one sub-theme, this kind of discrepancy is difficult to avoid in qualitative research, especially when the section of text cannot be disaggregated into smaller sections. So, for example, the following statement was coded by the first researcher as 'modeling mother' and by the second researcher as 'allowing child to have a go'.

"...he loves you know, doing anything adults do, so he loves brushing his teeth".

Participant 2

Another example of this kind of discrepancy was found. Whereas the first researcher coded the following statement as 'brushing early', the second researcher coded it as 'professional advice';

"Well, you get like a brush and thingy at the 8 month check with the health visitor. He got his first tooth when he was about 6 months..."

Participant 2

Further, the following statement was coded as 'perseverance' by the first researcher and 'routinisation' by the second researcher;

"That is the main thing and I think she got used to brushing her teeth cos I stuck to it every day. It's just persistence really. Like make sure you do it every day so they get used to it. So that they know what's going to happen."

Participant 10

Finally, the following statement was coded by the first researcher as 'restraining infant' and by the second researcher as 'support from co-caregiver'.

"...he [husband] has to like hold her in a head lock and she just screams, it's awful!"

Participant 14

Although such discrepancies were identified, the two researchers agreed that the sub-themes identified were all represented throughout the interview transcripts. Additionally, the researcher unaffiliated with the study did not identify any sub-themes that they disagreed could be relevant to mothers engaging in dyadic toothbrushing with their infant that aligned with dental expert guidelines. The unaffiliated researcher also did not identify any potential additional themes from the text that the first researcher may have failed to identify in the analyses. This would indicate that the thematic analyses conducted successfully identified all potential

influences associated with mothers engaging in dyadic toothbrushing with their infant that aligned with dental expert guidelines.

3.3 FINDINGS

The following section describes the main themes and sub-themes identified from the data and where each of these main themes and sub-themes may be located on the ecological model of development. Then, fuller descriptions of these main themes and sub-themes are provided, along with quotes derived from interviews to illustrate main themes and sub-themes.

3.3.1 Outline of Main Themes and Sub-Themes

Following thematic analyses, 5 main themes were identified as maternally perceived barriers to and facilitators of dyadic toothbrushing through infancy. Within 4 of these main themes a number of sub-themes were identified. Each of these 5 key themes (and their related sub-themes) is depicted in the 'thematic network' overleaf (see Figure 3.1). This thematic network also depicts where each of these themes are located upon Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Following the thematic network analysis, fuller descriptions of each main theme and corresponding sub-themes were generated, along with interview quotes to illustrate the themes identified. Quotes reported in this chapter have been selected as they are representative of each sub-theme, and illustrate well the concept represented in each sub-theme. For tables containing all quotes relevant to the themes, see Appendix E.

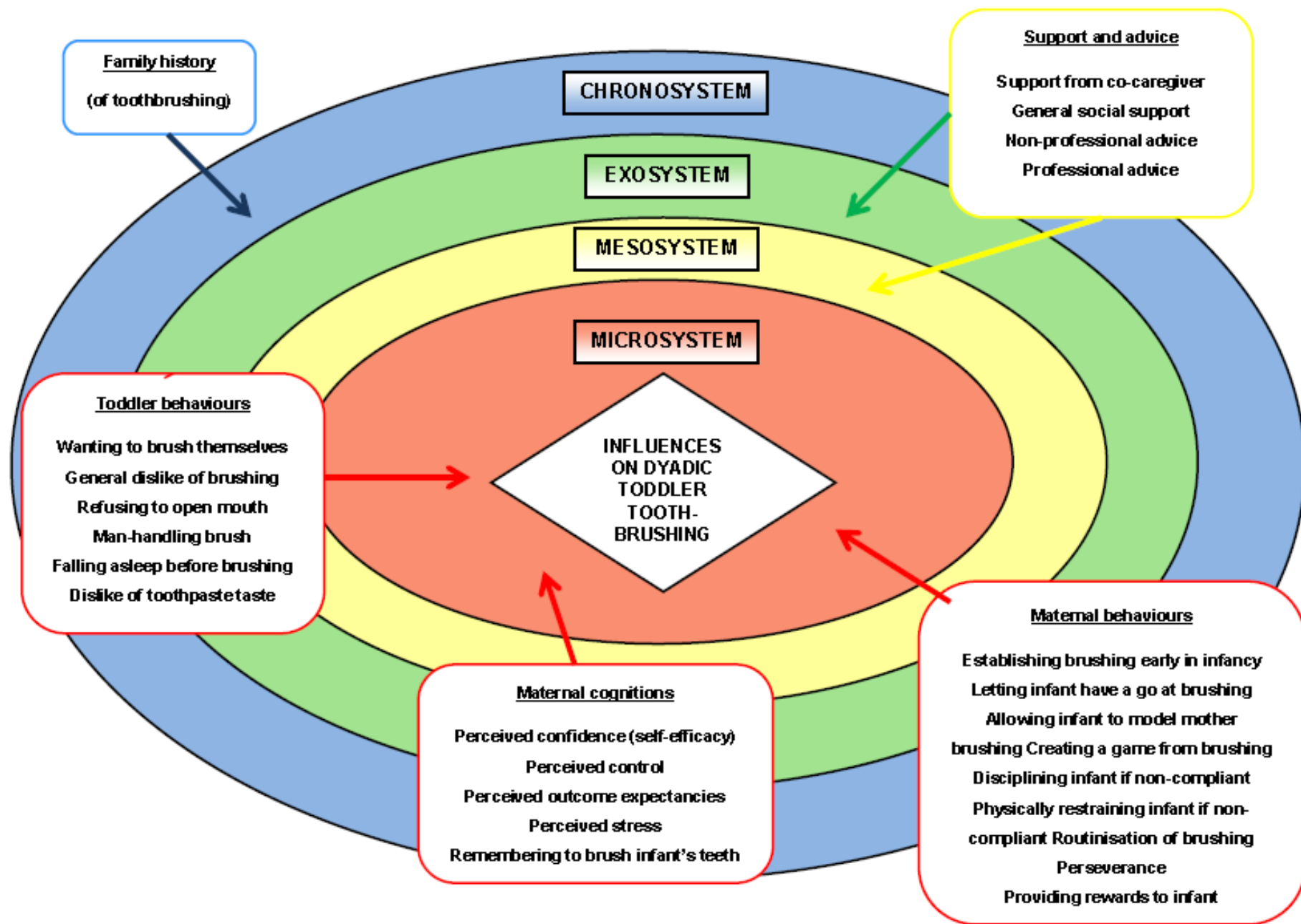


Figure 3.1- Thematic network of influences on early dyadic toothbrushing routines

3.3.2 Full Description of Themes and Corresponding Interview Quotes

The thematic network presented in Figure 3.1 depicts the multiple themes and sub-themes representing the range of influences on toothbrushing as a dyadic process with infants identified from thematic analyses of qualitative data. Each theme and sub-theme is located on the various levels of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Each of the identified themes and sub-themes identified that represent these multiple influences toothbrushing as a dyadic process with infants are now discussed. The relevant sub-theme identified from interviews are reported below with sub-theme title and then full definition underlined.

MICROSYSTEM INFLUENCES ON TOOTHBRUSHING AS A DYADIC PROCESS.

Multiple influences on toothbrushing as a dyadic process were identified as located within the mother-infant dyad and were associated with maternal variables (cognitions and behaviours) and infant variables (behaviours). These influences were conceptualised as lying at the level of the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

Main Theme 1- MATERNAL COGNITIONS: ‘Maternal cognitions’ are the attitudes and perceptions that mothers may have concerning their parenting role. Maternal cognitions were anything related to a mother’s attitudes or beliefs about dyadic toothbrushing with their infant and how they were associated with how easily dyadic toothbrushing was established and maintained. Most commonly reported cognitions are provided first followed by less commonly reported cognitions.

MATERNAL COGNITIONS- Sub-themes:

i) Perceived maternal confidence for toothbrushing- Perceived confidence in establishing and maintaining twice-daily toothbrushing with infants. Almost a third of the mother’s interviewed (6/16) alluded to perceptions of confidence and the importance of this to being able to initiate dyadic toothbrushing with their infant and then maintaining it. Some described a cognitive process whereby they perceived the task of establishing and maintaining dyadic toothbrushing with their infant as challenging, but also believed that they could be successful in doing this. For example, one mother commented;

“...you’ve got to trust yourself a lot more than, like I was a bit ‘oh I don’t know what to do’. But actually you do know what to do.”

Participant 8

However, because mothers saw the task as one that was necessary and important, they therefore felt confident they could, and should, establish and maintain dyadic toothbrushing successfully, even in the face of difficulties. For example, one mother

described that she had to persevere with maintaining dyadic toothbrushing with her son, even when he was exhibiting difficult, non-compliant behaviours;

“...well he used to do it but he doesn’t like me grabbing him. But I’ve got to do it so it’s just tough.”

Participant 15

On the whole, mother’s tended to describe that they had a responsibility to initiate dyadic toothbrushing with their infant, despite any difficulties they might have experienced whilst doing this.

ii) Perceived Control for toothbrushing- Perceived control of brushing infant’s teeth twice a day. Three mothers reported feeling confident and in control in their parenting role and reported fewer problems when establishing toothbrushing as a dyadic process with their infant. They saw that as a mother, they were the individual who controlled toothbrushing, not their infant. For example, one mother commented;

“I’m the parent, she’s not the parent, so I need to make a decision on her behalf...”

Participant 1

Mothers who described being in control over brushing their infant's teeth for them, described the fact that despite some non-compliance from their infant, they felt that they had enough authority to ensure they did brush their infant's teeth regularly and to an adequate level of hygiene.

iii) Perceived expectancies of establishing toothbrushing routines- Perceived positive outcomes of establishing and maintaining twice-daily with infants. Three mothers had positive 'outcome expectations' about toothbrushing and believed it was an important means to ensuring their infant's dental health. For example, one mother described some of the potential outcomes that may result from taking care of her infant's dental health through toothbrushing;

"...I've heard a lot of horror stories about kids having to have their teeth pulled out and things like that. There's absolutely no way at all I want to have that for (child's name)..."

Participant 2

On the whole the mothers interviewed also reported that they believed that they would have a successful outcome from their attempts at establishing toothbrushing as a dyadic process with their infant;

"...they're all going to get there at some point, it's not like it's going to last forever."

Participant 1

iv) Perceived maternal stress- Perceived stress that might be disruptive to twice-daily toothbrushing with infants. Three mothers reported feelings of stress related to difficulties they experienced whilst attempting to initiate dyadic toothbrushing when it was first established and then maintained. One mother in particular (Participant 9) reported that she suffered from Chronic Fatigue Syndrome and that this caused even routine parenting tasks such as toothbrushing to be tiring and stressful;

“...having Chronic Fatigue... it’s hard to know what’s normal for a baby. But I just have to deal with it and stuff, depending on whether it’s a good day or a bad day.”

Participant 9

v) Maternal ability to remember to brush- Ability to remember to brush infant’s teeth twice a day. One mother also reported experiencing some difficulties in remembering to brush her infant’s teeth, especially at night;

“I’m forgetful. I know you can’t really forget about it. When you’re thinking of everything else, you just forget.”

Participant 10

Main Theme 2- MATERNAL BEHAVIOURS: All the mothers interviewed reported using a number of parenting behaviours to help them overcome perceived barriers to establishing dyadic toothbrushing with their infant. These perceived barriers were largely associated with difficult, non-compliant infant behaviours. Underlying these parenting behaviours were key maternal cognitions associated with control and self-efficacy; when mothers felt confident and in control in their parenting role, they reported the use of positive parenting behaviours that facilitated dyadic toothbrushing. The parenting behaviours employed by mothers to facilitate dyadic toothbrushing with their infant are reported below. These parenting behaviours are reported from most frequently reported to least frequently reported parenting behaviours.

MATERNAL BEHAVIOURS- Sub-themes:

i) Establishing toothbrushing routines early in infancy- Perceived ability to and importance of establishing dyadic toothbrushing early in infancy. Establishing dyadic toothbrushing as early as possible was reported by almost all mothers (13/16). Toothbrushing was established either before the first tooth had erupted or as soon as this happened and was reported as being important in helping infants get used to toothbrushing from as young an age as possible. For example, one more stated;

“...it’s best starting as early as possible, maybe even when they’ve only got gums. Just to try and get them used to having the toothbrush.”

Participant 11

ii) Allowing infant to have a go of brushing their own teeth- Using the strategy of allowing infant's to have a go at brushing their own teeth as a means to aid compliance during twice-daily toothbrushing. One of the key findings from the data that provides an insight into how closely toothbrushing in the sample aligned with dental expert guidelines relates to mothers allowing their infant to have a go at brushing their own teeth. Approximately half of mothers reported using this strategy (9/16) to increase infant compliance during toothbrushing. This was in spite of the dental guidelines that state that parents should brush infant's teeth for them, and that toothbrushing for children under the age of seven-years should be closely supervised by an adult. This technique was reported by some mother's to be a response to their infant exhibiting difficult behaviours due to their drive for autonomous self-toothbrushing. For example, one mother commented that she allowed her son to brush his own teeth, and that only occasionally she would brush them for him to make sure they were cleaned effectively;

"...he likes to do his own teeth. Like we always again say 'open your mouth' and we check. And sometimes I do them again..."

Participant 8

Some comments made by mothers also raised questions about how effectively their infant's teeth were actually being cleaned by allowing their infant to brush their own teeth, for example;

“She brushes her own teeth now, but she does more chewing and sucking, but she’s quite good...”

Participant 4

Some mothers also used a turn-taking technique, by allowing their child to have a go at holding and using the brush, and then taking over to ensure their infants teeth were cleaned effectively. For example;

“...she gets to have a go, and then we rinse the tooth brush. And then I have another go, and she gets another go, and we rinse the toothbrush and it goes on.”

Participant 1

iii) Infant modelling mother’s toothbrushing behaviour- Providing opportunities to allow infant’s to observe their caregiver brushing their own teeth to facilitate infant learning about toothbrushing. Approximately half of mother’s interviewed (7/16) reported that they used a toothbrushing technique in which they brushed their own teeth whilst allowing their infant to observe whilst they were doing it. This ‘modelling’ technique was sometimes used in conjunction with the mother also brushing their infant’s teeth during the same toothbrushing episode. For example, one mother said that;

“...if he sees me doing mine he’ll want to do his as well. Like usually I do his in the morning when I’m doing mine and again in the evening. So he sees me doing mine.”

Participant 3

This theme was originally coded as 'joint brushing' reflecting the parenting behaviour of brushing their own teeth whilst brushing their infant's. However, upon further data collection and analysis it became clear that the specific manner in which this parenting behaviour facilitated toothbrushing was that it allowed the infant to 'model' their mothers toothbrushing behaviour through observation. However, this technique does raise questions as to how much mothers were in control of holding and using their infant's toothbrush for them during toothbrushing episodes. For example, one mother specifically described how her daughter copied toothbrushing through observation;

"I stand her on the toilet and I brush mine she does hers. And she copies. She copies a lot."

Participant 10

iv) Creating a game out of a toothbrushing episode- Turning twice-daily toothbrushing into a fun game to aid infant compliance. Another strategy, reported by approximately one-third of mothers (6/16) was turning toothbrushing into a fun game, for example, some of the mothers described singing a special song whilst brushing;

"...and we've got a silly song that we sing, that takes roughly a minute and a half to sing. It's kind of about brushing teeth and counting to 2, brushing teeth and counting to 3. It's just a silly..."

Participant 9

Other mothers also reported techniques such as making facial expressions that they encouraged their child to copy in order to get their child to open their mouth in order to allow toothbrush her to insert the toothbrush into her infants mouth and brush the teeth. One mother describes using this technique;

“I’ve just try to make a game of it. So we say ‘eee’ for brushing the front teeth and then ‘aaah’, and then when she has her mouth open I get in and brush the back ones.”

Participant 1

This technique may have been potentially more time consuming and certainly more effortful than simply brushing an infant’s teeth. However, because mothers were willing to take the effort and time to make toothbrushing fun for their infant, it may illustrate how important they saw infant compliance with the establishment of dyadic toothbrushing.

v) Disciplining infant if non-compliant during toothbrushing- Methods of disciplining infants for non-compliant behaviour during twice-daily toothbrushing.

Approximately a third of mothers (6/16) reported that sometimes it was necessary to discipline their infant (e.g. by with-holding privileges) when they exhibited non-compliant behaviours during toothbrushing. For example, one mother described how she withheld television privileges if her son displayed resistance to toothbrushing;

Researcher. "So in terms of brushing his teeth now then. He's alright with that?"

Participant. "Yeah, but if he doesn't do it I just say he can't watch telly."

Participant 11

This again may illustrate how important mothers considered toothbrushing to be. Had they not seen this parenting task as worthy of any time or effort, they may not have insisted on infant compliance with dyadic toothbrushing.

vi) Restraining infant if physically non-compliant during toothbrushing- Physically restraining infant during dyadic toothbrushing to overcome physical non-compliance.

The more punitive strategy of physically restraining their infant to ensure they could insert the toothbrush into their infants mouth and proceed with toothbrushing by just over one third (6/16) of mothers. This technique was usually employed when infants displayed non-compliant behaviours in response to toothbrushing (e.g. tantrums). For example, one mother described;

"...this sounds awful, but there are times when you have to literally hold him down to do it!"

Participant 3

The fact that mothers reported that they sometimes resorted to this parenting strategy illustrated well their level of determination to enforce dyadic toothbrushing with their infant, in which the mother was in control of holding and using the toothbrush to clean their infant teeth. This also possibly reflected how important mothers felt brushing their infant's teeth were.

vii) Routinisation of toothbrushing- Importance of turning twice-daily dyadic toothbrushing into a routine behaviour. Routinisation of toothbrushing and the embedding of toothbrushing into a wider repertoire of routine hygiene behaviours were also reported as being important to the maintenance of the behaviour as a routine by just under one-third of mothers (5/16). One particular mother described how toothbrushing fitted into a structured morning routine;

"...we'd always go downstairs and have breakfast first before then going upstairs and doing like washing, toothbrushing, and getting dressed."

Participant 8

The fact that mothers spoke about toothbrushing as an important routine behaviour demonstrated that they believed toothbrushing to be a fundamental aspect of infant-care like feeding and sleep routines. They also described seeing routines as essential to caring for their infant;

"I think routine is vital."

Participant 7

iix) Maternal perseverance with toothbrushing when faced with difficulties- The importance of persevering in the face of difficulties when trying to establish and maintain twice-daily dyadic toothbrushing routines. A quarter of mothers (4/16) also reported that it was important to persevere in the face of difficulties when trying to initiate dyadic toothbrushing when it was first established and then maintained. For example, one mother viewed persevering with dyadic toothbrushing as essential to getting it successfully established;

“Like don’t give in really. That is the main thing and I think she got used to brushing her teeth cos I stuck to it every day. It’s just persistence really. Like make sure you do it every day so they get used to it.”

Participant 10

Difficulties that required perseverance to overcome tended to be around difficult, non-compliant behaviours that disrupted toothbrushing episodes or general infant dislike of toothbrushing. One mother described this by stating;

“Persevere with it. Even if they don’t want to do it, eventually they’ll get used to it.”

Participant 11

Although these difficulties were challenging for mothers to cope with, the fact that they persevered in order to overcome them and enforce toothbrushing, perhaps demonstrated how important mothers believed toothbrushing to be.

ix) Providing rewards for infant compliance during toothbrushing- Importance of, and kinds of, rewards provided to infants for compliant behaviour during twice-daily dyadic toothbrushing. One mother (Participant 9) also reported that it was important to provide rewards to her infant when they exhibited compliant behaviours during toothbrushing. The use of this positive parenting strategy to encourage infant compliance during toothbrushing was used by this mother through providing a bedtime story after compliance with toothbrushing;

Researcher. "So you use the story as a reward?"

Participant. "He loves books. So it's kind of a lot of the 'I don't want to' is dealt with by 'that's fine but then I don't want to read a story for you'. 'Oh you've got clean teeth, that's great'."

Participant 9

Main Theme 3- INFANT BEHAVIOURS: Infant behaviours were particularly important in determining how easy mothers found it to initiate dyadic toothbrushing when it was first established and then maintained through infancy. Difficult infant behaviours such as non-compliance and oppositional-defiant behaviours were found to be particularly relevant and a widely-reported problem being reported by almost all mothers interviewed (14/16). As reported in the previous section regarding the main theme of 'maternal behaviours', mothers employed a number of strategies to overcome these difficult infant behaviours to enforce toothbrushing. These infant behaviours are reported below, with those most commonly reported outlined first.

INFANT BEHAVIOURS- Sub-themes:

i) Infant wanting to brush themselves causes non-compliance during toothbrushing- Infants desire to brush their own teeth and how this may disrupt twice-daily dyadic toothbrushing. The most common difficult, non-compliant infant behaviour that inhibited toothbrushing was infant attempts to man-handle the toothbrush and brush their own teeth, which was reported by half of mothers (8/16). Mothers reported that this made the task more difficult and time-consuming, and also potentially meant that their child's teeth may not be brushed effectively. For example one mother reported that;

"...he wants to do it himself. But you know if they do that then they're not going to do it properly."

Participant 7

However, some mothers did not appear to recognise that by allowing their infant to brush their own teeth, this may risk their child's teeth not being cleaned effectively. For example, one mother expressed pride in the fact that her 2-year old daughter brushed her own teeth;

"I'd give her one and then she'd brush. But yeah, she just took to it and she loves it. She's dead willing to do her teeth."

Participant 13

As reported in the previous section on 'maternal behaviours', by mothers sometimes utilising this infant desire to brush themselves in a positive way it actually facilitated the establishment of dyadic toothbrushing. Although allowing an infant to hold the brush themselves and use it to have a go at brushing their own teeth is not strictly aligned with the dental expert guidelines, as a strategy it was reported as encouraging infant compliance in dyadic toothbrushing. Some mothers reported that by allowing their infant to hold their toothbrush and attempt to brush their own teeth they actually started to enjoy the activity, and gained some ownership of the task. For example, one mother described that her daughter actually enjoyed brushing her own teeth;

"...as she's got older she honestly loves brushing her teeth. She brushes her teeth and then she does it again and again. Like with washing her hands. She's addicted! "

Participant 10

This theme was originally coded as 'infant handling toothbrush'. However, after collecting and analysing further data, this theme was refined as it became clear that infant's attempts to manhandle the toothbrush was in some cases related a infant's desire to brush their own teeth. Therefore, 'handling toothbrush' (see below for this sub-theme) and 'infant wanting to brush themselves' were coded as two separate themes.

ii) Infant's general dislike of toothbrushing cause's non-compliance- Infants disliking toothbrushing more generally, and how this can disrupt twice-daily dyadic toothbrushing. General dislike of toothbrushing was reported by approximately half of mothers (7/16) as being a barrier to toothbrushing with their infant. This general dislike was reported by some mothers as resulting in difficult, non-compliant behaviours such as tantrums. One mother simply described her son's reaction to toothbrushing thusly;

"Oh he hates me doing it!"

Participant 2

Some mothers gave more specific reasons for their infant disliking toothbrushing, which are explained in the outlines of the other infant behaviours reported in this section (e.g. disliking the taste of tooth-paste). However, for other infants there did not appear any specific reason for this non-compliance, and could be attributed to the more general behavioural difficulties children exhibit during the 'infant' period (also known more popularly as the 'terrible two's').

iii) Infant's closed mouth/ refusal to open mouth inhibits toothbrushing- Infants refusing to open their mouth for insertion of the toothbrush and how this can disrupt twice-daily dyadic toothbrushing. One of the less common difficult, non-compliant infant behaviour was infant refusal to open their mouth which was reported by nearly a quarter of mothers (4/16). This made the beginning stage of toothbrushing of mothers actually inserting the toothbrush into the infant's mouth more difficult, for example one mother reported that;

"She won't open her mouth at all, or she won't open it wide enough for you to be able to do anything..."

Participant 1

This refusal to open the mouth would then inhibit further stages of toothbrushing in which the toothbrush was used by mothers to mechanically remove food debris. Some mother reported that they coped with this difficulty by trying to force the toothbrush into their infant's mouth. For example, one mother describes that she sometimes had to use this strategy;

"...she would open her mouth, and sometimes she wouldn't open her mouth. And I used to have to kind of force the brush gently."

Participant 12

However, one of the more general parenting strategies that some mothers reported within the 'creating a game out of toothbrushing' sub-theme was the technique of making facial expressions and vocalisations that encouraged the infant to open their mouth. Most mothers did not specifically report that they used this technique to overcome an infant's closed mouth. However, it could be that by encouraging infants to mimic their mother as they make facial expressions and vocalisations, that this could encourage infants to open their mouth during toothbrushing and allow mothers to insert the toothbrush into their infant's mouth.

iv) Infant attempting to man-handle toothbrush prevents toothbrushing- Infant's trying to manhandle the brush to gain control of it and how this can disrupt twice-daily dyadic toothbrushing. Some mothers (3/16) reported that their infant sometimes attempted to man-handle the toothbrush by grabbing at it whilst their mother was trying to hold it and use it brush their teeth. This infant behaviour was reported by these mothers as acting as a barrier to successful completion of toothbrushing episodes. In some cases this toothbrush grabbing was due to infant's desires to brush their own teeth (see sub-theme 3.i) 'infant wanting to brush themselves causes non-compliance during toothbrushing'). For example, one mother describes this;

"...they try to take over the brush themselves..."

Participant 7

In other cases this was not the case. It may have been that some infants were not grabbing at the toothbrush because they wanted to brush themselves, but rather because they wanted to remove the toothbrush from their mouth because of a dislike of toothbrushing. For example, one mother describes how her daughter sometimes tries to man-handle the brush in order to remove it from her mouth when she does not want her teeth brushed anymore;

“...when she’s had enough she’ll try taking the toothbrush away from me, so she won’t let me do it anymore.”

Participant 1

v) Infant sleeping prevents mother from brushing their teeth- Infant’s falling asleep before they have had their teeth brushed and how this can disrupt twice-daily dyadic toothbrushing. Some mothers (2/16) reported that if their infant was sleeping they did not feel they could wake them in order to brush their teeth. This may have been due to mothers being concerned about being able to get their infant to go back to sleep again. For example, one mother states;

“I’ve skipped brushing his teeth cos he’s in the car, he’s falling asleep, so I’m like, ‘I’m not waking you up to brush your teeth.’”

Participant 2

vi) Infant disliking toothpaste taste causes non-compliance during toothbrushing-
Infant's disliking the toothpaste and how this can disrupt twice-daily dyadic toothbrushing.. Some mothers (2/16) also reported that their infant sometimes did not like the taste of tooth-paste and that this could disrupt toothbrushing. This finding concurs with anecdotal evidence from dentists that sometimes children find the taste of certain toothpastes to be too strong. One mother describes that this is the case for her son;

Participant. "It's a bit hard not to use the children's one 'cos he doesn't like the adult one."

Researcher. "Is that 'cos of the taste?"

Participant. "Yeah, it's a bit too strong for him."

Participant 11

MESOSYSTEM INFLUENCES ON TOOTHBRUSHING AS A DYADIC PROCESS:

Main Theme 4- SUPPORT AND ADVICE:

Almost all (13/16) mothers interviewed reported receiving some kind of support and advice about how they should go about establishing dyadic toothbrushing through the period of infancy, and many reported that they received support from individuals such as co-caregivers or friends or relatives. Some of this was more general support in coping with their parenting role, with other support being more specific to toothbrushing, such as the support co-caregivers provided.

SUPPORT AND ADVICE- Sub-themes:

i) Support provided by co-caregiver when establishing toothbrushing routines-
Importance and type of support provided by caregivers when establishing and maintaining twice-daily dyadic toothbrushing with infants. This sub-theme although reported as lying within the 'mesosystem' of the ecological model could potentially be located within the 'microsystem'. However, for the purposes of these analyses the 'microsystem' was conceptualised as any influences lying within the *mother-infant dyad*. Although co-caregivers (i.e. fathers) provided support with toothbrushing within the family home environment, mothers in this study had significantly greater care-giving responsibilities than co-caregivers. Therefore, support provided by co-caregivers was external from the mother-infant dyad and therefore this support was conceptualised as lying outside of the 'microsystem' in the 'exosystem'.

Approximately half of mother's (7/16) interviewed reported that they received support from their co-caregiver who in all cases was each mother's partner. Of those mothers who did discuss the level of support their co-caregiver provided, most of these (6/7) reported that their co-caregiver provided invaluable support during the process of toothbrushing with their infant. For example, some mothers reported that their co-caregiver often took control of toothbrushing when their child exhibited difficult, non-compliant behaviours during toothbrushing;

"I have to wait for (husband) to come back and he does it..."

Participant 14

ii) General social support with establishing toothbrushing routines and coping with infant-rearing- Importance and type of general social support received when establishing and maintaining twice-daily dyadic toothbrushing with infants.

Approximately two-thirds of mothers (10/16) interviewed reported that the social support they received from friends and family had been important in determining how well they coped more generally with caring for their infant. In particular, mothers reported that the support they received from mother and baby groups at their local Children's Centre was invaluable in helping them feel more confident in their parenting role. For example, one mother describes how important these groups were to her;

“...definitely get along to the groups, the support groups. You can make friendships that aren’t just important to you personally, but also for the benefit of your children. And I think it helps you to cope with your life better, just generally.”

Participant 5

Mothers also reported that it was important to them to have friends who were going through the same experience as them, namely learning how to cope with being a new mother. One mother who had experienced significant post-natal depression, described how highly she valued the support she had from the friends she made at the groups she attended;

“I had quite bad post-natal depression. I just thought I was never going to survive. But the main thing I found helped me was going to all the mother and baby groups. That totally helped me, cos you’d get there and there’d be other people looking dead bleary eyed and knackered. So you’d think ‘oh it’s not just me’.”

Participant 6

Although the mothers interviewed did not report that this social support was specifically important to dyadic toothbrushing with their infant, it could be suggested that this more general support may have had an indirect impact on how successfully mothers coped with dyadic toothbrushing. More general support may have provided

mothers with the ability to cope with a wide range of parenting tasks, including dyadic toothbrushing.

iii) Non-professional advice received about toothbrushing and establishing the routines- Importance and type of non-professional advice and support about infant toothbrushing when establishing and maintaining twice-daily dyadic toothbrushing with infants. Some mothers (3/16) reported that they had received advice from family members and friends, although this advice was about parenting more generally, rather than being specifically about dental health and toothbrushing routines. For example, one mother described how she and her friend shared advice about parenting with one another;

“I’ve got friends that have children, so they would say how it was going and you would say how it was going, and we’d give each other advice. You can share ideas.”

Participant 3

However, dyadic toothbrushing was not reported by mothers as having been a topic of discussion between themselves and family/friends. This demonstrates that although mothers made a lot of effort to establish dyadic toothbrushing (see 2. MAIN THEME- ‘MATERNAL BEHAVIOURS’), it was apparently not a major issue that they felt they needed to talk to others about, perhaps because they perceived they were coping with the task well.

EXOSYSTEM INFLUENCES ON TOOTHBRUSHING AS A DYADIC PROCESS:

SUPPORT AND ADVICE- Sub-theme:

i) Professional advice received about toothbrushing and establishing the routines-

Importance and type of professional advice and support about infant toothbrushing when establishing and maintaining twice-daily dyadic toothbrushing with infants.

Another of the themes identified related to 'support and advice' was not located on the mesosystem, but instead was located on the exosystem. Three-quarters of mothers (12/16) spoke about having received some kind of advice about infant and infant dental health from health-care professionals such as health visitors and dentists. However, this advice was reported to be minimal and mainly related to the age at which toothbrushing should be established. It did not appear to be related to what the dental expert guidelines were on correct toothbrushing technique, or how to maintain dyadic toothbrushing through difficult periods in child development. For example, one mother described the advice her dentist gave her about this issue;

"...the dentist, I said to him, 'I need to get (child) registered now 'cos he's got his first tooth' so he said 'start brushing it'."

Participant 15

As already commented, very little, if any, advice was received regarding how mothers should best go about engaging in toothbrushing as a dyadic process with their infant. Additionally, no mothers reported that they had received advice about how difficult infant behaviours should be dealt with during toothbrushing when these infant behaviours might compromise maternal control of the toothbrush.

Indeed, this was not even reported by mothers as being a potential barrier to toothbrushing raised by professional advice providers. The only advice received about dyadic toothbrushing was given to three mothers who were told that dyadic toothbrushing should be established as early as possible. Although only one mother reported that she received this advice, starting brushing early was reported as a strategy by the majority of mothers (13/16) (see sub-theme 2.i) 'establishing dyadic toothbrushing early in infancy'). This demonstrates that mothers in this study did not require this advice as they knew intuitively to do this.

CHRONOSYSTEM INFLUENCES ON TOOTHBRUSHING AS A DYADIC PROCESS:

MAIN THEME 5- FAMILY HISTORY- How mother's own experiences of toothbrushing as a child, and general family history around toothbrushing, is associated with how they establish and maintain twice-daily dyadic toothbrushing with their infant. Some mothers (3/16) reported that their own experiences of toothbrushing with their parents as a child was important in influencing how they approached the task of engaging in dyadic infant toothbrushing that aligned with dental expert guidelines. These mothers reported that when they had been encouraged to brush their teeth twice a day by their own parents, they perceived this behaviour to be 'normal' and expected and were more likely to engage in twice-daily dyadic toothbrushing with their own child. For example, one mother stated;

"It's about your parents teaching you the right things. Like their parents haven't taught them the right things, you do as you see."

Participant 2

Other mothers expressed that they were aware that intergenerational transmission of toothbrushing was an important issue, especially as they may help mothers to perceive the fundamental importance of toothbrushing as being axiomatic.

“...for me it’s just the norm and expected to brush your teeth twice a day. Whereas I’ve spoken to people over past few years and they only brush their teeth once day which is very strange to me.”

Participant 1

3.4 DISCUSSION

This section discusses each of the study findings and how these findings are associated with previous research findings reported in the literature. Additionally, limitations to the study are also discussed as are indicators for potential future study.

This study sought to explore novice mother's self-reported experiences, via qualitative interviews, of establishing toothbrushing as a dyadic process with their first-born infant aged between 24 – 30 months old. Qualitative data was then used to infer the various influences on the emergence of dyadic toothbrushing how these influences may act as either barriers to or facilitators of novice mothers establishing toothbrushing as a dyadic process through infancy. These maternally perceived barriers and facilitators were then located upon Bronfenbrenner's ecological model of child development (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) in order to help conceptualise how these influences may be associated with the dyadic toothbrushing. The findings from the study are now discussed with attention paid to those influences from the microsystem, and more specifically, the mother-infant dyad, that may be perceived as barriers to or facilitators of establishing and maintaining toothbrushing as a dyadic process through infancy.

3.4.1 Overview of main Findings

Some of the findings from this qualitative interview study concur with those from previous studies that have explored influences on childhood toothbrushing (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010), in that many influences were found to lie at the level of the mother-infant dyad. Although some influences were found that were located on the more distal levels of the ecological model, the majority of influences were found within the microsystem, and more specifically, within the mother-infant dyad. The more distal influences were related to general social support from partners, family and friends with coping with infant care tasks and dyadic toothbrushing more specifically. Other more distal influences related to information and advice, albeit scant, received from both professionals and non-professionals.

Many potential influences on the establishment and maintenance of dyadic toothbrushing through infancy were found within the 'microsystem' of the ecological model and were related to the mother-infant dyadic relationship. These influences were located within the mother (maternal cognitions and parenting strategies used whilst attempting to establish dyadic toothbrushing) and the infant (specifically infant behaviours, especially difficult, non-compliant infant behaviours). It is these microsystem influences that are now discussed in more detail.

3.4.2 Maternal Cognitions around Toothbrushing

During discussion of establishing toothbrushing as a dyadic process with their infants, mothers described in an indirect way, how they had experienced certain thoughts and attitudes whilst tackling this parenting task. Following data analyses, it became apparent that though they may not have realised it, mothers were actually referring to a number of 'cognitions' that were associated with how mothers approached dyadic toothbrushing.

The findings from the present study provide some indications that when mothers felt confident that they could establish effective dyadic toothbrushing successfully (had 'self-efficacy') they were more likely to experience success in establishing dyadic toothbrushing. Additionally, when mothers felt they were in control of their infant's toothbrushing (had an 'internal locus of control') and expected that their efforts to establish dyadic toothbrushing would be successful in preserving their infant's dental health (had 'positive outcome expectancies') they were also more likely to experience success. The findings related to maternal cognitions provide invaluable information about possible cognitive targets for interventions designed to support caregivers whilst they are attempting to establish twice-daily toothbrushing with their infant.

In the study, only two mothers reported that they sometimes forgot to brush their infant's teeth. Additionally, perceived stress was cited as another reason why mothers sometimes did not brush their infant's teeth twice a day. This stress was mainly associated with mothers perceptions of the difficulties experienced during toothbrushing episodes specifically, rather than more general life stress. The main

source of stress during toothbrushing episodes was difficult, non-compliant infant behaviours, which often prevented mothers brushing their infant's teeth, or at least, made toothbrushing episodes more difficult.

The findings related to maternal control of dyadic toothbrushing make sense when examined in relation to the literature on caregiver health locus of control (PHLoC) and how this relates to infant health developmental outcomes. This literature mainly relates to caregivers beliefs about the determinants of their infant's health status and the extent to which these determinants may be modified or influenced by their parenting behaviours (Bonichini et al., 2009). When caregivers have an external PHLoC, they may believe that they have minimal control of their infant's health developmental outcomes and therefore make few attempts to influence these outcomes by establishing and maintaining behaviours that may be conducive to positive dental health outcomes for their infant. Conversely, when caregivers have a more internal PHLoC, they believe that they have some degree of control over their infant's health developmental outcomes and therefore take steps to influence these outcomes so that they are favourable.

Some mothers interviewed in the study reported that when they expected that they would be successful in establishing dyadic toothbrushing, and that this would be beneficial to their infant's dental health, they were more likely to actually experience success. By persevering in the face of difficulties and reminding themselves that there would be 'light at the end of the tunnel', they managed this parenting task successfully. This finding relates to the literature on the importance of having positive 'outcome

expectancies' if one is to successfully acquire effective health (and other) behaviours (Bandura, 2004).

Caregiver outcome expectancies have been found to be a key determinant of child fruit and vegetable consumption (Bere and Klepp, 2004), physical activity (Welk et al., 2003) and adherence to, and positive outcomes following, family therapy (Nock and Ferriter, 2005). It would appear that when caregivers expect there to be a positive outcome (in terms of their infant's health), the likelihood of a positive outcome is increased. This is likely due to the close association between outcome expectancies and self-efficacy.

Although there has been some debate about the causal influence of outcome expectancies on self-efficacy (Williams, 2010), the causal influence of self-efficacy on outcome expectancies is relatively well accepted. When an individual has high self-efficacy (i.e. believe they have the abilities to execute a certain course of action successfully), they are more likely to believe that by executing said course of action, they will be successful in doing this and experience benefits for having done so (Bandura, 2004). However, some researchers have suggested that outcome expectancies can also influence self-efficacy. When an individual has positive outcome expectancies i.e. when they believe that executing a certain course of action will be beneficial in some way, they are more likely to believe they have the capabilities to execute a certain course of action to attain a goal (have high self-efficacy) (Williams, 2010).

The findings related to mothers perception of their confidence that they could succeed in establishing dyadic toothbrushing (i.e. their self-efficacy), concur with the increasing body of work linking this key cognition with infant dental hygiene routines and dental health status (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010). The findings from the present interview study contribute to this body of knowledge by highlighting the role that PSE may play in enabling mothers to overcome perceived barriers they may experience whilst attempting to establish dyadic toothbrushing.

More specifically, the present study revealed the potentially important role that parental self-efficacy (PSE) may play in enabling mothers to overcome the difficult, non-compliant behaviour often exhibited by infants during toothbrushing episodes. It is these difficult, non-compliant behaviours that appeared to pose the biggest challenge to mothers engaging in toothbrushing that aligned with the dental expert guidelines, i.e. toothbrushing in which the caregiver had principal control of holding and using the toothbrush. This finding is also in accordance with the research literature about the associations between PSE and severity of early childhood behavioural problems, namely conduct and oppositional-defiant disorders (Jones and Prinz, 2005). When caregivers have higher levels of PSE, they will have greater confidence in their abilities to execute the kind of positive parenting practices required to overcome and control their infant's sometimes difficult behaviour than caregivers who have lower PSE (Sanders and Woolley, 2005a). This can then result in positive child adjustment and development. For this reason, PSE has become a key target cognition for parenting skills training courses (Sanders and Woolley, 2005a; Webster-Stratton, 2001; Webster-Stratton et al., 2004).

These parenting skills training courses are aimed at increasing caregiver's self-efficacy to use 'positive parenting' techniques whilst raising their child.

3.4.3 Mother and Infant Behaviours around Toothbrushing

In addition to generating revealing data about the nature of mother's cognitions about dyadic toothbrushing more generally, the interviews also generated more specific data about the nature of dyadic holding and use of the toothbrush during toothbrushing. One of the perceived barriers to mothers having principal control of holding and using the toothbrush during dyadic toothbrushing was that mothers reported a number of difficult infant behaviours during toothbrushing. These ranged from general non-compliance such as tantrums to more specific behaviours, such as refusal to open their mouth and trying to man-handle the toothbrush. These kinds of difficult, non-compliant behaviours are commonplace during the infant years (aged 2-3 years) and were reported in the Amin & Harrison (2009) and Heubner & Riedy (2010) dental health interview studies.

A recent study reported rates of difficult, non-compliant behaviours in approximately 10% of UK children without developmental delay (Emerson and Einfeld, 2010). These behavioural difficulties are also associated with caregiver stress (Williford et al., 2007), although the research indicates that this relationship may be bi-directional. It would appear that although difficult infant behaviours are understandably stressful for caregivers to have to cope with on a daily basis (Williford et al., 2007) caregiver stress may actually contribute to the development of these behaviours (Whittaker et al.,

2011). Caregiver stress may lead to early non-compliant child behaviours because stressed caregivers, especially those living in socially deprived environments, have been found to engage in less consistent, more punitive parenting behaviours (Kohen et al., 2008), i.e. do not engage in positive parenting practices. Positive parenting practices have consistently been demonstrated to protect children from the development of non-compliant and other difficult behaviours such as oppositional-defiant and externalising behaviours (Dishion et al., 2008).

Caregiver stress, less positive parenting and therefore increased child behavioural difficulties have been found to be more prevalent in lower SES families (Cote et al., 2006). This may go some way to explaining the high rates of ECC in socially deprived areas. More families in low SES areas may be experiencing behavioural difficulties with their infant-aged children being non-compliant than families in higher SES areas. However, due to their increased stress levels (due to increased financial difficulties and other risk factors), they may feel less able to engage in positive parenting practices to overcome their infants difficult behaviours (which require time and patience; resources these caregivers may lack). Therefore, it would make sense that families in lower SES areas would have more problems overcoming these difficult child behaviours whilst attempting to engage in dyadic toothbrushing, and concede to infants attempts to take principal control of holding and using the toothbrush. This may provide one possible explanation for the higher rates of dental caries seen in children living in socially deprived environments, as infants may not be able to effectively clean their teeth to an adequate level of hygiene to prevent caries.

Despite the non-compliant behaviours reported by the majority of mothers, dyadic toothbrushing did seem to be in place with all the families in the study, even if they did not always align with the dental expert guidelines. Mothers had managed to overcome the impact of non-compliance through the use of a number of parenting behaviours and strategies. Providing education on these strategies would form an invaluable component of cognitive-behavioural interventions to help caregivers establish dyadic toothbrushing with their infants. The specific strategies used by mothers included a number of positive parenting strategies such as turning toothbrushing into a fun game, for example by using songs and games. This again concurs with the wealth of literature in the importance of play for a number of child developmental outcomes and for learning (Ginsburg et al., 2007; Vygotsky, 1978b).

In addition to making toothbrushing more fun and engaging for infants, mothers reported using other 'positive parenting' techniques. In doing this, mothers reported that they provided infants with the opportunity to become an active agent in the activity, allowing them to have some control over proceedings and engage in brushing their teeth themselves. Although this technique does not strictly conform to the dental expert guidelines, mothers reported that they found this parenting strategy to be helpful when trying to overcome child resistance to toothbrushing. It would appear from the data collected in this study that mothers perceived that infants responded more positively to toothbrushing when it is less of a 'procedure' that is carried out upon them by an adult, and more of an activity that they can claim some ownership and self-control of. This was also something that was briefly alluded to in the findings from the Heubner & Riedy (2010) study.

A further finding from the present study that supports the idea that infants wanted to have some ownership and autonomy during dyadic toothbrushing, was that mothers revealed in many cases that infants wanted to try to brush their teeth themselves. This may be a further important finding that may contribute to explaining the nature of dyadic toothbrush use during infant-hood. It may also, in part, also explain why studies have found that infants are engaging in more autonomous toothbrush use, and having more control of holding and using the toothbrush, than the dental expert guidelines recommend (BDHF, 2008; Huebner and Riedy, 2010; Zeedyk et al., 2005).

The finding regarding infant drive for autonomy in toothbrushing also concurs with Erikson's classical theory of human development (Erikson, 1968) and newer revisions of the theory (Newman and Newman, 2008). These theories state that around the age of 18-months, children reach a stage of development characterised by the need for autonomy versus shame and doubt. In this stage children want to try to do everything for themselves but are scuppered by the restrictions their caregivers put upon them, and the child's failed attempts to correctly execute particular skills. If they fail to execute these skills successfully it can lead to impaired self-esteem and confidence later on. Caregivers can provide a framework to facilitate the development of skills in their child to satisfy their child's need for autonomy whilst at the same time providing enough guidance and support to allow successes to be achieved. This process requires patience on the part of caregivers as they guide their child through the process of developing new skills through trial and error. It also requires the caregiver, whilst allowing their child to fulfil their need for autonomy via experimentation, to also curtail

this need for autonomy where appropriate in order to improve the chances their child develops socially appropriate behaviours.

This requirement of caregivers, to curtail where appropriate an infant's drive for autonomy, is perhaps an important consideration for dyadic toothbrushing during this period of development. In the present study only a few of the mothers interviewed made comments that indicated that they were aware that they should curtail the infants drive to hold and use their toothbrush themselves and engage in self-toothbrushing. Reasons mothers gave for wishing to curtail their infants drive for autonomy during toothbrushing, were largely related to their concern that their infant was not able yet to brush their own teeth to an adequate level of hygiene. Perhaps the reason some infants are being found to have more autonomous control of holding and using the toothbrush during toothbrushing than the dental expert guidelines recommend is that some caregivers do not understand the importance of caregiver conducted toothbrushing of infant teeth. Or, they may not feel able to overcome their infant's drive for autonomy in toothbrush use during toothbrushing.

3.4.4 Limitations to the Study

As with much exploratory qualitative research, the present study had some limitations that may mean that conclusions reached from the data generated should be done so with caution. Firstly, the sample in the study were self-selecting, and therefore could be seen as already motivated and competent mothers, given that they were motivated to take part in a research study. Therefore, it may be that the mothers included in this

study would have been likely to have been coping well with most infant-care tasks, such as enforcing dyadic toothbrushing routines. This may mean that the data collected in this study may not have uncovered the full range of potential challenges that mothers may face when establishing and maintaining twice-daily toothbrushing routines with infants. Additionally, the sample resided in a specific area of the UK and were largely White-British, so it is unknown how translatable the findings are to mothers either living in other areas of the UK, or mothers from other cultures living in other countries. As fathers were not included in the study, it is also unknown what kinds of perceived barriers and facilitators fathers may encounter when engaging in dyadic toothbrushing with infants.

Although participating mothers resided in wards in Salford that fell within the 7% most deprived areas in the United Kingdom, as measured by the Multiple Indices of Deprivation (IMD) (ODPM, 2004), they were found to be demographically atypical of the environment they were living. Half of the mothers interviewed had been to college and over half had received higher education, which is in contrast to the most recent Census data from 2001 indicates that of people living in Salford 23% of adults aged 16-74 had further or higher educational qualifications (ONS, 2001). However, the most recent data available from the Census is almost 10-years old (the 2011 Census data was unavailable during the writing of the thesis). Although the mothers in the present research study reported that they attended college and/or university, it is unknown how many mothers successfully completed their studies as no documentation of this was requested during the research.

All but one of the mothers interviewed were also rearing their infant in a two caregiver household. This may mean that although these mothers were living in a socially deprived area they were generally well educated and also had social support at home in the form of a husband or partner (in all cases mother's partners were the father of their child). This hypothesis is supported by longitudinal studies with mothers that have found that having a supportive co-caregiver reduces the likelihood of child externalising behaviours at age 5 years (Smeekens et al., 2007). This could mean that being educated and having a supportive co-caregiver could act as protective influences that may reduce the effect of social deprivation on the development of difficult child behaviours and the impact these behaviours may have on the establishment of dyadic toothbrushing. This would also concur with the published literature on facilitators of healthful behaviours that once established, enable individuals to minimise the negative effects of the social and economic environment on their health (Cutler and Lleras-Muney; Krueger and Chang, 2008).

3.4.5 Further Study

Collecting information about perceived barriers to, and facilitators of health related behaviours can also be a vital first step in the design of targeted interventions to overcome perceived barriers and enhance facilitators (Craig et al., 2008; Shepherd et al., 2002). Therefore, findings from this qualitative interview study are used to informing the design of a picturebook intervention to support caregivers to align their dyadic toothbrushing with the dental expert guidelines. The picturebook intervention is intended to help caregivers curtail their infant's drive for autonomous toothbrush use

and retain control of holding and using the toothbrush during toothbrushing. The development and evaluation of this behavioural intervention is reported in detail in Chapter Six of the thesis.

In addition to providing in-depth insights into the kind of processes investigated in this study, i.e. examining influences on emergence as toothbrushing as a dyadic process, qualitative interview data have also been demonstrated to be invaluable in informing the development of psychometric scales (DeVellis, 2003) such as PSE scales (Bandura, 2006). Such qualitative data may provide insights into the various barriers to, and facilitators of desired behaviours, such as child-care practices (Bloomfield et al., 2005), and this data may then be used to develop scales items reflecting an individual's self-efficacy for negotiating barriers and facilitators of the desired behaviour (Kendall and Bloomfield, 2005). This method of developing items for self-efficacy scale items has been used in developing PSE scales to identify caregivers who may be at risk of having low PSE and have also been used to evaluate interventions intended to improve PSE (Bloomfield and Kendall, 2007).

Therefore, the qualitative data collected in this present interview study is used to develop a PSE scale specifically designed to measure mother's perceptions of their PSE to initiate dyadic toothbrushing when it is first established and then maintained through infancy. Chapter Four of the thesis outlines this scale development study and the procedure used to develop scale items from the qualitative data collected from this interview study. This scale, once developed, may potentially be used as a screening tool

to identify mothers who may be at risk of requiring support when attempting to initiate and maintain twice-daily dyadic toothbrushing with their infants.

CHAPTER FOUR: DEVELOPMENT OF A TASK-SPECIFIC SCALE TO MEASURE MATERNAL SELF-EFFICACY TO ESTABLISH DYADIC TOOTHBRUSHING WITH FIRST-BORN INFANTS

4.1 Introduction

In order to make an original contribution to the existing literature, Chapter Three of the thesis reported on findings from the first qualitative interview study to explore *novice mothers* perceptions of their experiences establishing toothbrushing as a dyadic process with *first-born infants*. These data were then used to infer perceived barriers to and facilitators of, the establishment of toothbrushing as a dyadic process with first-born infants. Items were included within the interview schedule that probed potential issues around dyadic toothbrushing that later may be located upon the various levels of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

Following data coding and analyses, identified themes and sub-themes around perceived barriers to and facilitators of establishing dyadic toothbrushing routines and then maintaining them through infancy, were located upon the ecological model. Such qualitative data have previously been used to inform the development of items for inclusion in psychometric scales to measure parental self-efficacy (PSE) (e.g. Crncec et al., 2008; Kendall and Bloomfield, 2005). Therefore, this chapter describes a study in which qualitative data collected in the previous study reported in Chapter Three are

used to inform the development of a scale to measure PSE for enforcement of early dyadic toothbrushing routines with infants.

A key finding emerging from the data reported in Chapter Three relates to novice mothers reports of their confidence in their abilities to establish toothbrushing as a dyadic process with their first-born infant, especially when facing potential challenges to the routine. This finding provides support for the increasing evidence-base reported in the published literature that caregiver confidence, or 'self-efficacy' is central to caregivers being able to ensure that toothbrushing is established and maintained as a routine behaviour with children (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010). Parental self-efficacy (PSE) has also been suggested as a key cognition implicated in a number of child developmental outcomes as already discussed in Chapter Two and associated with other factors such as parenting style and child temperament. Studies have demonstrated that caregivers with higher PSE are more likely to have an effective, authoritative parenting style using more positive parenting techniques and less punitive one (Sanders and Woolley, 2005b), and report fewer serious temperamental and behavioural difficulties in their child (Jones and Prinz, 2005).

Overall the findings from Chapter Three support the literature cited above as the mothers interviewed largely reported that when their self-efficacy was high they felt more able to use positive parenting approaches to enforce toothbrushing. They also reported only very rarely having to resort to restraining their child due to externalising behaviours and other challenges to the routine. Examples of challenges to the routine

identified in Chapter Three include challenges that may lie at the level of the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) and may come from the infant, in terms of potential difficulties with behaviour.

In Chapter Two of the thesis PSE was discussed in detail, including the associations this cognition may have with other caregiver influences, such as maternal depression (e.g. Weaver et al., 2008). Additionally, within Chapter Two other potential caregiver influences on childhood toothbrushing routines, such as outcome expectancies (e.g. Huebner and Riedy, 2010), and locus of control (LoC) (Bonichini et al., 2009) were also considered. However, despite the potential importance of these other caregiver influences on child developmental outcomes, PSE is one of the more highly researched, and suggested to be most important, caregiver cognitions (Jones and Prinz, 2005). It also continues to be one of the key cognitive targets of, and criteria for measuring effectiveness of, early year's child-care skills interventions (e.g. Bloomfield and Kendall, 2012; Hautmann et al., 2012). A number of psychometric scales designed to measure general PSE have previously been developed (e.g. Crncec et al., 2008; Kendall and Bloomfield, 2005) in order to identify caregiver who may benefit from extra support and also assess the effectiveness of interventions designed to provide this extra support.

With specific reference to infant and child dental health, psychometric scales designed to measure PSE for infant and child toothbrushing and other dental health care behaviours may have the potential to act as clinical screening tools that allow health

care professionals to identify individuals that may be at risk of poor dental health. The British Dental Association (BDA) recently outlined in their guidelines the importance of early identification of individuals at risk of poor dental health (BDA, 2009). Therefore, scales designed to measure PSE to establish toothbrushing as a dyadic process, may potentially improve access to support for those caregivers at risk of having difficulties with establishing toothbrushing as a dyadic process with their infant. A number of previous studies have sought to devise ways to measure PSE related to dyadic dental health care routines, such as toothbrushing routines, with young *children* (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010). However, as yet, no psychometric scales have been developed that are specifically intended to measure caregiver PSE for the establishment of toothbrushing as it emerges as a dyadic process from *infancy*.

The PSE scale development studies previously reported in the literature have provided further support, via their scale standardisation procedures, for the association between PSE and childhood toothbrushing routines (Adair et al., 2004; Finlayson et al., 2005). These PSE scale development studies have found significant associations between child dental health behaviours PSE scores and self-reported dyadic toothbrushing frequency (Adair et al., 2004) and also clinical measures of child dental health (Finlayson et al., 2005; Kakudate et al., 2010). However, despite the support these previous scale development studies (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) provide for the association between toothbrushing routines with children and PSE, these studies have some procedural and conceptual limitations. These scales may also not be appropriate for measuring novice caregivers PSE for establishing toothbrushing as a dyadic process with specifically *infants*. This is due to the fact that the scale

development processes followed in these studies, including item development and scale standardisation did not include caregivers of infants only, i.e. children under the age of 2 years, and instead including wider age ranges with children older than two-years.

The methods used to develop these previously published child dental health scales may limit their appropriateness for use with dyads containing infants due to the populations used to standardise these scales, which included children who were developed to an age beyond infancy. Additionally, the scale item generation and scale standardisation and validation procedures used may raise questions as to firstly, the quality of the psychometric scale development procedures used and subsequently the reliability of the scales. Secondly, conceptually they may be limited in terms of how appropriate the scales might be for measuring PSE for establishing toothbrushing as a dyadic process with *infants*, with *novice mothers* with no experience of child-rearing as the previously published scales have been developed for use with older children. A further conceptual limitation to these previously developed scales is that they all measure PSE for general child dental health behaviours including toothbrushing, frequency of sugar intake and dental clinic visits. Therefore these scales may be considered as 'domain' rather than 'task' specific, and therefore may have limited reliability (Bandura, 2006). Table 4.1 summarises the key features of these scales and development procedures followed.

Table 4.1- Key features of dyadic dental health practices PSE scale development studies

Scale	Task-Specificity	Aim of scale	N	Age Group of Children	Population	Item Development Procedure	Scale Standardisation Procedures	Reliability
Adair et al. 2004	Domain specific	Predict dental health behaviours	2822	Mean unknown sd unknown Range 3 – 4 years	International parents from 17 countries	- Review of literature - Consultation with psychologists, dentists, sociologists, epidemiologists	- Factor analyses - Comparison with parental self-report of toothbrushing	$\alpha = .73$ for toothbrushing PSE factor items
Finlayson et al. 2005	Domain specific	Not stated	719	Mean 3.05 years sd unknown Range 1 – 5 years	African-American Mothers	- Modification of items from exercise scale based on Transtheoretical Model	- Factor analyses - Comparison with parental self-report of toothbrushing - Comparison with clinical dental data	$\alpha = .91$ for oral health PSE factors items
Kakudate et al. 2010	Domain specific	Not stated	119	Mean 5.3 years sd 2.1 Range 1 – 8 years	Japanese Mothers	- Review of literature -Consultation with dentists - Interviews with target population	- Factor analyses - Correlations with general self-efficacy scale (construct validity)	$\alpha = .91$ for PSE for brushing factor items

It would seem that the previously published dyadic child toothbrushing PSE scales may be limited in terms of their application with dyads containing *infants* as they have been developed for use with dyads containing older children and the scale development procedures used may limit reliability. Therefore, the latest and most reliable psychometric scale development procedures may be used to maximise the potential for optimal reliability and validity of a new dyadic toothbrushing in infancy PSE scale. Content of items within this new scale may be informed by the detailed qualitative data reported in Chapter Three obtained from the target population, novice mothers of infants, about their recent experiences establishing toothbrushing as a dyadic process with their first-born infant. Scale standardisation procedures then conducted with a similar population (novice mothers of infants), will provide initial pilot data regarding reliability of the scale and any underlying components within it.

A new dyadic toothbrushing scale may allow measurement of caregiver's perceptions of their self-efficacy to cope with challenges when attempting to establish toothbrushing as a dyadic process with first-born infants. Additionally, no previous scale has been designed to measure PSE of *novice mothers who have no previous experience of child-rearing*, and so may find establishing dyadic toothbrushing as particularly challenging due to lack of experience. A new scale may also provide the first 'task-specific' scale to measure caregivers PSE for coping with micro-aspects of the process of dyadic toothbrushing, as previous scales have measured PSE for other dental care behaviours including dental visits and dietary habits (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010). A detailed discussion of the previously published child dental health scale development studies is now provided, along with consideration of how

their application with novice mothers of first-born infants might be limited and the procedural and conceptual limitations of the scales.

4.1.1 Procedural Limitations of Previously Developed Child Dental Health PSE

Scales

The key procedural limitations to the published child dental health PSE scale studies (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) relate to the methods used to generate scale items and also the statistical methods used to standardise the scales. These limitations may raise questions as to how reliably these scales can measure PSE for dyadic toothbrushing routines with first-born infants.

i) Scale Item Development Procedures

One of the first limitations within these three existing dental health PSE scale development studies (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) is the processes followed to develop items for inclusion in these scales. The available literature regarding scale item generation (DeVellis, 2003; Guillemín et al., 2002; Worthington and Whittaker, 2006) has reported three main methods by which scales items may be generated. These main methods are i) review of previous literature and consultation with experts; ii) adaptation of items from previously published scales, and; iii) generation of new data through consultation with the target population for the scale.

With regards to item development for these dyadic dental health behaviours PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010), a combination of different methods were used. Firstly, Finlayson et al. (2005) report that they modified items from a pre-existing physical activity self-efficacy scale based on the Transtheoretical Model (Prochaska et al., 2002) in order to develop their dental health PSE items. In doing this, the authors did not follow self-efficacy scale development recommendations set out by Bandura (2006), regarding the importance of gaining information from the target population about perceived barriers to and motivators of the behaviours in question being carried out. Studies that employ this strategy may suffer a major methodological limitation, as what may constitute a barrier to self-efficacy for any specified behaviour may not be as relevant to other behaviour.

The other two dyadic dental health behaviour PSE scales report using the methods recommended in a recent review of self-efficacy scales for adult patients with chronic physical health conditions (Frei et al., 2009). Adair et al. (2004), report that they conducted a thorough review of the literature, and developed their scale items based upon this literature review and consultation with an international consortium of dental health and health behaviour experts (Pine et al., 2004b). These methods were also followed by Kakudate et al. (2010), but in addition, these authors also conducted interviews with 20 caregivers about their child's dental health, with additional items being generated from data derived from these interviews. Although these methodologies are recommended for developing scale items in the scale development literature (DeVellis, 2003), Adair et al. (2004) and Kakudate et al. (2010) provide minimal information about how they used information gathered from the literature,

experts in the field and population of interest to develop their scale items. Although this reporting issue may be due to word count constraints imposed by the journals these studies were published in rather than a lack of methodological rigour, it would be helpful if such details were made available to other scale developers.

Despite the lack of clear reporting of item generation procedures, the kind of formative, qualitative research conducted by Kakudate et al. (2010) is advised in the absence of previously published information (Bandura, 2006; Guillemin et al., 2002; Maibach and Murphy, 1995; Polit and Beck, 2007). Once identified, challenges and impediments to behaviour of interest can then be used to construct items for inclusion in a new scale (Bandura, 2006; Bejl and Shortridge-Baggett, 2001; Maibach and Murphy, 1995). This methodology has also been used in the construction of several measures of more general PSE, including the Tool to Measure Parental Self-Efficacy (Kendall and Bloomfield, 2005), the Self-Efficacy in Infant Care Scale (Prasopkittikun et al., 2006) and the Karitane Parenting Confidence Scale (Crncec et al., 2008).

ii) Scale Standardisation and Validation Procedures

Another limitation to the scale development studies already discussed (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010), are the methods employed to standardise and validate these scales, especially in terms of their predictive validity. Firstly, Kakudate et al. admit in their discussion of their paper that predictive validity was not evaluated, which is surprising in light of their relatively small sample size of 119 dyads. However, Kakudate et al. did assess concurrent validity of their scale by

correlating scores for dental health PSE with scores on a measure of general self-efficacy.

Finlayson et al. however, did evaluate predictive validity of their scale, through correlating PSE scores with child dental caries as measured by number of decayed, missing or filled teeth (DMFT). The authors found that higher scores for PSE were associated with lower rates of child dental caries. Additionally, both Adair et al. (2004) and Finlayson et al. (2005) compared scores on their PSE scales with caregiver self-reports of dyadic toothbrushing frequency. High scores for PSE on both scales were found to be associated with higher frequency of caregiver reported dyadic toothbrushing, with a significance value of $p < .0001$ for both scales.

These findings could be called into question however, as previous observational research has demonstrated that caregiver self-reports of toothbrushing with children can be inaccurate. Caregivers have been found to report that higher duration and frequency of toothbrushing with their children, and also more caregiver conducted as opposed to child conducted brushing than observational data would suggest (Martins et al., 2011; Zeedyk et al., 2005). However, in light of the sample sizes of the Adair et al. and Finlayson et al. studies, 2822 and 719 respectively, it is unsurprising that self-report data was relied upon, as conducting separate observations of dyadic toothbrushing behaviours would have been both time and labour intensive. However, stratified sub-samples from the larger samples could have been observed directly.

4.1.2 Conceptual Limitations of Previously Developed Child Dental Health PSE

Scales

In addition to the procedural limitations discussed, the previously published child dental health PSE scale studies contain some conceptual limitations, which may mean they are less appropriate for measuring PSE for specifically dyadic toothbrushing routines with first-born infants. These mainly relate to the task-specificity of the scales and also the age group the scales were standardised with.

i) Task-Specificity of Scales

Although the scales developed in these studies (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) all contained items specifically designed to measure PSE, none of these three scales were specifically developed to measure PSE for *toothbrushing*. Rather, they were each developed to measure PSE for general dyadic dental health behaviours, including toothbrushing, but also additionally, dietary habits, and attendance to dental appointments. The self-efficacy scale literature suggests that task-specific scales have greater predictive validity, being powerful predictors of an individual's ability to enact the actual behaviour that self-efficacy may underpin (Bandura, 2006).

Additionally, the developers of one of these scales (Kakudate et al., 2010), report that *two* levels of self-efficacy exist, 'general' and task-specific', whereas the classic self-efficacy literature states that there are *three* levels, 'general', 'domain-specific' and 'task-specific' (Bandura, 1997, 2000). This definition causes the authors to conclude that

their scale is 'task-specific' when it could also be considered as 'domain-specific'. Perhaps if the scale were truly 'task-specific', according to the Bandurian definitions of the levels of self-efficacy, it would measure PSE in relation to only one dental health behaviour, as opposed to three, including toothbrushing, dietary behaviours and dental visits.

Developing truly 'task-specific' scales may be important as the scale development literature suggests that scales used clinically to assess cognitions around specific behaviours need to be as specific to that behaviour as possible in order to have optimum reliability and diagnostic and predictive power (Kazdin, 2005). Additionally, self-efficacy is multi-faceted and situationally-dependent, so although an individual may have good self-efficacy in one area of functioning, their self-efficacy in another domain may be low (Wilson et al., 2006). Although the domain-specific PSE scales cited (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) contain toothbrushing items, these items appear to be quite general, and do not appear to measure caregiver perceptions of their ability to cope with very specific challenges to toothbrushing as a dyadic process with infants. Therefore, the ability of these scales to reliably measure caregiver perceptions of their PSE to cope with very specific challenges to toothbrushing is unknown.

ii) Ages of Children used in Standardisation of Scales

A further issue relevant to the scale standardisation and validation procedures followed in these studies is that the ages of children included may also reduce the reliability of these scales to measure PSE for the establishment toothbrushing as a dyadic process

through *infancy*. All studies have standardised these scales with samples of dyads containing children older than infants, when toothbrushing routines may already have been established for some time. These age groups include 1 – 8 years (Kakudate et al., 2010), 1 – 5 years (Finlayson et al., 2005), and 3 – 4 years (Adair et al., 2004). Additionally, for two of these studies, age ranges of children are wide (Finlayson et al., 2005; Kakudate et al., 2010). It is therefore difficult to determine how reliably each of these scales may be able to identify caregivers of *infants* who may be at risk of low PSE for *establishing* early toothbrushing routines at their very inception. Additionally, none of the previously published studies have specifically included caregivers of first-born children, which may raise questions as to how appropriate these scales are for measuring PSE of novice caregivers when establishing toothbrushing as a dyadic process with *first-born* infants.

Given the procedural and conceptual limitations to the previously published child dental health PSE scale studies, it is timely to now review the current guidelines for the construction and development of such scales. These guidelines have been generated through review of the literature and synthesised in order to provide an 8-step scale development process that informs the dyadic toothbrushing in infancy PSE scale development study reported in this chapter.

4.1.3 Recommended Psychometric Scale Development Procedures

It would appear just from consulting the dental literature around child dental health PSE scale development (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010),

and the wider psychometric literature (Guillemin et al., 2002; Maibach and Murphy, 1995; Polit and Beck, 2007) that there are a number of methods of scale item generation and scale standardisation that can be used. However, there are in addition to scale item development and standardisation a number of other technical considerations when designing standardised self-report scales. It has recently been suggested that there is a lack of transparency within the self-efficacy scale construction literature, with few authors providing adequate descriptions of the aims of new scale or the methodologies employed at each step of the scale development process (Frei et al., 2009). Although there is no single, all-purpose approach to developing self-efficacy scales (Guillemin et al., 2002; Maibach and Murphy, 1995; Polit and Beck, 2007), a number of recommendations have been published to guide researchers intending to construct self-efficacy scales which have been summarised in work published within the past decade and depicted on Figure 4.1 (DeVellis, 2003; Frei et al., 2009). Each of these steps is now discussed, with reference made to the previously developed child dental health PSE scale development studies where relevant.

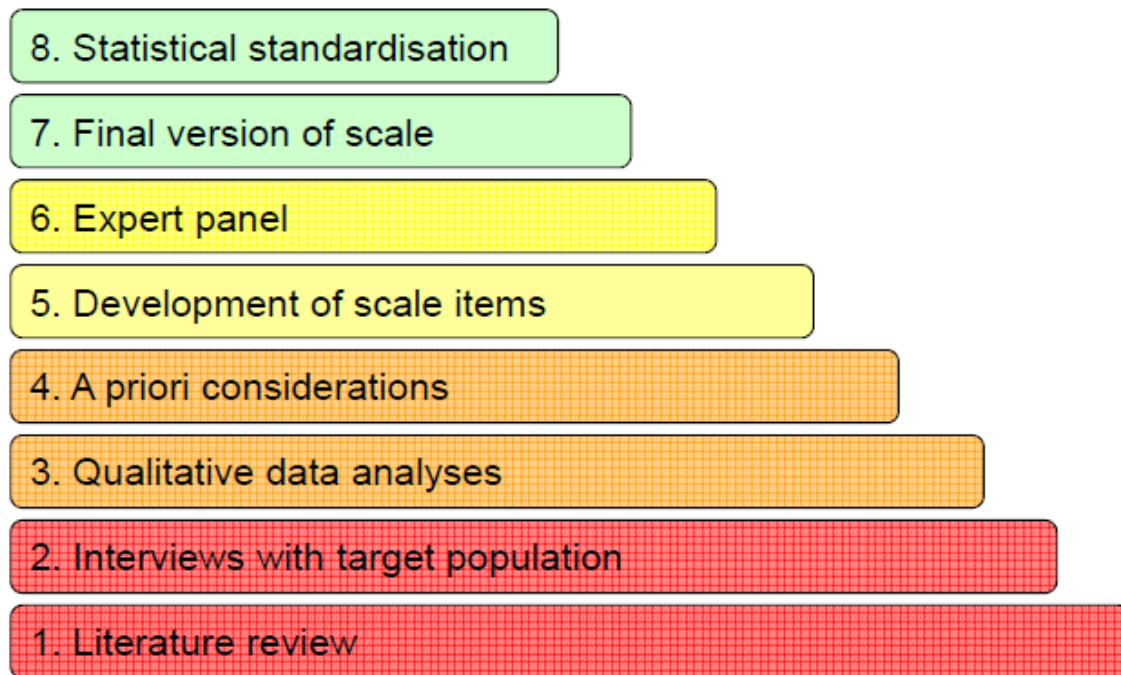


Figure 4.1- Scale development procedure followed

1. Literature Review:

When constructing a scale, the first priority should be to define and understand the nature of the 'latent variable', that is, the variable that will be measured by a new scale being constructed (Polit and Beck, 2007). This should be achieved via a thorough review of the available literature and clear differentiation between the latent variable and constructs similar to the latent variable that should not be confused with it. Authors of two of the previously developed child dental health PSE scale development studies state that literature reviews were conducted (Adair et al., 2004; Kakudate et al., 2010).

2. Interviews with Target Population/ 3. Qualitative Data Analyses:

In the absence of sufficient published data that allows full understanding of the latent variable, it has been suggested that the target population for a new scale should be consulted via interview for example. This is important for understanding the issues that

may prevent individuals from enacting the behaviour of interest, in this case, dyadic toothbrushing with infants. These steps of the scale development process are reported in Chapter Three of the thesis. Only one of the previous child dental health PSE scale development studies report using this method (Kakudate et al., 2010).

4. A Priori Considerations:

The next step in scale construction should be to determine certain *a priori* considerations, such as the *aim* of the scale, as this has been suggested to be an important step to when a new scale is developed (Frei et al., 2009). For example, scales are developed in order to *plan* intervention programmes or *evaluate* such interventions. Others are designed to *predict* future outcomes (on the basis of current self-efficacy) or to *discriminate* between different populations of individuals. For example, the only PSE scale construction study in which the authors clearly state the aim of the scale is that of Kendall & Bloomfield (2005), in which they constructed the Tool to Measure Parenting Self-Efficacy (TOPSE), a scale to *evaluate outcomes* in parenting skills interventions. The only previously developed child dental health PSE scale study that states the specific aim of the scale is the Adair et al. (2004) scale development study, in which the authors state that their scale is intended to *predict* child dental health behaviours.

Another key *a priori* consideration that should be considered is the level of task-specificity that scale should have (Frei et al., 2009). For example, the authors of the most recently developed child dental health PSE scale (Kakudate et al., 2010) state that their scale is designed to be ‘task-specific’ as opposed to ‘domain-specific’. However,

though reported by the authors as being 'task-specific' this scale is actually 'domain-specific', containing three main factors; 'toothbrushing self-efficacy', 'dietary habits self-efficacy' and 'dentist consultation self-efficacy'. A truly task-specific scale might instead measure PSE for just one of these three child dental health care tasks.

The format of a new scale is another important a priori consideration. The 'Likert scale' is one of the most common scale formats and is widely used in scales measuring opinions, beliefs and attitudes (DeVellis, 2003). Studies have found that reliability, validity and discriminating power of scales of around 7-points are optimum (Preston and Colman, 2000). It has also been hypothesised that cognitively, humans are only capable of a span of apprehension of up to seven items at any one time (plus or minus two) (Baddeley, 1994; Miller, 1956). However, it has also been suggested that having an even numbered Likert scale reduces the chance of a '*central tendency bias*', where respondents simply use the mid-point response most commonly, instead of responding in a more considered and accurate manner (Krabbe et al., 2006). It is also important that the response options be worded so that they have approximately equal intervals with respect to agreement, so that the difference in level of agreement between each adjacent pair of responses is about the same as for any other adjacent pair (DeVellis, 2003). For example;

'1- Strongly Disagree'; '2- Moderately Disagree'; '3- Mildly Disagree';

'4- Mildly Agree'; '5- Moderately Agree'; '6- Strongly Agree'.

5. Development of Scale Items/ 6. Expert Panels:

Although the later stages of scale development (such as reliability and validity analyses) are statistical in nature, the process of generating a pool of scale items is more qualitative. It is this step for which there is the least published detail on the methods employed by previous scale developers (Frei et al., 2009; Guillemin et al., 2002; Worthington and Whittaker, 2006).

When constructing *self-efficacy scale* items is that each item should include three factors; i) the behaviour, ii) the level of situational demand that may prevent the behaviour from being acted out and iii) the time frame (Maibach & Murphy, 1995). Very few of the self-efficacy scales that are reported in the literature contain items that measure all three of these factors, with most measuring only the strength of self-efficacy. This limitation is certainly present within items contained in the existing child dental health PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010).

Statements for inclusion in self-report scales should also be specific and refer to concrete/ discrete behaviours rather than referring to more general or abstract constructs. Self-efficacy statements should also be worded in such a way that they are declaration of *perceived capability* to carry out the behaviour of interest rather than *intention* to carry out said behaviour (Frei et al., 2009). An example of a concrete item that fulfils the recommended factors outlined above would be;

'I can remember to brush my child's teeth every night even when I am tired'.

A less concrete item that does not include all the necessary factors would be;

e.g. *'I will remember to look after my child's dental health'*.

It is also important that items should not be exceptionally lengthy or ambiguous as this increases complexity and decreases clarity for respondents (DeVellis, 2003). 'Double-barrelled' items that convey two or more ideas should also be avoided, as endorsement of such an item by a respondent might refer to either or both ideas conveyed by the item (DeVellis, 2003). Scale length is also a consideration as scales that are too lengthy may not be fully completed by respondents, but scales that contain too few items may not measure the construct of interest with adequate reliability (DeVellis, 2003).

When generating items for inclusion in a new scale, it is important that they reflect the construct being measured in different ways, and as a general rule, when constructing new assessment scales, considerably more items than are needed in the final draft of a scale are usually included in the first draft (DeVellis, 2003; Smith et al., 2003). It is common practice to produce alternate forms of the same item, each worded slightly differently and then through further enquiry retain the best of these for use in the scale (Bandura, 2006). The theoretical models that guide scale construction are based on a process of redundancy, with removal of redundant items being a key stage in scale development research (DeVellis, 2003). Panels of experts in relevant disciplines may be consulted to facilitate decisions as to which item versions should be retained and which should be removed, and also to facilitate generation of new items where necessary. Two of the previously published child dental health PSE scale development studies state

that experts were consulted when generating scale items (Adair et al., 2004; Kakudate et al., 2010).

To illustrate these steps in the scale development procedure, the methods for item generation for one of the previously published child dental health PSE scales, the Self-Efficacy Scale for Maternal Oral Care (SESMO- Kakudate et al., 2010) are now discussed. The developers of the SESMO created a scale item pool via two methods. Firstly, by conducting a review of the literature (though this is not reported as being an exhaustive review) and then consulting seven dental experts (six dentists and one dental hygienist) who developed appropriate items based on the findings from the literature review and their own clinical judgement. Secondly, the principal investigator conducted interviews with 20 caregivers about their child's dental health and additional items were generated from data derived from these interviews. Although these two methodologies are recommended for developing scale items in the scale development literature (DeVellis, 2003), the authors provide very little information about this stage of scale development.

7. Final Version of Scale/ 8. Statistical Standardisation:

When scale items have been generated and the scale has been constructed, they should then undergo a rigorous process of statistical standardisation, including checking of internal consistency of items and scale, test-retest reliability and factor analyses to identify the underlying structures within the scale. One of the previously published child dental health PSE scale development studies describes this process in detail (SESMO- Kakudate et al., 2010), so this study's standardisation methodology is now discussed in

order to illustrate the processes involved in this step of the scale development procedure.

Standardisation of the SESMO was conducted with a sample of 119 caregivers (mean age= 36.3 years; sd= 5.5 years) of children aged between 1 – 8 years old (mean age= 5.3 years; sd= 2.1 years) who had all visited a dental clinic and had a formal diagnosis of caries. A total of 67 of these 119 caregivers had children who had received treatment for their caries diagnoses. Once an initial item pool containing 36 items (scored along a 5-point Likert scale; 1= not confident, 5= completely confident) had been generated, some items were excluded following internal consistency/ reliability assessments. Those items that correlated well with the total scale score (co-efficient of over $\alpha = .40$) were retained and subjected to factor analyses combined with Varimax rotation, which generated three factors, each representing items relating to three child dental health care behaviours. These three factors represented 'toothbrushing self-efficacy', 'dietary habits self-efficacy' and 'dentist consultation self-efficacy'.

Following items with factor loadings of less than $\alpha .40$ being removed, each factor had Cronbach alpha co-efficient's of $\alpha = .78$, $\alpha = .79$ and $\alpha = .90$ respectively, giving the scale overall excellent reliability of $\alpha = .82$. Test-retest reliability was also assessed for the SESMO, by reassessing all caregivers 1-month after initial completion of the scale. Test-retest correlations for each of the three factors were .67, .54 and .70 respectively, and .74 for the scale overall. In addition to reliability assessments, concurrent validity of the SESMO was also assessed by correlating caregiver's scores on the SESMO with their

scores on a measure of general self-efficacy (GSE) and also each child's number of decayed, missing and filled teeth (dmft).

The correlation coefficient between GSE scores and overall SESMO was .39, for the dietary habits factor .49 and for the dental consultation factor .33 (all $p < .001$). The authors do not report the correlation between toothbrushing factor scores and GSE, which would indicate there was no correlation between scores on the toothbrushing factor and GSE. There were also significant negative correlations between child dmft and overall SESMO with a coefficient of -.33, and also the dental consultation factor with a coefficient of -.45 (both $p < .001$). Again, there did not appear to be a significant correlation for scores on the toothbrushing factor of the SESMO.

These validity findings might indicate that PSE for child toothbrushing is not associated with GSE. Additionally, given that the toothbrushing factor of the SESMO (Kakudate et al., 2010) was not reported to be significantly associated with dmft, this might call into question the ability of the toothbrushing items within the SESMO to predict child dental health outcomes. Therefore, it is timely that a new dyadic toothbrushing in *infancy* PSE scale should be developed that may be better able to predict dental health outcomes including toothbrushing frequency. All previously developed dyadic dental health behaviours PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) have additionally not been truly *task-specific*, and nor have they been specifically developed to measure PSE for establishing toothbrushing as a dyadic process with *infants*.

4.1.4. Aims of the Study

In light of the current lack of a task-specific scale that measures PSE for establishing *toothbrushing* as a dyadic process with *infants*, this study aims to develop the first task-specific scale to measure novice caregiver's PSE for establishing and toothbrushing as a dyadic process through infancy. This scale is intended to be able to *predict* caregiver's toothbrushing behaviours with their *first-born infant* and specifically to predict caregiver's abilities to overcome a number of challenges to the routine as identified within the qualitative interview study reported in Chapter Three of the thesis. Additionally, for the first time in child dental health PSE scale development, the eight-step process discussed in this chapter, generated from thorough review of the literature, is used in order to ensure the most current scale development procedures are used to optimise reliability and validity of the new scale.

Scale item content is informed by review of the literature, the qualitative interview data reported in Chapter Three of the thesis and consultation with experts from relevant disciplines including psychology and dentistry. Statistical standardisation procedures include analyses of internal reliability, test-retest and factor analyses. The scale, once developed and standardised, is used to evaluate a picture book intervention to increase caregiver control of holding and using the toothbrush during dyadic toothbrushing with infants. Additionally, within this intervention study, observational data of mother-infant dyads engaging in toothbrushing is used to assess the scales ability to predict actual observed behaviours around dyadic control of the toothbrush during brushing episodes. No previous child dental health PSE scales have previously been assessed for predictive

validity using observational data of dyadic toothbrushing episodes. This intervention study is reported in Chapter Six of the thesis.

4.2 METHOD

4.2.1 Design

This was a cross-sectional psychometric scale development and statistical standardisation study with first-time mothers residing in Salford, Greater Manchester, incorporating an 'expert panel' methodology to generate scale items and 'test-retest' methodologies to validate scale items.

4.2.2 Participants

Participating Mothers

Relevant ethical approval was gained to recruit participating first-time mothers of infants aged 12 – 36 months into the study. As this was a pilot study involving the initial first stages of scale development, including item development and exploratory factor analyses, a power calculation was not conducted. Therefore, as many participants as possible were recruited, which totaled 91. None of these mothers had participated in the qualitative interview study (see Chapter Three). Ethical permission to conduct this study was granted on 26/04/2010 by the University of Salford Research Ethics Committee Ref: REP10/036.

Following the process of scale development outlined above, the scale was then distributed to a group of first-time mothers living in Salford with infants aged 12 – 36 months. Mothers were recruited and the scale distributed via a number of strategies;

- i) Within local Children's Centres and day nurseries.
- ii) Online via local mother's forums, Facebook and Twitter.
- iii) Via online adverts on the Kids Confidential and Mumsnet websites with links to online versions of the scale.
- iv) Via an advert printed in local paper the Salford Advertiser
- v) Via a radio advert on Salford City Radio.

Participating mothers resided in Salford, Greater Manchester and were identified for inclusion in the study as they represented a range of socio-economic backgrounds. In order to obtain more detailed demographic information of the sample in the study, type of occupation of mothers and level of education was evaluated. In order to evaluate employment types of mothers in the study, the 'Registrar General's Scale of Social Class and Socio-economic Groups' was used to classify employment into the following categories; I) Professional, II) Managerial/Technical, IIIa) Skilled (non-manual), IIIb) Skilled (manual), IV) Partly Skilled, V) Unskilled, VI) Other. The rationale for using this scale of social class was provided in Chapter Three section 3.2.2 'Participants'. Table 4.2 summarises demographic characteristics of mothers in the sample.

Although all mother's resided in two of the most deprived wards of Salford, Greater Manchester, 54 mothers (59%) and 41 fathers (45%) had attended higher education and 74 (81%) of mothers were living with a co-cargiver (husband or partner). A total of 75 mothers were white-British (82%), 5 mothers were African (6%), 4 were White-other (4%), 2 were White-Irish (3%), 2 were Mixed other (2%), 1 was White and Afro-Caribbean, 1 was Chinese, and 1 was Asian.

Table 4.2- Demographic details of participating infants and mothers (n= 91)

Infant Age in years	Mean 2.10 (sd .55; range 1 – 3.08)
Infant Gender	40 female (44%), 51 male (56%)
Maternal Age in years	Mean 32.98 (sd 5.35; range 22.75 – 45.58)
Maternal ethnicity	75 White-British (82%) 5 African (6%) 4 White-other (4%) 2 White-Irish (3%) 2 Mixed other (2%) 1 White and Afro-Caribbean (1%) 1 Chinese (1%) 1 Asian (1%)
Maternal marital status	51 Married (56%) 23 Cohabiting (25%) 11 Single (12%) 6 Divorced (7%)
Maternal current employment status (some mother's stated more than one occupation, e.g. part-time employment and part-time study. Therefore total % > 100%.	39 Part-time employment (43%) 29 Full-time employment (32%) 12 Unemployed (13%) 8 Other, e.g. volunteering (6%) 3 Part-time education (3%) 3 Full-time carer (3%) 3 Part-time education (3%) 2 Full-time education (2%)
Maternal employment type	28 Skilled (non-manual) (31%) 24 Unemployed/full-time carer (26%) 16 Managerial/ technical (17%) 11 Professional (12%) 6 Skilled (manual) (7%) 6 Partly skilled (7%)
Maternal educational record	54 Higher education (59%) 22 Further education (24%) 11 Secondary education (12%) 4 Other (5%)

4.2.3 Scale and Materials

The final version of the newly developed dyadic toothbrushing in infancy PSE scale (see Appendix J) was required for completion by all participating mothers. Additionally, a demographic details questionnaire (see Appendix B) was developed in order to allow information such as employment status and ethnicity to be gathered.

4.2.4 PSE Item and Scale Construction Procedures

The procedures followed when developing the scale and items for inclusion in the scale, were summarised in Figure 4.1 earlier in this chapter. This procedure is in accordance with guidelines reported in the literature (Frei et al., 2009; Lorig et al., 1996; Maibach and Murphy, 1995).

i) Literature Review

This first step is reported in the previous chapters of the thesis. These chapters provide an overview of PSE more generally, how PSE related to childhood dental health and self-efficacy scale development methodology.

ii) Interviews with Target Population

This process is reported fully in Chapter Three of the thesis, where specific information about the interview schedule used is provided.

iii) Qualitative Data Analyses

This process is also reported fully in Chapter Three of the thesis, as are the methods used to analyse qualitative data and the findings generated from analyses.

iv) A Priori Considerations

Certain a priori considerations were made in order to form the basis of the scale development process. Firstly, one important a priori consideration in scale development is what the aim of a scale should be (i.e. discriminative, predictive, evaluative or planning). The decision was made to make the principal aims of the new PSE scale to be 'predictive', i.e. the scale should allow predictions about novice caregivers PSE for establishing toothbrushing as a dyadic process with first-born infants through infancy. This was due to the fact that the scale was originally intended to allow clinicians to identify caregivers who may be at risk of having low PSE when establishing and maintaining twice-daily toothbrushing as a routine with their infant ('predictive').

Additionally, the scale was intended to be 'evaluative', i.e. the scale should be appropriate for use when evaluating interventions designed to increase novice caregivers PSE for establishing toothbrushing as a dyadic process with first-born infants. The additional aim of being 'evaluative' was also made as the new PSE scale, once developed, was intended to evaluate a new picture book intervention to support families as they maintain established twice-daily toothbrushing as a routine with their infant (see Chapter Six of the thesis).

In addition to the aims of the scale, another a priori consideration was the format of the scale. The decision was made that items should have a 4-point Likert response format for answers to each of the scale items. This meant that each item was answered using the following choices on the Likert scale; 'very difficult', 'difficult', 'easy', 'very easy'. This decision was made for two main reasons.

Firstly, having an even-numbered Likert scale would facilitate the development of preliminary clinical cut-off scores (prior to further validation work to develop normative data to further inform clinical cut-offs), which was important as the main aim of the scale was to be clinically predictive, i.e. allow clinical predictions to be made as to which novice caregivers were likely to have low PSE related to establishing toothbrushing as a dyadic process with first-born infants. Therefore with a Likert scale of 1 – 4 (4= Very Easy, 3= Quite Easy, 2= Quite Difficult, 1= Very Difficult), any clinician using it to assess a novice caregiver would be able to assess whether they *may potentially* experience difficulties with establishing toothbrushing as a dyadic process with first-born infants. As there were 25 items in the scale, a maximum score would be 100 (a score of 4 on each of the 25 items) denoting high PSE, and a minimum score would be 25 (a score of 1 on each of the 25 items) denoting low PSE. Any novice caregiver scoring below the mid-point score of 63 could be predicted to have quite-very low PSE for establishing and toothbrushing as a dyadic process with first-born infants.

This scoring system has been used to successfully develop clinical cut-off scores in previously developed scales to measure such difficulties as psychopathology in adults with developmental disabilities (Moss et al., 1998) and dental anxiety in adults (Humphris et al., 2009). This statistical means of deriving clinical cut-offs is also a useful method when no known clinical methods of ‘diagnosis’ are available for comparison with a newly developed scale.

Secondly, using an even-numbered Likert scale can reduce the difficulties caused by mid-point scores denoting 'don't know' or 'neutral' non-committal responses from caregivers. And thirdly, by having a Likert-scale composed of just 4 points, although not allowing for more fine-grained assessments of PSE, allows for estimations of PSE without placing too much cognitive demand on responding caregivers who may find it difficult to apprehend scales that have more points.

v) Development of Scale Items

Scale items were developed from qualitative data generated during an interview study of perceived barriers to and facilitators of toothbrushing routines with 16 first-time mothers of infants between 24 – 30 months old (see Chapter Three).

First Draft of Scale Items: A total of 25 key sub-themes were identified in the interview study, each representing a separate barrier to or facilitator of novice mothers being able to establish toothbrushing as a dyadic process enacted twice-daily with first-born infants aged 24 – 30 months. Self-efficacy scale items were generated to represent each separate identified barrier and facilitator. Two versions of each self-efficacy scale item were generated meaning that 25 pairs of items were developed, with each pair representing each of the 25 perceived barriers and facilitators identified from the interview study. This meant that twice as many items were generated than would eventually be included in the scale; two items, each worded slightly differently, to represent each of the 25 perceived barriers and facilitators.

Items were worded in such a way that they did not ask mothers directly about their own caregiver behaviours with their own infant, but rather a hypothetical infant, in order to reduce the risk of social desirability bias. The use of such 'indirect' questions has been suggested to reduce the likelihood of socially desirable responses from participants (Fisher, 1993), by asking them to report on the external world rather than themselves. It is assumed that by asking a participant their opinion of something present in the external world, information about the participants own nature may be extrapolated.

Additionally, each scale item contained a number of components. A hypothetical situation in which mothers had to brush an infant's teeth (with each of these situations derived from the interview study- see Chapter Three), the behaviour of interest (i.e. toothbrushing), the frequency that the behaviour of interest had to be enacted (i.e. twice) and over a set period of time (i.e. per day). In this way, each item enquired as to how easy or difficult mothers believed it would be to brush an infant's teeth, twice every day, in situations that could potentially make brushing an infant's teeth more easy or difficult.

vi) Expert Panels

As part of the scale development process, two differently worded items were generated to represent each of the 25 identified perceived barriers and facilitators, creating a total of 25 pairs of items, or 50 items. Experts were then required to rate on a scale of 1 – 3 how appropriate they thought each scale item was for inclusion in the scale (1= retain item; 2= remove item; 3= retain but amend item). Decisions regarding which items to

retain were based on clarity of the item, wording, and how succinct each item was. There was also a space below each pair of items so that experts could provide more qualitative feedback if they felt that items would benefit from being amended, e.g. by being worded differently. Findings from the two expert panels were consolidated and scale items amended based on feedback from the expert panels. The expert panels contained some dental health experts, but primarily experts from within the discipline of psychology, and developmental psychology specifically. This was due to the fact that although the scale was developed to measure PSE for a dyadic *dental* behaviour (i.e. toothbrushing), the content of the scale items was mainly around infant development and parenting skills issues. Therefore, a greater breadth of expertise in these rather than dental issues was required from the experts included in the panels.

First, the items were presented to a group of 18 developmental psychologists (see Appendix H for this version of the scale). One of the key pieces of feedback from this first round of expert panel was that clarity of items and item length could be improved by including in the items the name of the hypothetical infant. Following this feedback, items were revised so that they were worded in such a way that they presented mothers with 'Keira', an infant not already known to them. Then, each item enquired as to how easy or difficult each mother believed it would be to brush 'Keira's' teeth in 25 hypothetical situations, each situation representing each of the key perceived barriers and facilitators of toothbrushing identified from the interview study. Each of the 25 situations were reflected in two versions of the same item, each worded slightly differently, totalling 50 items. See Appendix H for this second version of the scale.

Following the developmental psychology expert panel, the second (see Appendix I) version of the scale was then presented to a multi-disciplinary expert panel representing 5 dental and psychology professionals (2 dentists, 1 developmental psychologist, 1 health psychologist, 1 clinical psychologist). Following this process, one of each of the pairs of items was removed from the scale, and a Likert scale was applied to each scale item. This new Likert scale was applied to each item in order to measure maternal responses to each item, i.e. to allow mothers to rate how easy or difficult they thought it would be to brush 'Keira's' teeth in each of the 25 hypothetical situations described by the scale items.

Following feedback from the two expert panels, data were available from 23 experts. Firstly, the wording of any items rated as to be retained but amended, were amended accordingly. Then, feedback from all experts was consolidated by entering quantitative feedback (i.e. whether each expert rated each item as 1= retain item; 2= remove item; retain but amend item) onto an SPSS database. Then, the frequencies of ratings for each item were generated. In all cases, for each pair of items there was a clear 'favourite' item within each pair that the majority of experts rated as 1= retain item. The items rated by the majority of experts as 2= remove item were removed from the scale, leaving just one item from each pair and therefore a total of 25 items in the final version of the scale. See Appendix J for this final version of the scale.

vii) Construction of Final Version of the PSE Scale

Once the expert feedback had been consolidated and one item representing each key barrier and facilitator (as identified in the qualitative interview study) had been retained for inclusion, the total number of items reflecting the main themes identified in the interview study were;

Maternal Behaviours = 9

Infant Behaviours = 6

Maternal Cognitions = 5

Support and Advice = 4

Family History of Toothbrushing = 1

A full description of these 5 main themes and the 25 perceived barriers and facilitators of infant toothbrushing contained within them are provided in Chapter Three of the thesis. Chapter Three provides discussion of how the various perceived barriers and facilitators identified, and represented in PSE scale items, relate to the various levels of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

viii) Statistical Standardisation of Scale

A number of procedures were then followed in order to statistically standardise and validate the PSE Scale. These procedures are now described.

Collection of Initial PSE Scale Data (Time 1)

Following development of the PSE scale, packs including a hard copy of the scale, an invitation letter and a Freepost envelope were distributed to local Children's Centres and day nurseries. These packs were either left in foyers and reception areas, or arrangements were made with Children's Centre and nursery staff, who were willing to distribute the packs to mothers when they either dropped off or picked up their children from day care. Then, mothers could complete the PSE scale at a convenient time and return their completed scale to the researcher using the Freepost envelope provided.

In order to further facilitate collection of scale data from participants, participating mothers also had the option of accessing a link to an online version of the scale which was created using the Bristol Online Survey software (see Appendix K for screen shots of this online version of the PSE scale). The link to the survey was <http://www.survey.bris.ac.uk/salford/toddlerteeth>. Links to this online version of the PSE scale were distributed by e-mail and via social networking sites. Additionally, adverts were placed on the Kids Confidential and Mumsnet websites with links to online versions of the scale.

Both hard copy and online versions of the PSE Scale contained a section informing participating mothers that they would be contacted by the researcher approximately 2-weeks after they had completed the initial version of the PSE Scale (Time 1). It was explained that this would be done in order to ask mothers to complete the PSE Scale a second time (Time 2). This was done in order to assess 2-week test-retest reliability of

the scale. Mothers were asked to provide either postal address or e-mail address details, depending on their preference for how the second PSE scale questions (Time 2) should be sent to them.

Collection of Second PSE Scale (Test-Retest Reliability) Data (Time 2)

In order to assess test-retest reliability of the PSE Scale items, all participating mothers were asked to complete the PSE scale a second time, approximately 2-weeks later. Depending on whether mothers had indicated on their initial PSE Scale (Time 1) that they preferred for the second PSE Scale (Time 2) to be sent to their postal or e-mail address, mothers were either sent a hard copy of the second PSE Scale (with a Freepost envelope for return of the completed second PSE Scale) or e-mailed with a link to a second online version of the PSE Scale. The link to the online version of the second PSE Scale was <http://www.survey.bris.ac.uk/salford/toddlerteeth2>.

Both hard copy and online versions of the second PSE Scale were the same as the initial versions, but had most of the demographic questions omitted, apart from date of birth and contact details items to facilitate identification in the database of each mothers initial PSE Scale data. This was important for test-retest reliability analyses, as each participating mother's initial PSE scale data had to be paired with their second PSE scale data.

Statistical Analyses of PSE Scale Data

PSE Scale data were analysed in a number of ways in order to ascertain a number of features about the scale.

- To facilitate the process of selecting items for inclusion of a revised version of the PSE Scale, internal reliability of scale items was assessed through conducting item-total correlations and generating Cronbach's alpha coefficients (α) (Cronbach, 1951) for each item. Any items with α coefficients $< .40$ are be deemed to not have 'moderate' reliability and therefore may removed from the scale if removal of the items increases the reliability of the overall scale (Landis and Koch, 1977; Viera and Garrett, 2005).

- Item selecting was further facilitated through conducting test-retest reliability of the scale items and generating Intra-class Correlation Coefficients (ICCs) for each scale item and total scale score. Any items with ICC $< .40$ are be deemed to not have 'moderate' reliability and therefore may removed from the scale if removal of the items increases the reliability of the overall scale (Landis and Koch, 1977; Viera and Garrett, 2005).

- In order to explore factor structure within the whole scale, exploratory factor analyses (EFA) were conducted to determine the number of factors within the scale and facilitate the defining of these underlying factors.

4.3 RESULTS

4.3.1 Descriptive Statistics

Individual item scores for the sample (n=91) from the initial PSE scale (Time 1) are provided in Table 4.3, including minimum and maximum scores for each item from the sample, the mean score for each item and standard deviations, and also the total score for the sample on initial PSE scale. Mean scores for each individual item located within each of the 5 main themes is provided. Within each of the 5 main themes, item scores are provided in descending order, with highest mean scores reported first. The range of total initial PSE scale scores is also provided. Total scores for initial PSE scale ranged between 37 – 93 with a mean of 72.73 (sd 10.39).

Table 4.3- Descriptive data for scores on individual items for initial PSE scale (Time 1)

Item Number	Main Theme	Construct represented by item	Range	Mean (sd)
8	MATERNAL BEHAVIOUR	Allowing infant to model mother	2 – 4	3.70 (.57)
7		Providing rewards	1 – 4	3.34 (.78)
1		Routinisation	1 – 4	3.25 (.70)
5		Allowing infant to have a go	2 – 4	3.22 (.68)
10		Establishing brushing early	1 – 4	3.14 (.89)
2		Creating a game	2 – 4	3.13 (.70)
6		Perseverance	1 – 4	2.80 (.81)
3		Maternal discipline	1 – 4	2.42 (.75)
4		Restraining infant	1 – 4	2.12 (.70)
9	FAMILY HISTORY	Mother's experiences of toothbrushing as a child	1 – 4	2.97 (.99)
16	INFANT BEHAVIOUR	Wanting to brush themselves	1 – 4	3.00 (.63)
12		Man-handling brush	1 – 4	2.64 (.71)
11		General dislike	1 – 4	2.52 (.82)
15		Disliking taste	1 – 4	2.19 (.77)
14		Closed mouth	1 – 4	1.85 (.67)
13		Infant sleeping	1 – 4	1.51 (.69)
18	MATERNAL COGNITION	Expectations around toothbrushing	1 – 4	3.32 (.74)
20		Remembering to brush infant's teeth	1 – 4	3.30 (.71)
21		Confidence	1 – 4	3.22 (.70)
17		Maternal control of toothbrushing	1 – 4	3.20 (.76)
19		Stress	1 – 4	2.87 (.79)

24	SUPPORT AND ADVICE	Support from co-caregiver	1 – 4	3.29 (.78)
25		General social support	1 – 4	3.25 (.77)
23		Non-professional advice	1 – 4	3.19 (.76)
22		Professional advice	1 – 4	3.19 (.77)
TOTAL SCORE Time 1			37 – 93	72.73 (10.39)

4.3.2 Internal Reliability

Table 4.4 outlines the Cronbach α coefficient's generated for each of the scale items through conducting item-total correlations. Each α coefficient for each individual item located within each of the 5 main themes is provided. Within each of the 5 main themes, α coefficient's are provided in descending order, with highest α coefficient's reported first

Overall reliability for the total scale was $\alpha = .926$. Items with $\alpha < .40$ were then removed as they were deemed to be unreliable. Removed items were items 7, 8 and 13. Items and corresponding coefficients for these items shaded in grey in Table 4.4. After the removal of these items, overall reliability of the scale was found to increase slightly to $\alpha = .934$, so the decision was made to remove these unreliable items for the exploratory factor analyses (EFA) reported later in this chapter.

Table 4.4- Cronbach alpha coefficients for scale items from internal reliability analyses

Item Number	Main Theme	Construct represented by item	Cronbach α
6	MATERNAL BEHAVIOUR	Perseverance	.73
1		Routinisation	.67
3		Maternal discipline	.65
5		Allowing infant to have a go	.51
10		Establishing brushing early	.50
2		Creating a game	.49
4		Restraining infant	.47
7		Providing rewards	.32
8		Allowing infant to model mother	.19
9	FAMILY HISTORY	Mother's experiences of toothbrushing as a child	.64
11	INFANT BEHAVIOUR	General dislike	.65
14		Closed mouth	.50
16		Wanting to brush themselves	.47
12		Man-handling brush	.44
15		Disliking taste	.42
13		Infant sleeping	.15
18	MATERNAL COGNITION-	Expectations around toothbrushing	.75
19		Stress	.73
21		Confidence	.70
17		Maternal control of toothbrushing	.68
20		Remembering to brush infant's teeth	.60
23	SUPPORT AND ADVICE	Non-professional advice	.66
24		Support from co-caregiver	.65
25		General social support	.63
22		Professional advice	.59

4.3.3 Test-Retest Reliability

Shapiro-Wilks tests were conducted to assess normality and data were found to be normally distributed (all $p \geq .05$). Test-retest reliability was examined in 51 mothers who responded to a request to complete the scale a second time (Time 2) approximately 2 weeks following their completion of the initial version of the scale (Time 1). Mean initial PSE scale total score was 72.73 (sd 10.39) and mean second PSE scale total score was 73.94 (sd 10.26). A Paired Samples T-Test conducted on data derived from participants who had responded to the second PSE scale ($n=51$) indicated no significant difference between initial PSE scale and second PSE scale total scores ($t= -1.14$; $df= 51$; $p= .26$).

In addition to examining differences between initial PSE scale and second PSE scale total scores, ICCs were generated for each scale item and also for the overall scale total. Table 4.5 outlines the ICCs generated for each of the scale items. Overall, the scale was found to have an ICC of .723, indicating substantial test-retest reliability.

Each ICC for each individual item located within each of the 5 main themes is provided on Table 4.5 also. Within each of the 5 main themes, ICCs are provided in descending order, with highest ICCs reported first. A total of 8 items were found to have less than 'moderate' test-retest reliability ($ICC < .40$), these being items 4, 7, 8, 10, 11, 12, 13, 23. After removal of these 8 items, overall inter-rater reliability of the scale actually decreased to $ICC = .700$, therefore the decision was made to retain these items for the EFA reported later in this chapter.

Table 4.5- ICCs for scale items from test-retest reliability analyses

Item Number	Main Theme	Construct represented by item	ICC
6	MATERNAL BEHAVIOUR	Perseverance	.57
1		Routinisation	.55
2		Creating a game	.50
5		Allowing infant to have a go	.50
3		Maternal discipline	.42
4		Restraining infant	.38
8		Allowing infant to model mother	.37
10		Establishing brushing early	.37
7		Providing rewards	.30
9		FAMILY HISTORY	Mother's experiences of toothbrushing as a child
16	INFANT BEHAVIOUR	Wanting to brush themselves	.54
14		Closed mouth	.52
15		Disliking taste	.42
13		Infant sleeping	.37
11		General dislike	.34
12		Man-handling brush	.30
19	MATERNAL COGNITION-	Stress	.76
18		Expectations around toothbrushing	.59
17		Maternal control of toothbrushing	.57
21		Confidence	.54
20		Remembering to brush infant's teeth	.49
22	SUPPORT AND ADVICE	Professional advice	.51
24		Support from co-caregiver	.45
25		General social support	.43
23		Non-professional advice	.20

In order to examine differences between second PSE scale responders (n=51) and non-responders (n=40), the two groups were compared in terms of maternal age, infant age, IMD level and initial PSE scale total score. As data on these variables were found to be normally distributed, Independent Samples T-Tests were conducted with the between subjects variable being whether mothers completed a Time 2 infant toothbrushing PSE scale or not. The findings from the analyses are reported in Table 4.6. The two groups (second PSE scale 'responders' and 'non-responders') were not found to significantly differ according to infant age, IMD or initial PSE scale total score, and so second PSE scale response or non-response could not be explained by maternal or infant age or family SES. However, non-responders to the second PSE scale (i.e. those mothers who completed only the initial PSE scale) were found to be significantly younger than those mothers who completed both the initial PSE scale and second PSE scale.

Table 4.6- Differences between second PSE scale responders and non-responders

	Only Time 1 PSE completed Mean (sd)	Only Time 1 PSE completed df	Time 1 and Time 2 completed Mean (sd)	Time 1 and Time 2 completed df	t	p value
Maternal age (years)	30.61 (5.32)	90	34.67 (4.70)	50	-3.773	<.001
Infant's age (years)	2.08 (.57)	90	2.12 (.54)	50	-.299	.765
IMD level	31.13 (20.27)	90	29.33 (16.56)	50	.458	.648
Time 1 total PSE score	72.60 (12.34)	90	72.57 (10.43)	50	.013	.990

4.3.4 Exploratory Factor Analyses

Following internal reliability and test-retest reliability analyses, unreliable items (items 7, 8 and 13) were removed and exploratory factor analyses (EFA) conducted in order to ascertain underlying structures within the scale. Principal component analysis and Varimax rotation were carried out to ascertain the number of components underlying the scale. Five main components were found that accounted for 68.11% of the variance. Table 4.7 outlines the percentage of the variance accounted for by each of the five main components identified within the scale following rotation.

Table 4.7- Percentage of variance accounted for by each component

Component	Total	% of Variance	Cumulative %
1	5.071	23.051	23.051
2	2.944	13.380	36.431
3	2.459	11.176	47.607
4	2.340	10.636	58.243
5	2.171	9.867	68.111

The Scree Plot in Figure 4.2 also depicts the extent to which these five main components account for the variance within scale data compared to other possible components.

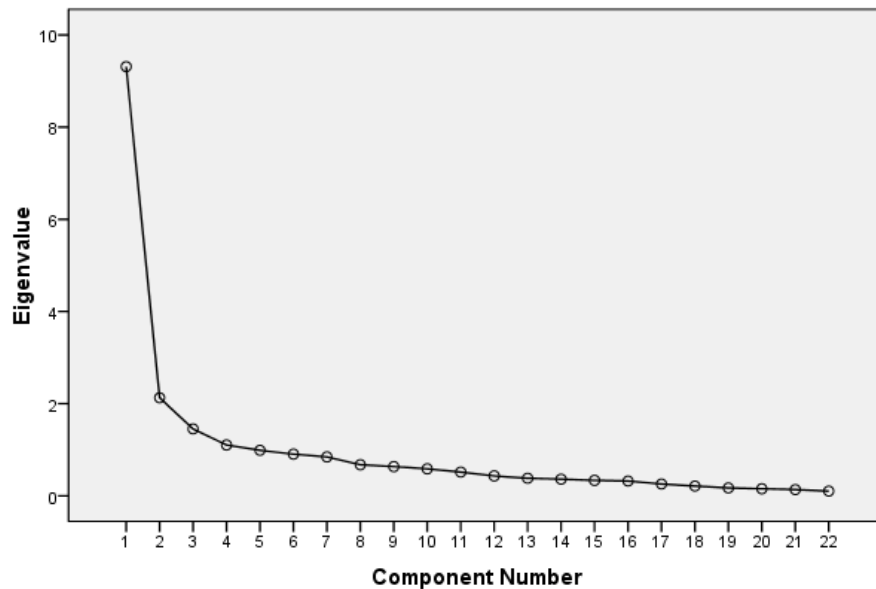


Figure 4.2- Scree plot depicting variance accounted for by all scale components

Items loading onto each component with a loading value of $\geq .50$ were considered to be adequately loaded onto their corresponding component. Items 1 and 6 were not found to load onto any of the identified 5 components (all had factor loadings $< .50$) and are shaded in grey in Table 4.8. Factor loadings for each underlying component of the scale for all reliable items are also provided in Table 4.8, with factor loadings within each component displayed in size order (largest to smallest). There was only one instance of cross-loading with item 18 (Expectations around toothbrushing) loading onto both component 1 (Eigenvalue .59) and component 3 (Eigenvalue .51).

In order to ascertain whether Items 1 and 6 should be removed from the final version of the PSE scale, the overall reliability of the scale was calculated again. Without Items 1 and 6 overall reliability was $\alpha = .932$. This was only a marginally higher reliability than if these two items were retained ($\alpha = .922$).

Table 4.8- Factor loadings and components for each reliable PSE scale item

Item Number	Main Theme	Construct represented by item	Components				
			1	2	3	4	5
25	SUPPORT AND ADVICE	General social support	.86	.09	.14	.15	.02
23		Non-professional advice	.81	.18	.10	.29	-.06
24		Support from co-caregiver	.78	.10	.11	.20	.14
22		Professional advice	.73	.27	.23	-.24	.19
17	MATERNAL COGNITION	Maternal control of toothbrushing	.64	.12	.34	.15	.25
19		Stress	.59	.15	.18	.41	.33
18		Expectations around toothbrushing	.59	.15	.51	.14	.31
16	INFANT BEHAVIOUR	Wanting to brush themselves	.53	-.03	-.10	.16	.47
21	MATERNAL COGNITION-	Confidence	.52	.36	.49	-.02	.23
4	MATERNAL BEHAVIOUR	Restraining infant	-.03	.74	.23	.10	.30
15	INFANT BEHAVIOUR	Disliking taste	.28	.73	-.06	.07	-.09
14		Closed mouth	.15	.69	-.02	.45	-.04
3	MATERNAL BEHAVIOUR	Maternal discipline	.13	.68	.28	.29	.33
10	MATERNAL BEHAVIOUR	Establishing brushing early	.10	.07	.85	.29	.07
20	MATERNAL COGNITION	Remembering to brush infant's teeth	.45	.07	.62	.05	.19
12	INFANT BEHAVIOUR	Man-handling brush	.09	.22	.14	.64	.10
9	FAMILY HISTORY	Mother's experiences of toothbrushing as a child	.47	.12	.03	.62	.21
11	INFANT BEHAVIOUR	General dislike	.15	.42	.37	.61	.13
6	MATERNAL BEHAVIOUR	Perseverance	.43	.43	.26	.44	.14
5	MATERNAL BEHAVIOUR	Allowing infant to have a go	.18	.17	.17	-.01	.80
2		Creating a game	.10	.06	.20	.38	.64
1	MATERNAL BEHAVIOUR	Routinisation	.29	.39	.42	.14	.42

4.3.5 Labelling of Components

Following the EFA conducted on the scale, the remaining 19 items and the components they loaded strongly onto were examined in order to generate potential labels that described these components. Table 4.9 outlines the items that loaded onto each of the 5 components, along with potential labels that describe the underlying construct each component measures.

Table 4.9- Potential labels for the 5 components identified from EFA

Component Number	Component Label	Items within Component		
		Item Number	Main Theme	Construct represented by item
1	Cognitions and co-constructed knowledge about toothbrushing	25	SUPPORT AND ADVICE	General social support
		23		Non-professional advice
		24		Support from co-caregiver
		22		Professional advice
		17	MATERNAL COGNITION	Maternal control of toothbrushing
		19		Stress
		18		Expectations around toothbrushing
		16	INFANT BEHAVIOUR	Wanting to brush themselves
		21	MATERNAL COGNITION	Confidence
2	Mother-infant conflict about toothbrushing	4	MATERNAL BEHAVIOUR	Restraining infant
		15	INFANT BEHAVIOUR	Disliking taste
		14		Closed mouth
		3	MATERNAL BEHAVIOUR	Maternal discipline
3	Preparation and anticipation skills	10	MATERNAL BEHAVIOUR	Establishing brushing early
		20	MATERNAL COGNITION	Remembering to brush infant's teeth
4	Coping with intrusive input	12	INFANT BEHAVIOUR	Man-handling brush
		9	FAMILY HISTORY	Mother's experiences of toothbrushing as a child
		11	INFANT BEHAVIOUR	General dislike
5	Positive parenting practices	5	MATERNAL BEHAVIOUR	Allowing infant to have a go
		2		Creating a game

4.4 DISCUSSION

This scale development study synthesised the current psychometric scale development guidelines to construct a process to develop a scale to measure novice caregivers PSE to establish toothbrushing as a dyadic process with first-born infants. The process used to develop this scale has never before been used to develop a scale to measure novice caregivers PSE for toothbrushing as a dyadic process with first-born infants. Indeed, this new scale is the first truly *task-specific* scale to measure PSE for dyadic toothbrushing alone. The three previous child dental health PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) have all been designed to measure general child dental health care behaviours including toothbrushing, dietary habits and dental visits. Additionally, none of these previous child dental health care PSE scales have been designed to measure novice caregivers PSE for establishing toothbrushing as a dyadic process with first-born *infants*, but instead have focussed on older children.

Items for inclusion in the new scale were generated using the 25 key perceived barriers/facilitators of dyadic toothbrushing with infants identified from the qualitative interview study reported in Chapter Three of the thesis were used to inform content of the PSE scale items. Each of the 25 perceived barriers/facilitators were represented in an item included in the scale included in the statistical study reported here, totalling 25 scale items. In addition to each item reflecting a key barrier/facilitator, each also reflected the behaviour of interest (toothbrushing) and the frequency that the behaviour had to be enacted (twice a day).

Statistical techniques were used to standardise the scale and explore underlying structures within it. These included internal reliability, test-retest reliability and exploratory factor analyses. The findings from these standardisation techniques are now discussed.

4.4.1 Internal Reliability of the Scale

Initial internal reliability analyses revealed three items to have poor internal reliability ($\alpha < .40$) and were therefore removed before factor analyses were conducted, leaving a total of 22 reliable items. These three items were Items 7, 8 and 13. Items 7 and 8 reflected maternal behaviours. Item 7 reflected mother's perceptions of their self-efficacy to provide infants with rewards for compliant behaviour during toothbrushing. Item 8 reflected mother's perceptions of their self-efficacy to allow their infant to observe them brushing their own teeth in order to provide opportunities for their infant to model their mother's toothbrushing behaviours. Item 13 reflected an infant behaviour that may impact on toothbrushing, that is, an infant falling asleep before their mother had an opportunity to brush their teeth before bedtime.

Once unreliable items were removed overall internal reliability was found to be 'excellent', $\alpha = .932$. This would indicate that the items within the scale are highly correlated, and all appear to be measuring a similar construct. However, when a scale has such a high coefficient alpha, it could be criticised on the grounds that the items within it are not measuring sufficiently different constructs to merit having multiple items within a scale. Such a 'congeneric' scale would contain within it a number of scale

items that essentially measure the same thing. This may mean that many of the items within the scale could be redundant, as fewer items could still reliably measure the construct of interest (Boyle, 1991).

The excellent alpha coefficient generated for the PSE scale developed within this study could also be seen as strengthening the scale however. As the PSE scale is designed to be used as a clinical tool, reliability should ideally be high. Recommendations within the literature suggest that any clinical tool should have an overall reliability of at least $\alpha = .90$ (Nunnally, 1978), therefore, with a alpha coefficient of .932, the PSE scale developed in this study meets this expectation. Additionally, as the PSE scale was specifically designed to be 'task-specific', and therefore measure a very precise and specific construct, it would not be surprising that the items within the scale are highly correlated and yield a high internal reliability alpha coefficient. If that scale was designed to be 'domain-specific' rather than task-specific, and include items regarding dietary behaviours and dental visits in addition to toothbrushing items, the overall reliability may have been lower. If inclusion of these extra items in a domain-specific scale had reduced the overall reliability to $< .90$, the scale may not have been considered to be reliable enough to be used as a clinical tool (Nunnally, 1978).

Compared to the toothbrushing sub-scales of the previously developed child dental health scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010), the newly developed toothbrushing PSE scale had higher reliability. The toothbrushing sub-scale reliability coefficients for the previous scales were $\alpha = .73$ (Adair et al., 2004), $\alpha = .91$

(Finlayson et al., 2005) and $\alpha = .91$ (Kakudate et al., 2010), compared to the $\alpha = .932$ of the newly developed scale.

4.4.2 Test-Retest Reliability of the Scale

There were some issues with test-retest reliability of the scale, with 8 items having ICC's of less than 'moderate' reliability ($ICC < .40$). These items included the following; 4- 'restraining infant', 7- 'providing rewards', 8- 'allowing infant to model mother', 10- 'establishing brushing early', 11- 'general dislike of toothbrushing', 12- 'infant man-handling brush', 13- 'infant sleeping', 23- 'non-professional advice'. However, removal of these 8 items reduced overall test-retest reliability from $\alpha = .723$ to $\alpha = .700$. Therefore the decision was made to retain these items.

Although these items only had moderate test-retest reliability, the stability of a cognition such as self-efficacy over time is unknown. It may not necessarily be the case that these items did have poor test retest reliability, but rather that PSE for managing the challenges represented in each of these items may be variable and may be subject to change over time. Therefore, regardless of how reliable these items might be, they will not have good test-retest reliability as they measure variable constructs. Indeed, Bandura suggests that self-efficacy is inherently dynamic and variable and can change over time and from situation to situation (Bandura, 1997).

Compared to the previously developed child dental health PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010), only one of these previous scales, the SESMO (Kakudate et al., 2010), had assessed test-retest reliability, and found test-retest of the toothbrushing this previous scale to be $r = .67$. It is difficult to compare test-retest reliability of the toothbrushing sub-scale of the SESMO to the newly developed toothbrushing PSE scale as different methods of were used to assess test-retest reliability in each of the studies. The test-retest reliability of the SESMO was assessed by correlating initial scores with repeat assessment scores using Spearman Rank correlation, whereas ICC's were used in the present study. However, simply comparing the test-retest reliability coefficients of the two studies would suggest that test-retest of the newly developed dyadic toothbrushing in infancy PSE scale is higher than that of the SESMO.

4.4.3 Findings from Exploratory Factor Analyses

Following the three unreliable items being removed, EFA revealed an underlying structure within the remaining scale that contained 5 components. However, two of the remaining reliable items did not load sufficiently strongly onto any of the 5 identified components (had factor loadings $< .50$). These two items were Items 1 and 6. Item 1 reflected mother's ability to turn toothbrushing into a regular routine with their infant and Item 6 reflected caregiver's ability to persevere with infant toothbrushing in the face of difficulties. Additionally, Item 18, which reflected maternal outcome expectancies, loaded onto two components, components 1 and 3.

Decreasing the minimum factor loading to .40 would have resulted in much more significant cross-loading (i.e. 8 items would have loaded onto more than one component), which would have decreased the reliability of the factor analyses. It therefore was appropriate to set the minimum factor loading to .50 as this retained the reliability and 'cleanness' of the factor analysis. The decision was taken to retain the two items that had factor loading $< .50$ as the removal of these two items did not increase the overall reliability of the scale. As Items 1 and 6 were initially found to have internal reliability coefficients of .67 and .47 respectively, the decision was made to retain them in the final version of the scale, as these items may measure important constructs.

4.4.4 Description of Scale Components

Potential labels to describe the 5 components which 20 of the scale items were found to be contained within were generated and are now discussed in more detail.

- Component 1: Cognitions and co-constructed knowledge about toothbrushing

This component describes items measuring maternal cognitions related to toothbrushing including locus of control, perceptions of stress, outcomes expectancies and PSE. In addition to these cognitions, items related to sources of advice and support around toothbrushing also loaded onto this component. Therefore, all items loading onto this component appeared to be related to more intellectual and 'cerebral' influences associated with infant toothbrushing, i.e. 'cognitions and knowledge'. However, as some of the items within this component related to advice, knowledge and

support provided by others, i.e. individuals not including the mother, the term 'co-constructed' was included in the label generated to describe this component. One item which loaded onto this factor was Item 16 which related to an infant's desire to brush their teeth themselves. This item does not particularly fit with the constructs the other items within this component measure.

- **Component 2: Mother-infant conflict about toothbrushing**

This component describes items measuring possible sources or caregiver-infant conflict around toothbrushing. For example, items relating to mothers having to use punitive discipline to cope with difficult infant behaviours during toothbrushing (i.e. restraint) and other more general forms of discipline. Additionally, items contained within this component also reflected difficult infant behaviours that could potentially contribute to conflict during toothbrushing. These included infants refusing to open their mouth during toothbrushing and disliking the taste of toothpaste.

- **Component 3: Coping with intrusive input**

This component describes items measuring possible sources of intrusive input that could act as a barrier to infant toothbrushing. For example, these sources of intrusive input could come from the infant, e.g. the infant trying to man-handle the brush when their mother is attempting to brush their teeth for them, or the infant generally disliking toothbrushing. Another possible source of intrusive input could come from caregiver's family history of toothbrushing, and their own mothers not encouraging them to brush their own teeth as an infant.

- **Component 4: Preparation and anticipation skills**

This component describes items measuring caregiver's child-care skills around toothbrushing that relate to preparation and anticipation of this specific child-care task.

So for example, these items relate to mothers starting toothbrushing with their infant as early as possible (i.e. upon the eruption of their first tooth) and remembering to brush their infant's teeth twice every day.

- **Component 5: Positive parenting practices**

This component describes items measuring mother's abilities to cope with their infant's drive for autonomous toothbrushing. For example, mothers can cope with this drive by allowing their infant to have a go at brushing their own teeth. They can also cope with it by turning toothbrushing into a fun game that both members of the dyad take part in. Both of these coping strategies were reflected in each of the items loading onto this component.

4.4.5 Limitations to the Study

As with much research, there were some potential limitations to this study, the most immediate being the relatively small sample size (n=91 for Time 1 PSE scale; n=51 for Time 2 PSE Scale). This was mainly due to the difficulties experienced throughout the conduct of all the studies reported in the thesis with recruiting participants in a community sample, especially samples living in deprived communities. Participants had to be identified from local community services such as Children's Centres and nurseries and also online via websites such as Mumsnet. Information about the study was posted

on notice boards within these community settings and on websites as it was difficult to meet enough mothers in person to speak to them about the study. Even the group sessions ran in the local Children's Centres contained small numbers of mothers, so recruitment of participants in such a 'face-to-face' manner was very time consuming. Additionally, the populations identified for the studies reported in the thesis (mothers living in socially deprived environments where the highest rates of child dental caries are) are difficult to engage with research (Chadwick and Treasure, 2005). So multiple methods of recruitment had to be utilised, including newspaper, website and radio adverts and also spending time in local Children's Centres and nurseries talking to mothers.

The fact that participating mothers were also self-selecting may also be considered a limitation, as these mothers, considering they were motivated to take part in a research study, may have also been motivated, capable mothers more generally. This may have meant that they might have had relatively high PSE, more so than mothers who are not motivated to take part in research. Therefore, how reliably the scale may measure PSE in mothers who might be less motivated to participate in research, and might be at risk of having low PSE is unknown. Additionally, all participating mothers resided in Greater Manchester so the PSE scale was standardised with this specific population. How well the scale could measure PSE of mothers residing in other areas of the UK and also mothers from different cultures living in other countries is also unknown.

There was also a restriction in the amount of time the research could be completed in and this meant that analyses had to be conducted on the data in the time available for

collection of data. However, compared to the Kakudate et al. (2010) scale development study, the sample size was not significantly smaller as the Kakudate et al. study had a sample size of 119 caregiver-child dyads. But compared to the Adair et al. (2004) and Finlayson et al. (2005) studies, sample size was significantly smaller as these studies had sample sizes of 2822 and 719 respectively.

Due to the participant recruitment difficulties experienced, the amount of data available for analyses fell short of some of the scale development guidelines. For example, in scale development research, it is recommended that the participant-item number ratio is at least 10:1 (Costello and Osborne; Kim-Cohen et al., 2004). Following statistical standardisation and removal of the 3 unreliable items, the scale was left with 22 items. This meant that with a sample size of 91, the participant-item number ratio for the analyses reported in this chapter was 4.14:1. In order to fulfil the sample size guidelines, a sample size of 220 mothers would have to have been included in the study, and therefore more than twice as many participants would have to have been recruited in the time available. This would not have been feasible considering the recruitment difficulties experienced in research in deprived communities.

Considering the sample size limitations experienced, further work could now be conducted to collect PSE scale data from a larger sample of participants in order to conduct confirmatory factor analyses (CFA) and generate normative data. This normative data could then also be used to calculate Standard Error of Measurements and therefore confidence intervals to increase the potential reliability of the scale. By generation confidence intervals, a discrete single total score need not be relied upon to

measure PSE, as confidence intervals would provide a range of scores that may provide a 90 – 95% accurate impression of their PSE score. In addition, further work could include male caregivers such as fathers.

However, one way in which the sample included in the present study may provide more reliable data than those provided by the previous scale developmental studies is that the age range of infants included in the present study was much narrower than in two of the previous studies. The age range in the present study was 12 – 36 months, compared to 1 – 8 years old (Kakudate et al., 2010) and 1 – 5 years (Finlayson et al., 2005).

4.4.6 Further Study

In additional further work, the newly developed dyadic toothbrushing PSE scale is used to evaluate a picture book intervention to increase maternal control of holding and using the toothbrush during dyadic brushing episodes with infants. This intervention study is reported in Chapter Six of the thesis. In this intervention study the predictive validity of the new PSE scale is assessed through correlating PSE scale scores with observed dyadic toothbrushing behaviours. None of the previous child dental health care PSE scales (Adair et al., 2004; Finlayson et al., 2005; Kakudate et al., 2010) have been assessed for their predictive validity using observational data.

In addition to the new PSE scale data being used to evaluate this intervention, observational data of dyadic toothbrushing episodes from participating mother-infant

dyads are also used. In order to develop the observational coding schedule the next study reported in Chapter Five describes a cross-sectional observational study of dyadic toothbrushing episodes in three age groups of infants, including 12-, 18- and 24-months. In addition to developing the observational coding schedule, the observational study is used to compare the three age groups of dyads in terms of frequency and duration of both maternal and infant control of holding and using the toothbrush during observed episodes. This is done to identify the age at which the intervention may be most appropriate, i.e. the age at which infant control of holding and using the toothbrush may be posing as barrier to effective maternally controlled infant toothbrushing.

**CHAPTER FIVE: AGE RELATED DIFFERENCES IN DYADIC
TOOTHBRUSH HOLDING DURING TOOTHBRUSHING ROUTINES:
A CROSS-SECTIONAL OBSERVATIONAL STUDY**

5.1 Introduction

Throughout the thesis, influences on the emergence of toothbrushing as a dyadic process through infancy have been discussed, specifically with reference to dyads containing novice caregivers of first-born infants. The empirical work reported in the thesis so far has identified that a number of influences may lie at the level of the caregiver-infant dyad, which is located within the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). One key influence that has been explored in the studies reported in Chapters Three and Four of the thesis is parental self-efficacy (PSE). This cognition has been found to potentially mediate caregiver's abilities to overcome barriers to effective dyadic toothbrushing with infant's that is conducted via caregiver control of holding and using the toothbrush.

One key barrier to infant toothbrushing that is conducted via caregiver control of holding and using the toothbrush has been suggested to be young children exhibiting a drive to engage in autonomous self-toothbrushing. Observational studies (Martins et al., 2011; Zeedyk et al., 2005), qualitative interview studies (Huebner & Riedy, 2010) and survey studies (BDHF, 2008) that report data on dyadic toothbrushing during

infancy suggesting that young children may be engaging in early self-toothbrushing at as young an age as 24 – 30 months. This is in contrast to best-practice guidelines from national and international general health and dental health bodies such as the American Academy of Pediatric Dentistry (AAPD, 2011a), the British Dental Health Foundation (BDHF, 2010) and National Health Service (NHS, 2009) which state that is important that caregivers brush infant's teeth for them.

A number of aspects of infant development may potentially explain why many young children might engage in such early self-toothbrushing. One potential aspect of development during *infancy* that may contribute to the emergence of this early self-toothbrushing is the improving fine motor skills during this period of development (AAP- Gerber et al., 2010) and also increasing drive towards autonomous tool use from the age of approximately 8-months (Barrett et al., 2007; Claxton et al., 2009). From this age, infants have an increasing capacity for ever more complex manipulation of objects in order to achieve certain goals, such as the use of spoons in self-care tasks such as self-feeding (Carruth et al., 2004) and potentially self-toothbrushing (BDHF, 2008; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005).

Additionally, through the second year of life, infants demonstrate an increasing ability to copy action sequences enacted by other people through social learning and imitation (Nielsen, 2006). Specifically, by the end of the first year of life, the majority of infants are able to imitate actions that involve objects (Masur, 2006) through understanding the functions of objects such as tools (Hernik and Csibra, 2009). In this way, twice-daily toothbrushing could be conceived as an 'imitogenic experience' (Ray and Heyes, 2011),

as it is a dyadic activity in which an infant engages in regularly in which the same object is used daily in the same manner. Daily dyadic toothbrushing therefore provides an activity in which an infant can engage in direct and mirror-mediated self-observation and observation of their caregiver using the toothbrush, and therefore this may provide opportunities for infants to imitate this action.

It would appear then that very young children may be engaging in self-toothbrushing (BDHF, 2008; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005), which may make sense given what is understood about developing infant tool use (Barrett et al., 2007; Claxton et al., 2009), social learning and imitation (Nielsen, 2006). In order to more fully understand the emergence of early self-toothbrushing an observational methodology may allow exploration of how duration and frequency of caregiver versus infant control of holding and using the toothbrush may change across the second year of life. This may be achieved through the inclusion of three age groups of dyads containing infants either, 12, 18 or 24-months old in order to assess age associated differences in caregiver and infant control and use of the toothbrush during brushing episodes. It would be expected given the published literature that between 12 and 24 months a number of developmental changes should occur including those related to fine motor skills (AAP- Gerber et al., 2010), tool use skills (Barrett et al., 2007; Claxton et al., 2009), drive for autonomy (Erikson, 1968; Helwig, 2006) and ability to copy novel action sequences (Nielsen, 2006).

Despite the growing evidence-base to support the idea that many young children may be engaging in early self-toothbrushing (BDHF, 2008; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005), previous studies have not specifically aimed to examine at what age such early self-toothbrushing might start by examining dyadic toothbrushing in dyads containing infants as young as 12 – 24 months. Nor have they aimed to examine *how* the suggested early self-toothbrushing might first start, for example, it has been suggested that infants learn to use tools better through observing an adult using the tool, rather than by individual learning through manual exploration of the tool (Gardiner et al., 2012). The published literature also reveals that previously only two studies have used an observational methodology (Martins et al., 2011; Zeedyk et al., 2005) to examine dyadic toothbrushing, although these previous studies did not aim to use a cross-sectional methodology to examine potential age associated differences in dyadic interactions during toothbrushing. These two studies are now discussed and critiqued with reference to how the new study reported in this chapter extends and improves on these previous observational studies.

5.1.1 Observational Research of Early Dyadic Toothbrushing

Observation of events in the natural world is one of the fundamental practices of all the natural and human sciences. Within the discipline of developmental psychology, observational methods have been employed to examine caregiver-child interactions for a number of years (Aspland and Gardner, 2003; Gardner, 2000), including in studies relating to children's health behaviours such as eating behaviours during mealtimes (Orrell-Valente et al., 2007). Two observational studies of caregiver and child use of

toothbrushes during dyadic toothbrushing routines have previously been conducted (Martins et al., 2011; Zeedyk et al., 2005). The two main findings generated from these studies relate to the unreliability of caregiver self-reports of toothbrushing, and also the fact that children may be engaging in significant self-toothbrushing from a very young age.

The first observational study of caregiver and child toothbrush holding and use during dyadic toothbrushing was conducted with 18 families containing a child approximately two-years old (mean age 2.5 years, range 31 – 33 months) (Zeedyk et al., 2005) in Scotland, with families being asked to record any toothbrushing episodes with their child during a 24-hour period. The numbers of episodes recorded by each family range from one – four per day; one episode per day in two families; two episodes per day in seven families; three episodes per day in seven families and four episodes per day, in two families. This created a total number of 45 recorded episodes amongst the 18 participating families. These recorded toothbrushing episodes were then analysed to assess the style of toothbrushing in each session.

Toothbrushing episodes were operationalised by Zeedyk et al. (2005) as being characterised by five main brushing styles which were defined by whether they were caregiver or child led, or whether a joint brushing technique was used. This was determined by measuring the number of seconds that the caregiver and child were each holding the toothbrush within each episode;

- i) Exclusively caregiver-led (only the caregiver holds the toothbrush during the episode).

- ii) Exclusively child-led (only the child holds the toothbrush during the episode).
- iii) Caregiver holding the toothbrush at the start of the episode and then the child holding the toothbrush after their caregiver has brushed their teeth for them.
- iv) Child holding the toothbrush at the start of the episode and then the caregiver holding the toothbrush after their child has brushed their own teeth.
- v) Caregiver and child alternating holding the toothbrush throughout the episode.

However, Zeedyk et al. (2005) only included within their coding schedule either caregiver only holding the toothbrush or infant only holding the toothbrush, they did not include codes in their schedule that accounted for the caregiver and infant holding the same brush at the same time. So for example, their coding schedule did not account for occurrences of the infant holding the toothbrush but which the caregiver's hand over the infant's hand, guiding the infant through the process of using the toothbrush.

Of these 45 episodes of dyadic toothbrushing with 2.5 year old infants, only five (11%) were exclusively caregiver-led, i.e. the caregiver had full control of holding the toothbrush during the entire toothbrushing episode, and a total of 15 (33%) of the 45 episodes depicted exclusively child-led toothbrushing in which the child had full control of holding the toothbrush during the toothbrushing episode. The study found that the most common style of brushing at the age of around two-years was a *shared* style, in which both caregiver and child shared control of holding the toothbrush during the toothbrushing episode, with a total of 25 (56%) of the 45 recorded episodes depicting this style of toothbrushing. Families were also found to be relatively consistent in the style of brushing they employed, with 13 of the 18 participating families (72%) using the same style in each of episodes they recorded and were included in the data analyses for

the study. Only one family displayed toothbrushing in which caregivers exclusively held the toothbrush in all episodes, and in 6 of the families (33%), the caregiver did not hold the toothbrush within any of the episodes they recorded.

What Zeedyk et al. (2005) also found was that caregiver's perceptions of the effectiveness of their toothbrushing with their child did not bear any relation to the observed effectiveness from the video recorded episodes. Caregivers were asked to complete a questionnaire containing items that asked them about how confident they felt that each recorded episode of toothbrushing depicted effective toothbrushing with their child. For 33 of the 45 recorded episodes (73%), caregivers reported that they felt 'very' or 'fairly' confident that these episodes of toothbrushing had been effective in cleaning their child's teeth. In the remaining 12 of the 45 recorded episodes, caregivers reported that they were 'somewhat unconfident' that the toothbrushing depicted in these episodes resulted effective toothbrushing with their child. This would indicate that in nearly three-quarters of the recorded toothbrushing episodes in the study, caregivers felt confident that they had effectively cleaned their child's teeth during toothbrushing.

However, findings from this self-report questionnaire data are in contrast to the behaviours observed in the video recorded toothbrushing episodes. It was found that in episodes where the child exclusively held the toothbrush, the total amount of time the toothbrush was in the infant's mouth was significantly shorter than when caregivers exclusively held the toothbrush; 10 versus 33 seconds respectively. Additionally, irrespective of whether the caregiver or child held the toothbrush, the Zeedyk et al.,

(2005) study found that many toothbrushing episodes recorded by the families fell short of professional expectations in terms of the length of time of each episode. The average episode contained only 56 seconds of time in which the toothbrush was in the infant's mouth, as opposed to the NHS recommended time of 2 minutes (NHS, 2009). However, the NHS guidelines do not stipulate whether this 2 minute period relates to the total time the brush should be inserted into a child's mouth or the overall length of a toothbrushing episode including time when the brush is *not* inserted into the infant's mouth. This is in contrast to the self-report questionnaire data from the study which demonstrated that in the majority of recorded toothbrushing episodes, caregivers felt that their child's teeth had been brushed and cleaned effectively. This would indicate that in this study, caregiver self-reports of the effectiveness of toothbrushing with their child may be inaccurate.

Another dyadic toothbrushing observational study was conducted more recently in a study conducted by a team of dental professionals in Brazil (Martins et al., 2011), which sought to compare observed dyadic toothbrushing episodes with mothers self-reports of their dyadic toothbrushing episode with their child. The 201 mothers of children aged 24 – 48 months (mean age 41.3 months), participating in the study completed a self-report questionnaire that included 6-items. Each item measured a specific behaviour within a typical dyadic toothbrushing episode with their child. Items in this questionnaire enquired as to what kind of toothpaste they used to clean their child's teeth, how much toothpaste was used and who dispensed it onto the toothbrush. Additionally, items asked mothers who cleaned their child's teeth (mother or child), whether their child spat out the toothpaste after brushing, and whether their child

rinsed their mouth out. These questions appear to probe for information about the operational aspects of dyadic toothbrushing episodes, and whether dyadic toothbrushing conforms to dental guidelines, for example as to whether toothpaste is used, and whether the correct amount of toothpaste is used. Although one item in the questionnaire enquired as to who brushed each child's teeth, this issue did not appear to be of central interest to the study.

The aim of this study was to compare their self-reported dyadic toothbrushing behaviours with observed toothbrushing behaviours, by one week following completion of the questionnaire, mothers attending an appointment at the dental clinic, where they were instructed to bring their child's usual toothbrush and toothpaste with them. They were then asked to reproduce a typical dyadic toothbrushing episode whilst being observed by a paediatric dentist. The dentist then conducted live behavioural coding during the toothbrushing episode, making notes on the same 6 behaviours measured by the questionnaire. Martins et al. (2011) do not define what a toothbrushing episode was in terms of start and finish. Comparisons of self-reported behaviours as measured by the questionnaire and observed behaviours were then made. Significant discrepancies were found in a number of these behaviours, with mothers self-reports of behaviours indicating more effective dyadic toothbrushing than seen in the observed dyadic toothbrushing episodes. This may have been due to caregiver self-reports of toothbrushing inflating effectiveness of toothbrushing episodes, or it is possible that mothers performance in toothbrushing may have been hampered by anxiety from being directly observed by a dentist.

With regards to whether it was the mother or child that was principally responsible for brushing the child's teeth, from the questionnaire data, 164 mothers (81%) reported that it was they rather than their child that brushed their child's teeth. However, from the observed toothbrushing episodes, only 133 mothers (66%) were seen to take principal responsibility for brushing their child's teeth and were primarily in control of holding and using the brush during each episode. This finding demonstrates not just a discrepancy between self-reported and observed dyadic toothbrushing behaviour, but that approximately one third of mothers in the Martins et al. (2011) study were observed to not brush their child's teeth for them even though some of these children were only 24-months old.

5.1.2 Methodological Issues in Dyadic Toothbrushing Observational Research

These two previously conducted observational studies of dyadic toothbrushing (Martins et al., 2011; Zeedyk et al., 2005) have revealed that caregiver self-reports of dyadic toothbrushing may be inaccurate. They may be inaccurate in that caregivers may report they are primarily in control of holding and using the brush during dyadic toothbrushing, whereas observations reveal young children may be engaging in autonomous toothbrushing at a younger age than recommended by dental experts. However, there a number of methodological issues that may need to be considered when assessing the reliability of findings from such studies.

A number of methods of conducting observational research exist, and each may be more or less appropriate given the research questions being asked. Laboratory-based observations may allow careful control of variables to be imposed, such as the nature of the task set to the caregiver-infant dyad and the time taken to engage with the task (Gardner, 2000). However, the ecological validity of such structured, laboratory-based observations has been called into questions, and the presence of the research may influence the behaviours exhibited by the caregiver and child being observed. Therefore, it has been suggested that structured, laboratory-based observations such not be solely relied on when investigating caregiver-child interactions (Karp et al., 2004).

A more ecologically valid style of observational research is one in which caregiver-child dyads are observed in a more naturalistic environment, such as the home (Gardner, 2000). With this kind of observational methodology, caregiver-child dyads may still be set a structured task, such as playing with a toy for a set duration, but engage in the task at home where behaviour may be more naturalistic. Additionally, since video technology has become more advanced and yet less expensive, the researcher may be removed from the equation completely, as camcorders can be set up in order to record data for later analyses. Video recording of caregiver-child interaction has become a standard tool in clinical assessment of social-communication disorders for example (Gunning et al., 2004) and also in teaching and assessing self-care behaviours in children and adults with intellectual disabilities (Damen et al., 2011). More recent direct research into the feasibility of this methodology has demonstrated that it may allow the

generation of good quality, reliable and valid data when families are provided with a camcorder and asked to record their own data (Wilson et al., 2011).

The *kind* of observational methods used in observational research may impact upon reliability of findings. Laboratory and clinic based observations are highly structured and therefore data yielded from such studies and clinical assessments may not reflect naturalistic dyadic interactions (Wakschlag et al., 2005). Therefore, an alternative approach may be 'naturalistic' or, 'non-participant' observation, which may be employed in the home environment and does not necessitate the presence of the researcher or clinician. This method has become possible in light of advances in technology and the increasingly high quality of visual and audio recordings provided by small, easy to operate camcorders (Paterson et al., 2008; Shrum et al., 2005).

The observational methodology employed in the Zeedyk et al. (2005) study may be considered to be more naturalistic than the one employed in the Martin et al., (2011) study, as Zeedyk et al. provided participating families with camcorders and asked them to record dyadic toothbrushing episodes themselves at home, without the need for a researcher observer to be present. However, in the Martins et al. (2011) study direct observation of participants by a researcher was the method employed, a technique which may not yield the most reliable data (Wakschlag et al., 2005). In situations in which a participant is being directly observed, there can be a risk of an observer effect, in which the participant behaves in a more socially desirable manner. However, despite the use of a direct observation technique in the study, mothers were still observed to take principal responsibility for brushing their child's teeth for them less than indicated

in data from the self-report questionnaires. Perhaps if a less direct observation technique had been used, the discrepancy between self-reported behaviour and observed behaviour may have been even more pronounced.

There are however, also methodological issues when utilising camcorders in the home environment when observing caregiver-child interactions. Firstly, the lack of presence of the researcher means that there is little control over the way in which the caregiver-child dyad engages in the set task. For example, the task may not have been executed correctly or for the correct duration. Therefore, very clear instructions need to be provided to caregivers when employing this methodology. Additionally, research has demonstrated that there may be some delays in collection of camcorders and the data stored within them when families have been asked to collect their own observational data and that in some cases data and camcorders may be lost (Wilson et al., 2011).

An additional methodological issue with these two observational studies is the methods used to code and analyse observational data. Although in the Zeedyk et al. (2005) study dyadic toothbrushing episodes were video recorded and then coded from video recordings, in the Martins et al. (2011) study this did not happen. In the Martins et al. study live coding was conducted by just one coder, which raises questions as to how effectively this one coder was able to accurately capture every behaviour of interest. Additionally, there is no mention in Martin et al. (2011) published article of their coding schedule having been subject to any kind of reliability analyses being conducted on the coding schedule used. This raises significant questions as to the reliability of the data generated from the Martins et al. observations.

In terms of inter-rater reliability checks, Zeedyk et al. (2005) reported that they estimated inter-rater reliability through conducting Pearson's correlation coefficients for sets of values generated by two coders. Although this method may provide an estimation of the extent to which two sets of data are correlated, it only allows estimations of how much two sets of data vary with one another, but it does not reveal where there systematic differences may lie. For example, two coders could score an observational data set as containing a specified total duration of a specific behaviour. If these two total durations are statistically similar, a Pearson's correlation co-efficient may indicate a significant degree of correlation. However, it may be the case that the two coders have in fact identified and coded the specified behaviour in very different parts of the observational data set.

Despite the limitations to the coding methods employed of the two observational studies discussed (Martins et al., 2011; Zeedyk et al., 2005), they do reveal that children may be engaging in significant self-toothbrushing as early as between the ages of 2 – 4 years. Additionally, as explored in Chapter Two of the thesis, what is known about the early drive for autonomous tool-use indicate that infants may begin to handle and attempt to use tools such as spoons from around the age of 12-months to engage in self-care activities (Barrett et al., 2007; Carruth et al., 2004). This knowledge from the field of developmental psychology provides some indications as to how the two previous observational studies of dyadic toothbrushing (Martins et al., 2011; Zeedyk et al., 2005) could be extended and improved. The following section discusses how knowledge and methods from developmental psychology research may be used to extend and improve on these studies specifically in relation to understanding how

infants might first start to learn how to use toothbrushes. Additionally, how new methods can be used to explain the developmental trajectories of early toothbrush use in infancy is also discussed.

5.1.3 The Contribution of Developmental Psychology to Understanding Infant

Self-Toothbrushing during Early Dyadic Toothbrushing

Given the published observational studies indicating that young children may be engaging in early self-toothbrushing at as young an age as 2.5 years old (Martins et al., 2011; Zeedyk et al., 2005), it is expedient to conduct *cross-sectional observational* research of *dyadic toothbrushing* with multiple age groups. This may allow examination of age related differences through the second year of life regarding the member within each dyad (caregiver or infant) that has principal control of holding the toothbrush during toothbrushing episodes. Additionally, such cross-sectional data may contribute to building developmental trajectories describing how control of holding and using the toothbrush may pass from solely caregiver to solely infant between the ages of 12 and 24 months.

Such cross-sectional methodologies are central to developmental psychology research as they allow age related differences to be identified and described between multiple groups in a more cost and time-effective manner than longitudinal methods (Butterworth and Harris, 1994, pg 32). Cross-sectional designs have been used previously to explore a range of infant developmental outcomes such as gross motor development (Pin et al., 2009), reaching and grasping behaviours (Fagard et al., 2009)

and object retrieval skills through using tools (Esseily et al., 2010). Therefore, a cross-sectional methodology may be particularly appropriate for examining age related differences in toothbrush use during dyadic toothbrushing episodes.

Such a cross-sectional observational methodology may extend the previous observational studies of dyadic toothbrushing (Martins et al., 2011; Zeedyk et al., 2005) by exploring *how* early self-toothbrushing might emerge. A coding schedule for such a study might capture whether the caregiver or infant is holding and using the brush at any one time and also whether both caregiver and infant are holding the same brush with one dyad member's hand placed over the other. Additionally, a new coding schedule might allow the capture of instances when each member of the dyad is holding and using their own separate toothbrush and engaging in joint brushing, with the caregiver demonstrating to the infant how to correctly brush their teeth. This new coding schedule might also allow developmental trajectories to be built demonstrating how control of the toothbrush during dyadic toothbrushing may transfer from caregiver control through to infant control as infant age increases through the second year of life.

Additionally, methods by which caregivers demonstrate to infants how to use toothbrushes, for example by allowing observation of the caregiver engaging in toothbrushing and allowing infants to engage in manual exploration of the toothbrush, might also be included in such a cross-sectional observational study. The published literature suggests that it is through the observation and modelling of behaviour of adults that the learning of a number of skills is facilitated in infancy, such as those related to using tools (Barrett et al., 2007; Claxton et al., 2009; Gardiner et al., 2012). By the end of the first

year of life, most infants can imitate actions that involve objects (Masur, 2006) and throughout the second year of life, infants copy others through social learning (e.g. Nielsen, 2006). This may potentially mean that infants learn the correct use for toothbrushes through simply observing their caregiver using the toothbrush, and so become motivated to imitate toothbrush use and try to brushing their own teeth.

5.1.4 Aims and Hypotheses

Previous observational studies of dyadic toothbrushing have revealed early self-toothbrushing in children as young as 24-months old (Martins et al., 2011; Zeedyk et al., 2005), therefore the present study aims to examine how this self-toothbrushing may occur before this age, from the age of 12-months. The present study makes an original contribution to the literature as it incorporates the first cross-sectional observational methodology of dyadic toothbrushing, with infants aged 12, 18 and 24-months. A novel coding schedule is used to capture caregiver and infant control of holding and using the toothbrush during dyadic toothbrushing episodes, and additionally dyadic joint brushing, and also techniques used by caregivers to demonstrate toothbrushing to their infants. By including three age groups of infants, developmental trajectories describing how control of holding and using the toothbrush may pass from solely caregiver to solely infant between the ages of 12 and 24 months may be provided.

It is hypothesised, based on the existing literature and what is known about infants increasing ability to copy others through social learning that as infant age increases, the duration and frequency of infant attempts to hold the toothbrush and demonstrate

self-toothbrushing will increase. It is also hypothesised that as duration and frequency of infant holding and use of the brush increases with age that this will occur alongside a decrease in maternal holding and use of the toothbrush. Additionally, duration and frequency of caregiver-infant shared control of the toothbrush may increase with infant age. This is captured via coding of instances when the infants hand is placed over the caregivers hand when the caregiver is holding the toothbrush. It is also hypothesised that as age increases, there should be a greater duration of shared toothbrush control, with each member of the dyad holding and using their own separate toothbrush. It is also hypothesised that as this shared toothbrush control using two separate brushes increases with age instances of maternal demonstration to the infant of correct toothbrushing technique will also increase.

5.2 METHOD:

5.2.1 Design

This was a cross-sectional observational study comparing three age groups of mother-infant dyads (12 months, 18 months and 24 months) during toothbrushing episodes. The independent variable was age group of infant (12, 18 or 24 months) and the primary dependent variables were the duration and frequency of maternal toothbrush holding and use and duration and frequency of infant toothbrush holding and use. Secondary variables were numbers of dyads exhibiting toothbrushing demonstration behaviours including, mother allowing infant to observe them brushing their own teeth and mother allowing infant to manually explore the toothbrush.

5.2.2 Participants

Relevant ethical approval was gained to recruit 36 participating first-time mothers of infants aged, 12 months, 18 months or 24 months into the study. Ethical permission to conduct this study was granted on 26/04/2010 by the University of Salford Research Ethics Committee Ref: REP10/036. A total of 36 mother-infant dyads participated, with 12 dyads in each of the three age groups. Participating mothers resided in the Greater Manchester area in regions of the city representing a range of levels of social deprivation. Mothers were recruited via a number of strategies, including within local Children's Centres and day nurseries, online via local mother's forums, Facebook and Twitter and via an advert printed in local paper the Salford Advertiser.

Maternal Demographics

In order to evaluate specific demographic details of each mother, employment types of mothers, and level of education were assessed. The 'Registrar General's Scale of Social Class and Socio-economic Groups' was used to classify employment into the following categories; I) Professional, II) Managerial/Technical, IIIa) Skilled (non-manual), IIIb) Skilled (manual), IV) Partly Skilled, V) Unskilled, VI) Other. The employment data collected would indicate that a large proportion of families had at least one caregiver employed in some kind of professional or skilled work which required them to be educated to a higher level. As the tables below demonstrate, taken as a whole sample, over two-thirds of mothers (64%) and two-thirds of fathers (64%) held undergraduate higher education degrees.

A total of 29 mothers (80%) were either married or co-habiting. In terms of ethnicity, 28 of mothers were white-British (78%), 4 were white-other (11%), 3 were white-Irish (8%) and 1 mother was African (3%). Table 5.1 shows demographic characteristics of mothers participating in the study by infant age group.

Table 5.1- Demographic details of mothers in each of the three age groups (n= 12 in each group)

	12-month old group (n = 12)	18-month old group (n = 12)	24-month old group (n = 12)
Maternal Age in years	Mean 31.72 (sd 3.58; range 23.67 – 37.58)	Mean 35.06 (sd 6.22; range 21.50 – 45.00)	Mean 30.88 (sd 4.32; range 25.67 – 41.75)
Maternal ethnicity	7 White-British (59%) 3 White-Irish (25%) 1 White-other (8%) 1 African (8%)	11 White-British (92%) 1 White-other (8%)	10 White-British (83%) 2 White-other (17%)
Maternal marital status	9 Married (76%) 1 Cohabiting (8%) 1 Single (8%) 1 Divorced (8%)	5 Married (42%) 4 Single (33%) 3 Cohabiting (25%)	8 Married (67%) 3 Cohabiting (25%) 1 Single (8%)
Maternal current employment status	4 Full-time employment (33%) 5 Part-time employment (42%) 3 Full-time carer (25%)	4 Full-time employment (33%) 4 Full-time carer (33%) 3 Part-time employment (25%) 1 Currently unemployed (9%)	8 Part-time employment (67%) 2 Currently unemployed (17%) 1 Full-time employment (8%) 1 Full-time carer (8%)
Maternal employment type	4 Professional (33%) 2 Managerial/ technical (17%) 2 Skilled (non-manual) (17%) 2 Unemployed/full-time carer (17%) 1 Skilled (manual) (8%) 1 Partly skilled (8%)	4 Unemployed/ full-time carer (33%) 3 Professional (25%) 3 Skilled (non-manual) (25%) 2 Managerial/ technical (17%)	6 Skilled (non-manual) (51%) 3 Unemployed/ full-time carer (25%) 1 Professional (8%) 1 Managerial/technical (8%) 1 Skilled (manual) (8%)
Maternal educational record	11 Higher education (92%) 1 Further education (8%)	6 Higher education (50%) 4 Further education (34%) 1 Secondary school (8%) 1 Other (8%)	6 Higher education (50%) 3 Further education (25%) 2 Secondary school (17%) 1 Other (8%)

Infant Demographics- age and gender

Table 5.2 provides data regarding age and gender of all participating infants.

Table 5.2- Infant gender and age by age group (n= 12 per group)

	Age Group		
	12 months (n=12)	18 months (n=12)	24 months (n=12)
Gender	6 males, 6 females	6 males, 6 females	6 males, 6 females
Mean age in months (sd)	11.92 (.52) Range 11 – 13	17.75 (.97) Range 16 – 19	24.83 (1.47) Range 22 – 26

Timing and eruption of the primary dentition

Table 5.3 reports data provided by mothers regarding mean age at which the first primary tooth erupted by age group and also the mean number of erupted primary teeth in each age group.

Table 5.3- Timing and eruption of the first primary dentition by age group (n=12)

	Age Group		
	12 months (n=12)	18 months (n=12)	24 months (n=12)
Age of eruption (months) of first primary tooth	6.09 (1.04)	8.64 (2.38)	6.50 (2.65)
Number of erupted primary teeth at time of study	7.09 (4.51)	11.45 (2.51)	17.33 (2.46)

Data regarding first primary tooth eruption and number of erupted teeth was found to be non-normally distributed using the Kolmogorov-Smirnov Test ($z = .264$, $p < .0001$; $z = .178$, $p = .009$ respectively). Mann-Whitney U Tests revealed that the 18-month group experienced their first primary tooth eruption at a significantly later age than the 12-month ($p = .007$) and 24-month ($p = .038$) old groups. Additionally, it was found that the 24-month old age group had significantly more erupted primary teeth than the 12-month ($p < .000$) and 18-month ($p < .000$) old groups. Compared to current UK norms (NHS, 2010), the 12- and 24-month old groups experienced the eruption of their first primary tooth between the expected 5 – 7 months, and the 18-month old group at around 8 – 9 months old.

5.2.3 Materials

A participant information sheet (see Appendix L) was developed to inform participants about the study. Canon Legria FS306 camcorders and 2 gigabyte memory cards were required along with Joby Gorillapod® Original tripods and sets of camcorder use instructions (see Appendix M) to aid collection of observational data. Observer® XT software was also required for analyses of collected observational data. Additionally, a demographic details questionnaire (see Appendix B) was required in order to allow information such as employment status and ethnicity to be gathered. This demographic information was collected in order to allow more precise assessment of socio-economic status and also identify whether the sample of participants was representative of Salford in terms of ethnicity.

5.2.4 Procedure

After each mother had been provided with study literature, they were then visited at home by the researcher. During this home visit the researcher firstly completed the informed consent procedure, then gathered demographic information from each mother and also provided each with their camcorder. The standardised instructions on camcorder use were provided, and in addition the researcher demonstrated to each mother how to use their camcorder. Mothers were asked to record between 5 – 7 toothbrushing episodes with their infant during the week they had the camcorder and were encouraged to carry out their usual and typical toothbrushing in order to ensure that behaviours recorded were naturalistic as possible.

In cases where mothers did not have someone at home to help them collect the observational data, the researcher set up a small tripod called a Gorillapod® in the bathroom or whatever room in the house each mother usually brushed their infant's teeth in. This was done because it would not have been possible for each mother to both hold their infant to brush their teeth and hold the camcorder to record the data at the same time. Setting up the gorilla-pod allowed the camcorder to be placed securely in a location that would allow correct recording of data whilst allowing each mother to be able to hold their infant and brush their teeth.

After a period of one week, the researcher telephoned or text each mother (depending on their preference) in order to arrange a convenient time and day to visit each mother at home to collect back the camcorder and data. Once data had been collected from each mother, video files were saved to password protected external hard drives.

5.2.5 Data Coding and Analyses

All data collected from camcorders were transferred into separate electronic files for each participant. These electronic files of data were then imported to ObserverXT® in order to allow analyses of data. A total of two video recorded toothbrushing episodes per participant were imported into ObserverXT® for data coding and analyses. These two episodes were identified from the selections of episodes provided by each participant as being of good enough quality in terms of lighting and being able to view the behaviours of both the infant and mother in each dyad. Additionally, imported episodes were also identified as being 'typical' for each dyad, i.e. episodes in which the infant did not exhibit unusually difficult behaviours for them for example.

Development of Coding Schedule

An initial coding schedule was developed prior to data analyses. This coding schedule included variables of mother and infant toothbrushing behaviours. The behaviour of interest was toothbrush holding, and additionally attempts at correct toothbrush use, i.e. the toothbrush being inserted in the infant's mouth. To discover the member of each dyad that was holding and using the toothbrush at any particular time during each recorded toothbrushing episode was the principal reason for coding data.

Additionally, behavioural codes were included that would allow the capture of data relating to shared toothbrush control, e.g. if both members of the dyad were holding and using separate toothbrushes, or whether members were holding and using the same individual brush. Additionally codes were included in order to capture what kinds

of toothbrushing teaching methods mothers in the study employ to teach their infant to brush. These include whether the mother allows their infant to observe them brushing their own teeth, and also if the infant is allowed to manually explore the toothbrush through holding it. For a full outline of this coding schedule see Table 5.3. Once the coding schedule had been fully developed it was set up as a formal coding schedule in ObserverXT® observational data analysis software. In addition to the coding schedule described in Table 5.4, the location of toothbrushing was also examined, with codes been used for whether the toothbrushing episode was conducted in the bathroom, living room, kitchen, bedroom or another location.

Table 5.4- Dyadic tool use (toothbrush) coding schedule for analyses of observational data

Categories and 3-letter codes
1. ONLY <u>mother holding brush</u> but toothbrush not in infant's mouth (OPN)
2. ONLY <u>mother holding brush</u> with toothbrush inside infant's mouth (OPC)
3. ONLY <u>infant holding brush</u> but toothbrush not in infant's mouth (OIN)
4. ONLY <u>infant holding brush</u> with toothbrush inside infant's mouth (OIC)
5. MOTHER <u>hand over infant's</u> but toothbrush not in infant's mouth (PHN)
6. MOTHER <u>hand over infant's</u> with toothbrush inside infant's mouth (PHC)
7. INFANT <u>hand over mother's</u> but toothbrush not in infant's mouth (IHN)
8. INFANT <u>hand over mother's</u> with toothbrush inside infant's mouth (IHC)
9. BOTH <u>mother and infant</u> each holding a separate toothbrush with neither inserting brush into infant's mouth (BSN)
10. BOTH <u>mother and infant</u> each holding a separate toothbrush with mother inserting brush into infant's mouth (BSP)
11. BOTH <u>mother and infant</u> each holding a separate toothbrush with infant inserting brush into infant's mouth (BSI)
12. Mother brushes own teeth and allows infant to observe (either stood facing infant or allowing infant to view reflection in mirror) (PBO)
13. Infant is allowed to hold toothbrush and manually explore it (CET)
14. OFF TASK - e.g. neither mother nor infant holding toothbrush; or infant removed self from bathroom/room where brushing taking place; or episode completely broken down due to tantrum for example (a written description for the reason that dyad is off task will be noted on ObserverX [®] T in each case) (OT)

All recorded toothbrushing episodes were rated on a scale of 1 – 3 for quality of recording by the author, with 1 indicating good quality recording, 2 indicating an incomplete or interrupted episode (e.g. because of difficult infant behaviours), and 3 indicating poor quality recording in which each member of the dyad could not be adequately seen (i.e. whether both members of the dyad could be adequately seen and heard to allow analyses). Then, a total of 2 toothbrushing episodes from the recorded episodes provided by each dyad were selected for analyses according to the criteria outlined. This meant that each dyad had 2 toothbrushing episodes coded and included in the analyses, totalling 72 coded and analysed toothbrushing episodes from the whole sample.

Comparison of the three age groups using ObserverXT® generates four measures for behavioural codes in the coding schedule for each toothbrushing episode. Toothbrushing episodes were each coded from the START of brushing, when tooth-paste applied to brush, and then coded up to the END of toothbrushing, when brush either placed on sink for last time or inside cup.

The measures generated by ObserverXT® are described below and are used in the Results section to analyse the main outcome data relating to which member of each dyad are in control of holding and using the toothbrush (categories 1 – 12 in the coding schedule in Table 5.3);

- Frequency of the behaviour in each coded toothbrushing episode ('freq').
- Duration of the behaviour in seconds (secs) in each coded toothbrushing episode ('dur').
- Mean duration of each occurrence of the behaviour in each coded toothbrushing episode in seconds ('mean/dur').
- The mean frequency per minute of the behaviour in each coded toothbrushing episode ('rate/min').

Inter-Rater Reliability Analyses of the Coding Schedule

In order to assess the reliability of the coding schedule, two separate techniques were used. These three methods are outlined below.

- i) **Re-coding of 20% of data by second coder:** Firstly, 20% of the data (7 participants; 14 toothbrushing episodes in total) were re-coded by a second researcher unaffiliated with the research and Intra-Class Co-efficient's (ICCs) were then generated using Cohen's kappa's (κ). This was done for each of the 12 behavioural codes relating to which member of each included dyad are in control of holding and using the toothbrush codes. Inter-rate reliability coefficients were generated for i) frequency and ii) duration of each of the behaviours represented by each of the behavioural codes, therefore generating two ICCs for each behavioural code, and a total of 24 ICCs. These ICCs are provided in Table 5.5.

Table 5.5- ICCs for each behavioural code in the coding schedule

Behavioural Code		ICC (κ)
ONLY <u>mother holding brush</u> but toothbrush not in infant's mouth	Frequency	.88
	Duration	.88
ONLY <u>mother holding brush</u> with toothbrush inside infant's mouth	Frequency	.91
	Duration	.96
ONLY <u>infant holding brush</u> but toothbrush not in infant's mouth	Frequency	.96
	Duration	.70
ONLY <u>infant holding brush</u> with toothbrush inside infant's mouth	Frequency	.96
	Duration	.99
MOTHER <u>hand over infant's</u> but toothbrush not in infant's mouth	Frequency	.97
	Duration	.99
MOTHER <u>hand over infant's</u> with toothbrush inside infant's mouth	Frequency	.88
	Duration	.98
INFANT <u>hand over mother's</u> but toothbrush not in infant's mouth	Frequency	.67
	Duration	.60
INFANT <u>hand over mother's</u> with toothbrush inside infant's mouth	Frequency	.60
	Duration	.61
BOTH <u>mother and infant</u> each holding a separate toothbrush with neither inserting brush into infant's mouth	Frequency	1.00
	Duration	1.00
BOTH <u>mother and infant</u> each holding a separate toothbrush with mother inserting brush into infant's mouth	Frequency	1.00
	Duration	1.00
BOTH <u>mother and infant</u> each holding a separate toothbrush with infant inserting brush into infant's mouth	Frequency	1.00
	Duration	1.00
Off Task	Frequency	.45
	Duration	.17

Reliability was excellent for 17/24 ICCs generated (ICCs ranging .81 – 1.00), moderate for 3/17 (ICCs ranging .61 – .70), and adequate for 2/17 (ICCs ranging .51 - .60). The 2 ICCs generated for frequency and duration and for the 'Off Task' behavioural code were found to be less reliable with ICCs of .45 and .17 respectively. However, when the definition used to describe 'Off Task' was refined, reliability of this behavioural code increased with ICCs for frequency and duration increasing to .62 and .60 respectively. Additionally, the 'Off Task' behavioural code was only used in 10/72 recorded toothbrushing episodes included in the analyses, and also was not one of the main variables of interest in the analyses. It is therefore unlikely that the 'Off Task' behavioural code compromised the overall reliability of the coding schedule.

- ii) **Comparison of visualisation outputs from ObserverXT:** In order to ensure that each of the two researchers coding the inter-reliability analyses data were coding for each of the 12 behavioural codes at the same points in the video clips included, a third reliability assessment was conducted by comparing visualisation outputs provided by ObserverXT®. See Figure 5.2 for an example of one of these visualisation outputs. These visualisation outputs depict graphically the occurrence of coded behaviours against time in seconds, per video clip. A comparison of these visualisation outputs revealed the coding of the inter-rater reliability video clips to have produced visualisation outputs from each of the two researchers to be visually comparable.

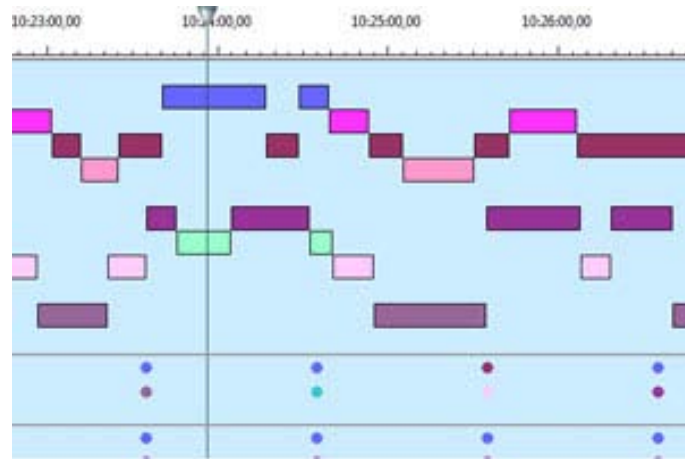


Figure 5.1- Example of a data visualisation output from ObserverXT

5.3 RESULTS

The following results section outlines the main findings from the statistical analyses conducted on the data collected in the study, for which there are four main parts. In all sections reporting results, two dyadic toothbrushing episodes from each dyad are included all analyses.

The first part of this results section outlines broad overviews of principle features of the dyadic toothbrushing episodes included in all statistical analyses. Firstly, descriptive data around the location within the home dyadic toothbrushing took place and also the physical configuration of each dyad during toothbrushing episodes. This section also reports on durations of toothbrushing episodes cross age groups comparisons, in order to gain a general overview of whether toothbrushing sessions in the three age groups are conforming to dental expert guidelines.

The second part of this results section reports on statistical analyses of the key behaviours of interest, i.e. examining age related differences in maternal use of the toothbrush, and age related differences in infant use of the toothbrush. Additionally, age related differences in caregiver-infant joint toothbrush use are reported in this section.

The third part of this results section provides graphical illustrations of developmental trajectories of any changes in mother and infant control of holding and using the brush during dyadic toothbrushing, across the three age groups.

The fourth part deals with analyses of data regarding age related differences in the methods of toothbrush use demonstration mothers use during dyadic toothbrushing episodes.

5.3.1 Principle features of dyadic toothbrushing episodes included in data analyses

Descriptive data regarding location of dyadic toothbrushing and dyadic physical configuration

In order to gain a general overall impression of dyadic toothbrushing episodes, data were coded for the location of toothbrushing, i.e. the room in the family home where it was conducted, and also the physical configuration of the dyad, i.e. whether the infant was being held by their mother or whether they were standing. Table 5.6 presents data regarding the location in the family home dyadic toothbrushing was conducted in and Table 5.7 presents data regarding the physical configuration of the dyad during toothbrushing episodes. Data presented includes a total of two observations for each of the 36 dyads included in the study, with a total of 72 observations for the whole sample.

Table 5.6- Comparison by age group of location in home dyadic toothbrushing takes place

Location in family home	Age Group		
	12 months (n=12)	18 months (n=12)	24 months (n=12)
Bathroom	19 (79%)	16 (67%)	20 (84%)
Living room	3 (13%)	4 (17%)	2 (8%)
Kitchen	0	2 (8%)	0
Bedroom	2 (8%)	2 (8%)	2 (8%)

Table 5.7- Comparison by age group of dyadic physical configuration during toothbrushing

Location in family home	Age Group		
	12 months (n=12)	18 months (n=12)	24 months (n=12)
Caregiver holding infant	20 (83%)	4 (17%)	4 (17%)
Infant standing	0	14 (58%)	18 (75%)
Infant lying down	0	2 (8%)	2 (8%)
Infant in bath	4 (17%)	4 (17%)	0

Comparison of toothbrushing episodes length by age group

Table 5.8 provides data on the average toothbrushing episode length in seconds for each of the three age groups. A toothbrushing episode was defined as the period of time between the mother applying the toothpaste to the brush and the toothbrush being placed back in its holder or on the sink following the completion of brushing, with the toothbrush both being inserted into the infants mouth and *not* being inserted into the

infants mouth. The data presented in Table 5.8 refers to *total* toothbrushing episode length, which includes time spent with the toothbrush inserted in the infant’s mouth and also time spent with the toothbrush *not* inserted in the infant’s mouth. However, it is difficult to compare the toothbrushing times found in the present study with the two minute toothbrushing times cited in the published guidelines (e.g. NHS, 2009). This is because it is not clear whether the two minute guide refers to *total* episode length with the brush both being inserted into the infant’s mouth and *not* inserted into the infant’s mouth, or whether it refers to only the time the brush is inserted into the infant’s mouth. Normality of data were examined using Shapiro-Wilk tests as the sample size was less than 50 (n=36). Data regarding toothbrushing episode length were found to be non-normally distributed using the Shapiro-Wilk Test ($z = .109, p = .003$).

Table 5.8- Comparison of toothbrushing episode length of each age group

	Age Group		
	12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)
Length of toothbrushing episode	144.89 (62.79)	109.16 (83.33)	105.11 (46.56)

ANOVA analyses revealed that there were no significant age related differences in toothbrushing episode length between the age groups ($F= 5.386; df= 2, 71; p= .07$).

5.3.2 Statistical analyses of age related differences in mother and infant holding and use of the toothbrush

The second part of the Results section deals with age related differences in the main behaviours of interest, being duration and frequency of maternal holding and use of the toothbrush, and duration and frequency of infant use of the toothbrush.

As all data were found to be non-normally distributed using the Shapiro-Wilk Test (all $p \leq .05$), Kruskal-Wallis ANOVAs were conducted for all analyses reported throughout this Results section, in order to identify differences between the age groups. Where significant age related differences were identified, Mann Whitney Tests were conducted to identify between which two age groups the significant differences lay. Therefore, findings from analyses of variables related to maternal use of the toothbrush are reported first, followed by findings from analyses of variables related to infant use of the toothbrush.

Table 5.10 provides data for each age group in amount of maternal holding and use of the toothbrush during recorded episodes. Additionally, data are also provided from exploratory ANOVA's conducted on the data to identify potential age related differences in maternal holding and use of the toothbrush during toothbrushing episodes. These data contribute to the identification of any age associated differences between the ages of 12, 18 and 24 months in the amount of maternal holding and use of the toothbrush.

Table 5.10- Mother only toothbrush holding and use in each age group

Behaviour		Age Group			df	F Ratio	P
Mother only use of toothbrush		12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)			
Brush inserted in mouth	Freq	6.05 (4.75)	2.27 (2.37)	3.79 (2.26)	2, 71	11.64	.003
	Dur (secs)	26.67 (21.31)	11.00 (12.12)	19.58 (11.87)	2, 71	8.497	.014
	Mean /dur (secs)	4.67 (4.28)	3.70 (3.71)	5.14 (3.20)	2, 71	2.973	.226
	Rate/min	2.55 (1.63)	2.86 (4.47)	2.57 (1.70)	2, 71	1.856	.395
Brush NOT inserted in mouth	Freq	8.35 (5.25)	4.14 (2.62)	4.54 (2.69)	2, 71	10.800	.005
	Dur (secs)	66.31 (57.69)	28.14 (23.11)	20.13 (14.09)	2, 71	12.715	.002
	Mean /dur (secs)	7.69 (4.77)	8.14 (8.28)	4.75 (5.20)	2, 71	9.034	.011
	Rate/min	3.51 (1.78)	3.91 (4.14)	2.98 (1.68)	2, 71	1.158	.560
Total (brush both inserted and not inserted in mouth)	Freq	14.40 (9.82)	6.41 (4.51)	8.33 (4.87)	2, 71	10.887	.004
	Dur (secs)	92.98 (65.67)	39.13 (26.74)	39.71 (21.94)	2, 71	13.331	.001
	Mean /dur (secs)	12.36 (4.96)	11.84 (8.28)	9.90 (5.96)	2, 71	3.340	.188
	Rate/min	6.05 (3.31)	6.78 (8.57)	5.55 (3.31)	2, 71	.925	.630

Post hoc Mann-Whitney U tests were conducted in order to ascertain between which of the three groups the significant differences lay. These post hoc tests revealed that;

i) Mother holding toothbrush - brush *inserted* into infant's mouth:

- Frequency 12 > 18 months ($p = .002$)
- Duration 12 > 18 months ($p = .009$)

- Frequency 18 < 24 months ($p = .01$)
- Duration 18 < 24 months ($p = .02$)

ii) Mother holding toothbrush - brush *not inserted* into infant's mouth:

- Frequency 12 > 18 months ($p = .003$)
- Duration 12 > 18 months ($p = .009$)

iii) Total mother toothbrush holding - brush both *inserted* and *not inserted* into infant's mouth:

- Frequency 12 > 18 months ($p = .002$)
- Duration 12 > 18 months ($p = .002$)

Table 5.11 provides data for each age group in amount of infant holding and use of the toothbrush during recorded episodes. Additionally, data are also provided from exploratory ANOVA's conducted on the data to identify potential age related differences in infant holding and use of the toothbrush during toothbrushing episodes. These data contribute to the identification of any age associated differences between the ages of 12, 18 and 24 months in the amount of infant holding and use of the toothbrush.

Table 5.11- Infant only toothbrush holding and use in each age group

Behaviour		Age Group			df	F Ratio	P
		12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)			
Brush inserted in mouth	Freq	1.15 (1.35)	1.82 (2.28)	3.13 (2.71)	2, 71	7.979	.019
	Dur (secs)	5.79 (8.50)	17.29 (28.94)	22.83 (26.02)	2, 71	8.489	.014
	Mean /dur (secs)	2.44 (3.52)	5.09 (6.61)	8.89 (14.90)	2, 71	5.144	.076
	Rate/ min	.59 (.76)	.86 (.94)	1.80 (1.67)	2, 71	9.817	.007
Brush NOT inserted in mouth	Freq	2.30 (2.05)	2.64 (3.03)	4.25 (3.60)	2, 71	4.120	.127
	Dur (secs)	15.95 (27.17)	14.07 (22.27)	23.25 (21.48)	2, 71	5.214	.074
	Mean /dur (secs)	4.05 (5.32)	2.99 (3.41)	4.94 (3.39)	2, 71	4.233	.120
	Rate/ min	1.08 (1.05)	1.18 (1.05)	2.38 (1.90)	2, 71	7.506	.023
Total (brush both inserted and not inserted in mouth)	Freq	3.45 (3.24)	4.45 (5.17)	7.38 (6.17)	2, 71	5.610	.060
	Dur (secs)	21.74 (30.92)	31.36 (42.10)	46.08 (38.84)	2, 71	6.205	.045
	Mean /dur (secs)	6.49 (7.00)	8.08 (7.86)	13.84 (17.18)	2, 71	2.951	.229
	Rate/ min	1.67 (1.76)	2.05 (1.93)	4.18 (3.47)	2, 71	8.616	.013

Post hoc Mann-Whitney U tests were conducted in order to ascertain between which of the three groups the significant differences lay. These post hoc tests revealed that;

i) Infant holding toothbrush - brush *inserted* into infant's mouth:

- Frequency 18 < 24 months ($p = .05$)
- Rate/min 18 < 24 months ($p = .028$)

ii) Infant holding toothbrush - brush *not inserted* into infant's mouth:

- Rate/min 18 < 24 months ($p = .022$)

iii) Total infant toothbrush holding- brush both *inserted* and *not inserted* into infant's mouth:

- Rate/min 18 < 24 months ($p = .026$)

Statistical analyses of age related differences in joint holding and use of the toothbrush

In addition to examining the two main behaviours of interest, these being maternal holding and use of the toothbrush, and infant holding and use of the toothbrush, other behaviours captured by the coding schedule were also examined. These behaviours relate to shared toothbrush control, with either each member of the dyad using the *same* brush, or each using *separate* brushes. Analyses from these additional behaviours are presented in this section.

Tables 5.12 and 5.13 provide data for each age group in amount of joint holding and use of the toothbrush during recorded episodes. Additionally, data are also provided from exploratory ANOVA's conducted on the data to identify potential age related differences in joint holding and use of the toothbrush during toothbrushing episodes. These data contribute to the identification of any age associated differences between the ages of 12, 18 and 24 months in the amount of joint holding and use of the toothbrush. Firstly, data regarding the mother's hand being placed over the infant's hand are presented in Table 5.12.

Table 5.12- Mother hand over infant's hand during toothbrush holding and use in each age group

Behaviour		Age Group			df	F Ratio	P
		12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)			
Brush inserted in mouth	Freq	.55 (.83)	.95 (1.89)	.79 (1.69)	2, 71	.726	.695
	Dur (secs)	1.36 (2.87)	2.50 (5.74)	2.45 (5.76)	2, 71	.629	.730
	Mean/dur (secs)	.77 (1.45)	.84 (1.25)	.77 (1.66)	2, 71	.815	.665
	Rate/min	.27 (.47)	.44 (.74)	.43 (.95)	2, 71	.867	.648
Brush NOT inserted in mouth	Freq	.95 (1.54)	1.50 (2.56)	1.17 (2.55)	2, 71	.452	.798
	Dur (secs)	1.91 (3.67)	3.80 (7.80)	2.08 (5.51)	2, 71	1.101	.577
	Mean/dur (secs)	.80 (1.01)	1.24 (1.98)	.48 (.84)	2, 71	1.361	.506
	Rate/min	.41 (.62)	.55 (.86)	.62 (1.12)	2, 71	.111	.946

Secondly, Table 5.13 provides data relating to the infant's hand being placed over the mother's hand in order to examine potential age related differences in this joint toothbrush use behaviour.

Table 5.13- Infant hand over mother's hand during toothbrush holding and use in each age group

Behaviour		Age Group			df	F Ratio	P
		12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)			
Brush inserted in mouth	Freq	1.15 (1.73)	.23 (.53)	.63 (1.31)	2, 71	4.329	.115
	Dur (secs)	5.03 (11.21)	.71 (2.09)	.90 (2.40)	2, 71	3.738	.154
	Mean /dur (secs)	1.43 (3.05)	.52 (1.50)	.37 (.64)	2, 71	3.542	.170
	Rate/ min	.58 (.97)	.14 (.36)	.45 (.98)	2, 71	3.606	.165
Brush NOT inserted in mouth	Freq	2.10 (2.27)	.59 (.91)	.96 (1.71)	2, 71	8.405	.015
	Dur (secs)	3.62 (4.05)	.65 (1.33)	1.61 (3.76)	2, 71	9.692	.008
	Mean /dur (secs)	1.31 (1.07)	.37 (.53)	.67 (.78)	2, 71	10.359	.006
	Rate/ min	.90 (.94)	.34 (.55)	.58 (.90)	2, 71	5.987	.050

Post hoc Mann-Whitney U tests were conducted in order to ascertain between which of the three groups the significant differences lay in whether the infant's hand was over the mother's hand during toothbrush holding and use that resulted in the brush *not* being inserted into the infant's mouth.

- Frequency 12 > 18 months ($p = .007$)
- Duration 12 > 18 months ($p = .004$)
- Mean/duration 12 > 18 months ($p = .002$)
- Rate/min 12 > 18 months ($p = .016$)

Another form of shared toothbrush control was also examined, this being each member of the dyad holding and using a separate brush, with either the mother inserting the brush into the infant's mouth, the infant inserting the brush into their own mouth, or neither member of the dyad inserting the brush into the infant's mouth.

Table 5.14 provides data for each age group in amount of dyadic holding and use of separate toothbrushes during recorded episodes. Additionally, data are also provided from exploratory ANOVA's conducted on the data to identify potential age related differences in dyadic holding and use of separate toothbrushes during toothbrushing episodes. These data contribute to the identification of any age associated differences between the ages of 12, 18 and 24 months in the amount of dyadic holding and use of separate toothbrushes.

Table 5.14- Both mother and infant holding and using separate brushes during toothbrushing in each age group

Behaviour		Age Group			df	F Ratio	P
		12 months (n=12) Mean (sd)	18 months (n=12) Mean (sd)	24 months (n=12) Mean (sd)			
Mother inserts brush into infant's mouth	Freq	.50 (2.24)	.64 (1.40)	0.00 (0.00)	2, 71	7.303	.026
	Dur (secs)	1.67 (7.45)	2.73 (6.26)	0.00 (0.00)	2, 71	7.302	.026
	Mean/dur (secs)	.17 (.75)	1.09 (2.44)	0.00 (0.00)	2, 71	7.679	.022
	Rate/min	.14 (.61)	.39 (.91)	0.00 (0.00)	2, 71	7.551	.023
Infant inserts brush into infant's mouth	Freq	.80 (2.19)	1.36 (2.08)	.54 (1.56)	2, 71	4.076	.130
	Dur (secs)	6.64 (23.78)	7.12 (15.36)	5.20 (15.57)	2, 71	4.076	.130
	Mean/dur (secs)	1.00 (3.06)	2.11 (3.81)	3.21 (13.50)	2, 71	4.232	.121
	Rate/min	.31 (.82)	.46 (.72)	.29 (.91)	2, 71	4.069	.131
Neither inserts brush into infant's mouth	Freq	1.35 (4.11)	2.64 (3.99)	.58 (1.70)	2, 71	6.555	.038
	Dur (secs)	4.73 (12.30)	18.73 (34.68)	2.31 (6.16)	2, 71	7.532	.023
	Mean/dur (secs)	.79 (2.22)	3.09 (5.11)	1.00 (3.12)	2, 71	6.960	.031
	Rate/min	.46 (1.24)	1.08 (1.43)	.33 (1.04)	2, 71	6.315	.043

Post hoc Mann-Whitney U tests were conducted in order to ascertain between which of the three groups the significant differences lay. These post hoc tests revealed that;

- i) Both holding separate toothbrushes with *mother inserting brush* into infant's mouth
 - Duration 18 > 24 months (p= .015)
 - Mean/duration 18 > 24 months (p= .015)
 - Rate/min 18 > 24 months (p= .015)

- ii) Both holding separate toothbrushes *neither inserting brush* into infant's mouth
 - Duration 12 < 18 months (p= .039)
 - Mean/duration 12 < 18 months (p= .034)

 - Frequency 18 > 24 months (p= .025)
 - Duration 18 > 24 months (p= .018)
 - Mean/duration 18 > 24 months (p= .031)
 - Rate/min 18 > 24 months (p= .031)

An additional behaviour that was captured by the observational coding schedule was instances in which either the infant held the mother's toothbrush and placed it into their (infant's) mouth, or when the mother held the infant's toothbrush and placed it into their (mother's) mouth. These behaviours represent instances when cross-contamination may have occurred, with bacteria being passed either from the mothers mouth to the infants, or being passed from the infants to the mothers. A total of four dyads exhibited behaviours in which cross-contamination may have occurred, with one of these dyads containing a 12-month old infant, and three containing an 18-month old infant.

5.3.3 Building developmental trajectories of dyadic toothbrush use across the three age groups

In order to contribute to building developmental trajectories illustrating how control of holding and using the toothbrush may pass from solely mother to solely infant control across the three age groups, the following bar graphs were constructed from the data presented in the statistical analyses presented in the previous sections. Figures 5.3 – 5.8 therefore depict the transition of mother to infant control across the three age groups.

The first bar graph depicted in Figure 5.3 presents overall developmental trajectories for frequency of i) total mother, ii) total mother-infant joint, and iii) total infant, toothbrush holding and use during dyadic toothbrushing episodes. Here 'total' refers to the fact that data included relates to all toothbrush holding and use, that is, whether the toothbrush holding and use resulted in the brush being inserted into the infants mouth or not. Figure 5.3 demonstrates that between 12 to 24 months, maternal only holding and use of the brush decreases and infant only use of holding and use of the brush increases. The relation of shared toothbrush control of the brush across the ages of 12 to 24 months is less clear however.

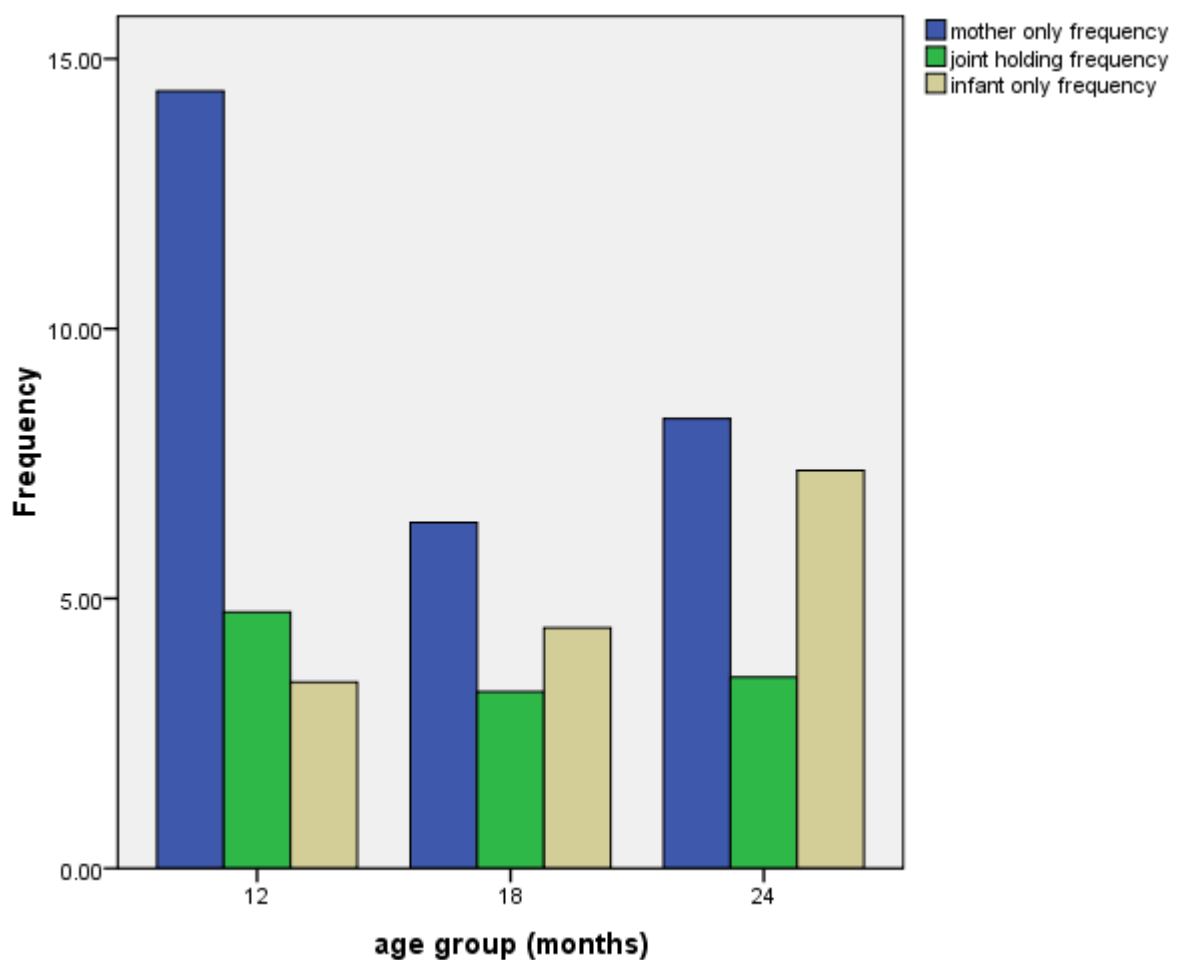


Figure 5.3- Developmental trajectories of frequency of total mother, joint and infant toothbrush holding and use

The second bar graph depicted in Figure 5.4 presents overall developmental trajectories for *duration* of i) total mother, ii) total mother-infant joint, and iii) total infant, toothbrush holding and use during dyadic toothbrushing episodes. Figure 5.4 demonstrates that as with frequency of total use depicted in Figure 5.3, that 12 to 24 months, maternal only holding and use of the brush decreases and infant only use of holding and use of the brush increases. The relation of shared toothbrush control of the brush across the ages of 12 to 24 months is less clear.

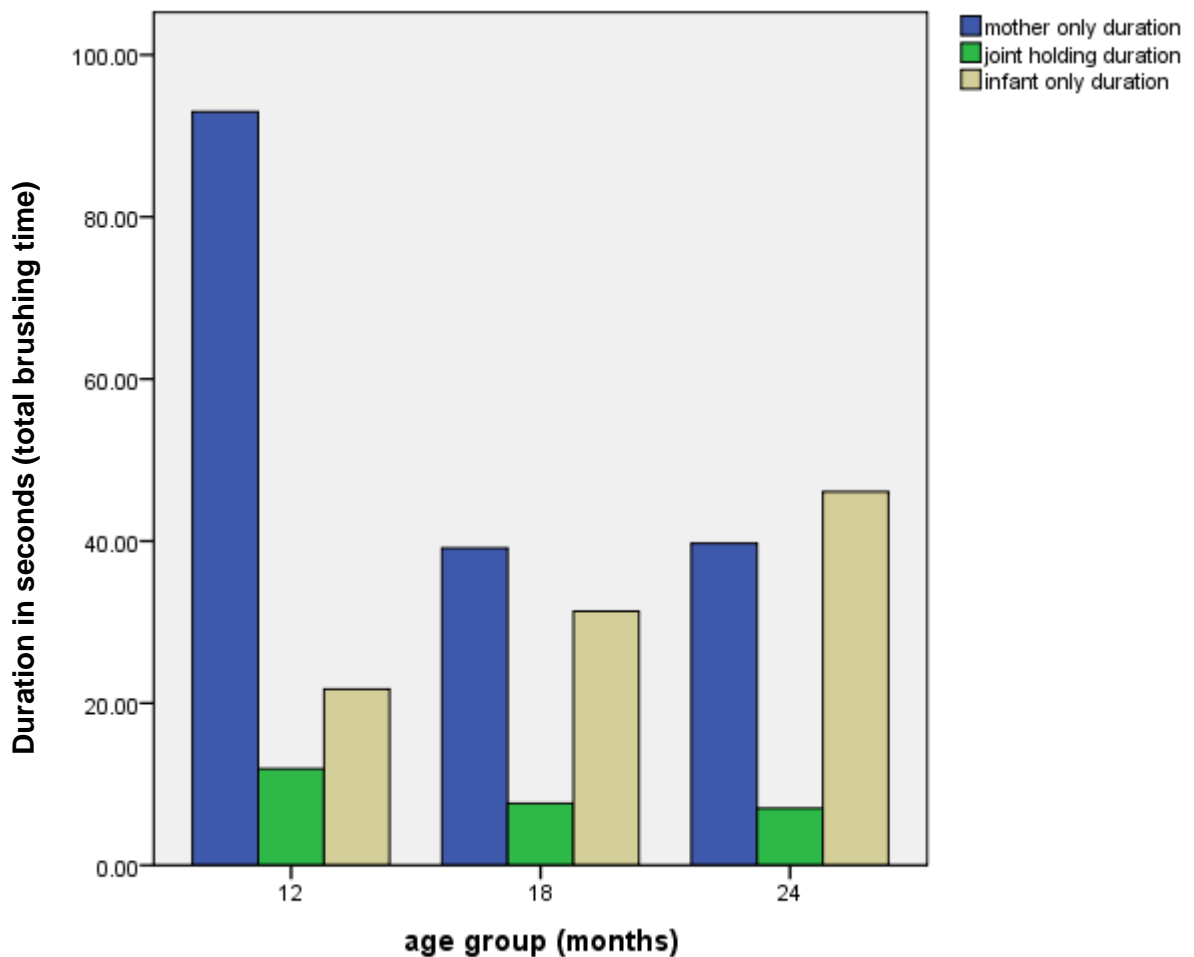


Figure 5.4- Developmental trajectories of total mother, joint and infant toothbrush holding and use

The next set of four bar graph depicts the spectrum of toothbrushing holding and use styles, from i) solely maternal, through to ii) mother's hand over infant's, iii) infant's hand over mother's, iv) both members of dyad using separate brushes, through to v) solely infant holding and use of the brush, and how changes in each of these across the age span might co-occur.

The bar graph depicted in Figure 5.5 demonstrates that in terms of *frequency* of the toothbrush *not* being inserted in the infant’s mouth, as maternal use of the brush decreases between the ages of 12 and 24 months, infant use increases. However, in terms of the relationship between age and the three joint toothbrush use techniques (mother’s hand over infant’s, infant’s hand over mother’s, both members of dyad using separate brushes), the relationship is less clear.

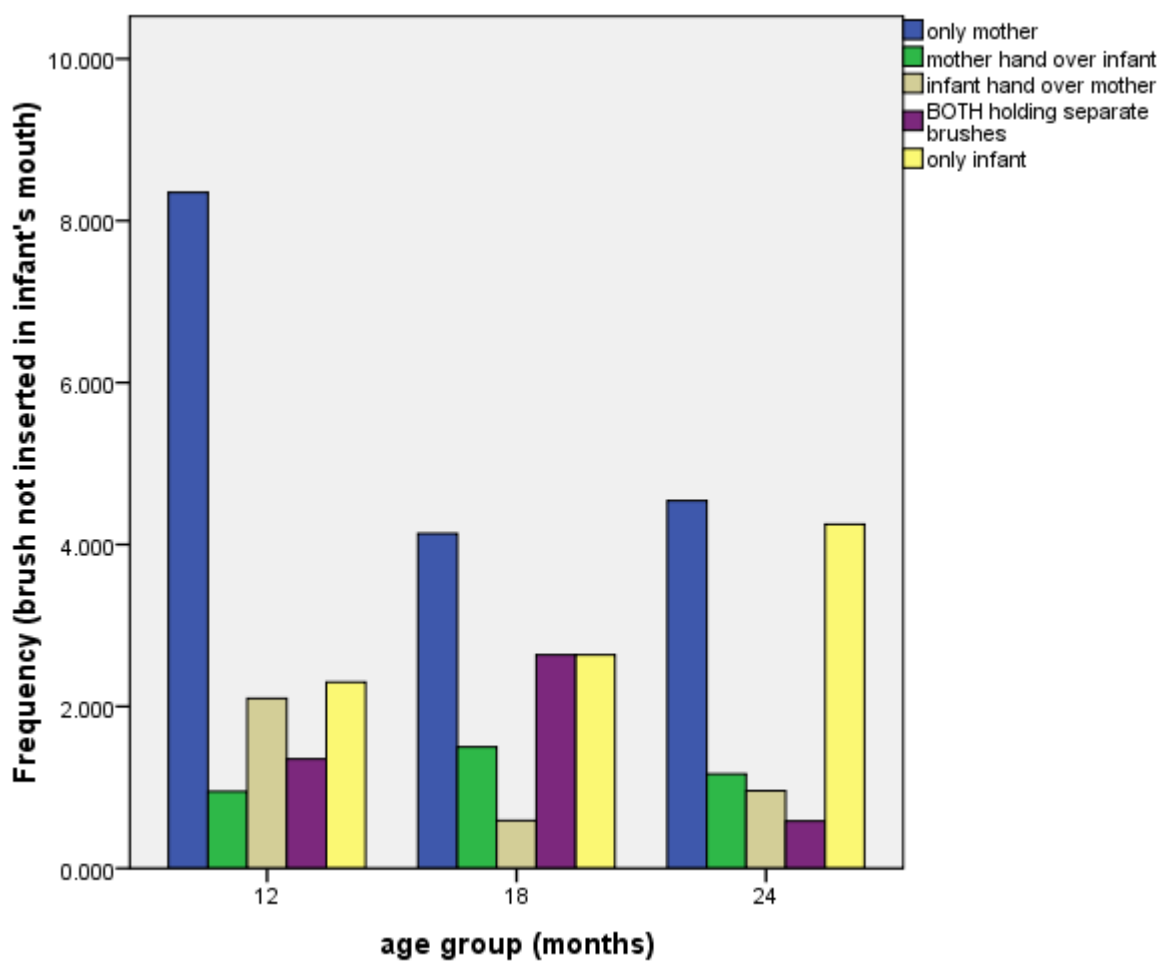


Figure 5.5- Age related changes in frequency of a range of toothbrush holding and use behaviours resulting in the brush being inserted into the infant's mouth

As with the relationships depicted in Figure 5.5 with regards to *frequency* of toothbrushing holding behaviours, in terms of *duration* of the toothbrush *not* being inserted in the infant's mouth, as maternal use of the brush decreases between the ages of 12 and 24 months, infant use increases, as Figure 5.6 below demonstrates. However, in terms of the relationship between age and the three joint toothbrush use techniques (mother's hand over infant's, infant's hand over mother's, both members of dyad using separate brushes), the relationship is less clear.

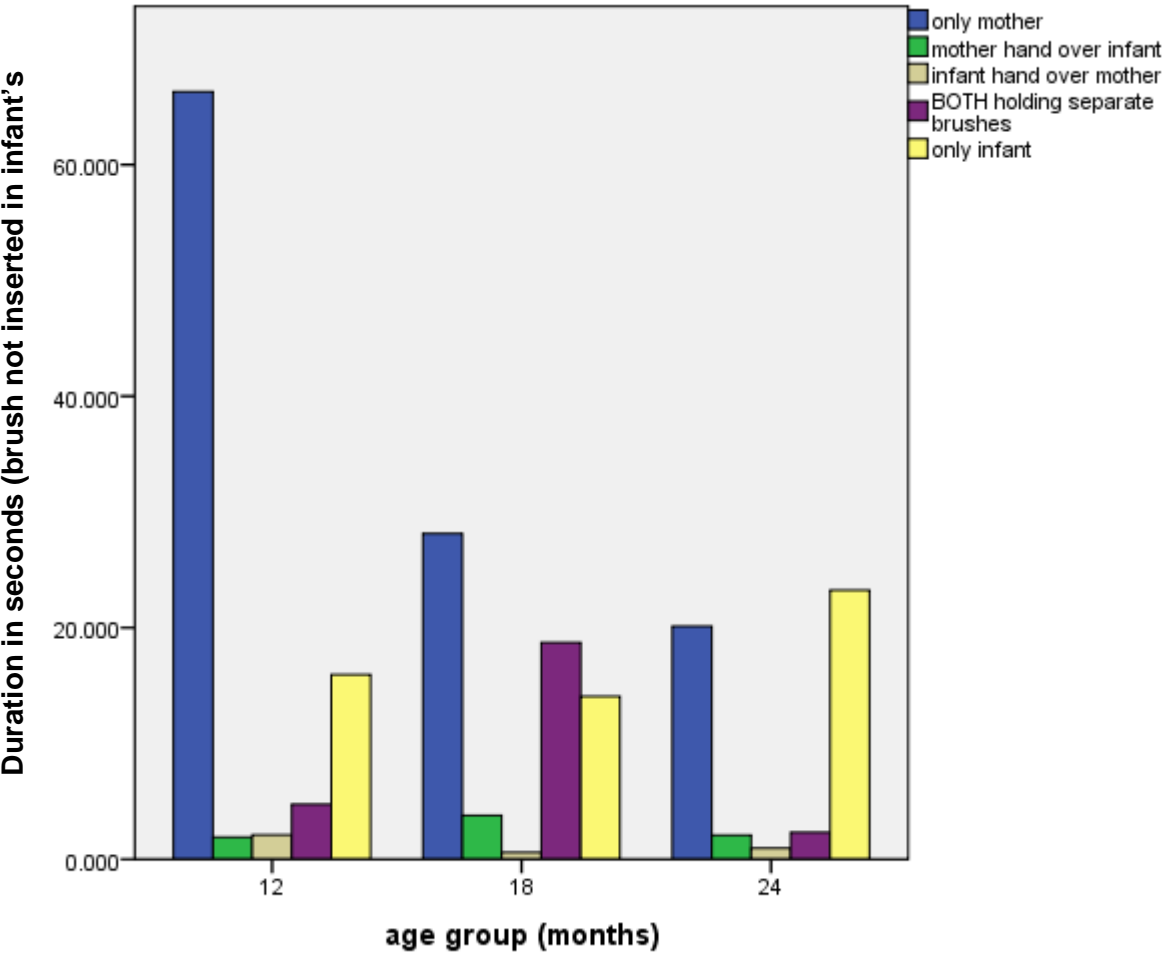


Figure 5.6- Age related changes in duration of a range of toothbrush holding and use behaviours resulting in the brush being inserted into the infant's mouth

Similarly, during toothbrush holding and use that results in the toothbrush being inserted into the infant's mouth, Figure 5.7 below demonstrates that in terms *frequency* of the toothbrush being inserted in the infant's mouth, as maternal use of the brush decreases between the ages of 12 and 24 months, infant use increases. However, in terms of the relationship between age and the three joint toothbrush use techniques (mother's hand over infant's, infant's hand over mother's, both members of dyad using separate brushes), the relationship is less clear.

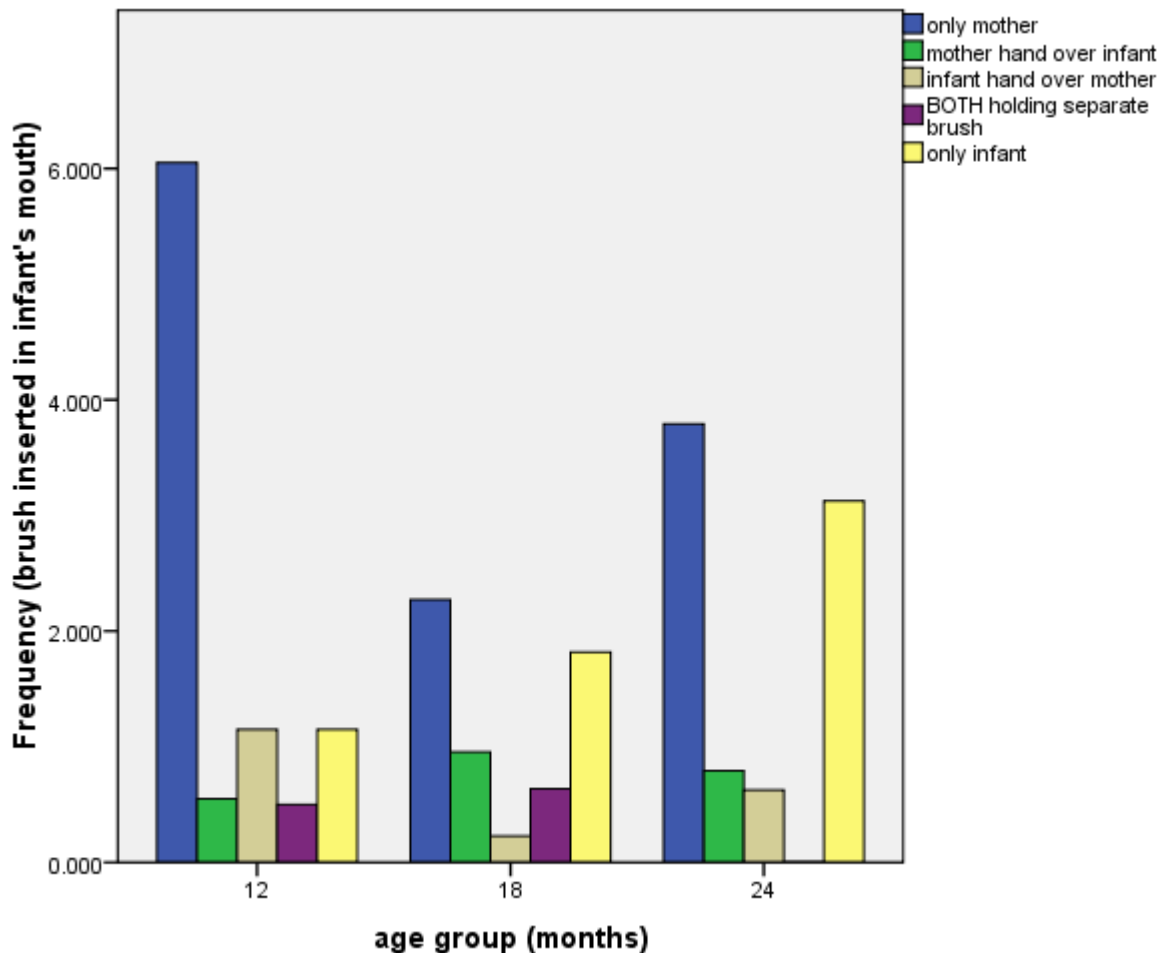


Figure 5.7- Age related changes in frequency of a range of toothbrush holding and use behaviours resulting in the brush being inserted into the infant's mouth

Finally, in toothbrush holding and use that results in the toothbrush being inserted into the infant’s mouth, Figure 5.8 below demonstrates that in terms of *duration* of the toothbrush being inserted in the infant’s mouth, as maternal use of the brush decreases between the ages of 12 and 24 months, infant use increases. However, in terms of the relationship between age and the three joint toothbrush use techniques (mother’s hand over infant’s, infant’s hand over mother’s, both members of dyad using separate brushes), the relationship is less clear.

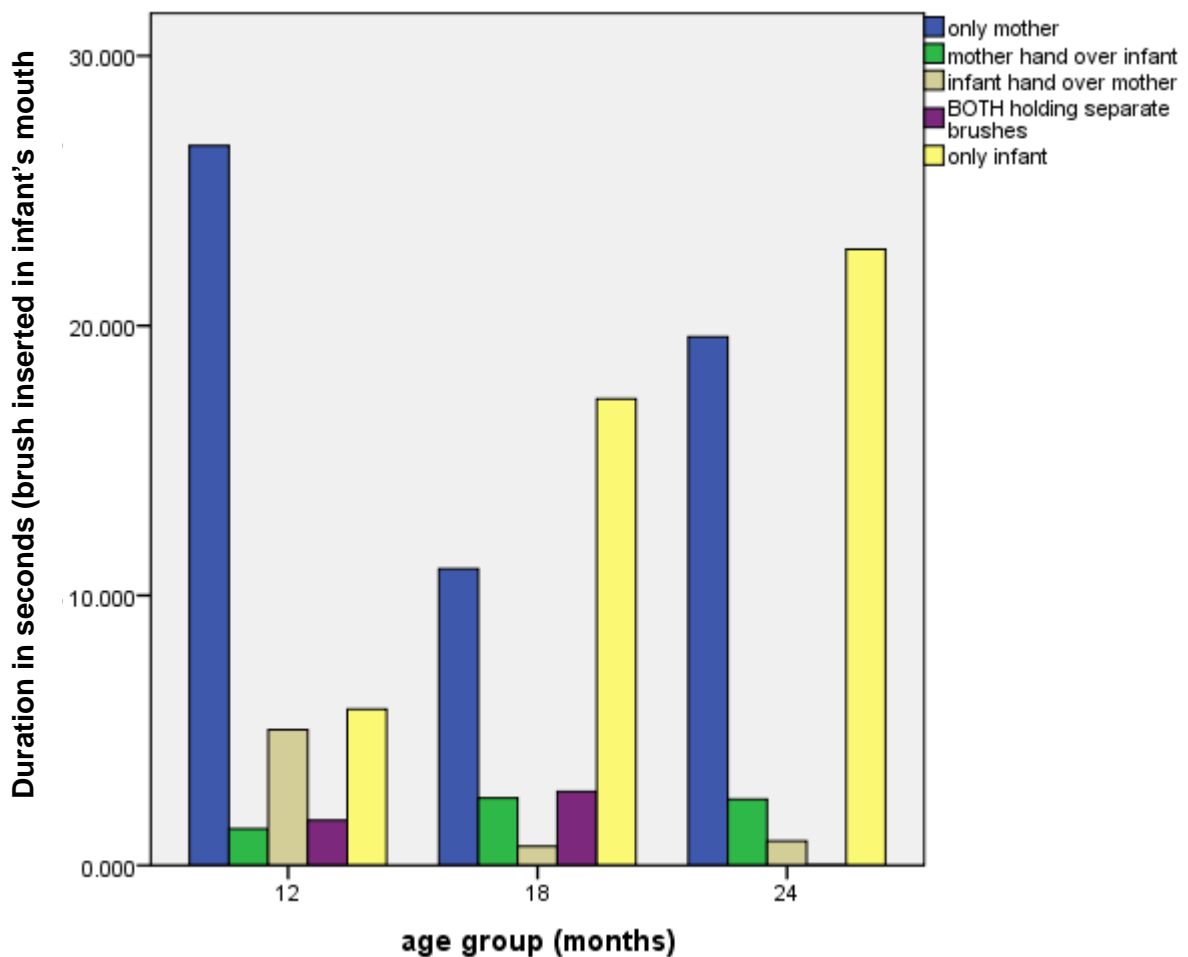


Figure 5.8- Age related changes in duration of a range of toothbrush holding and use behaviours resulting in the brush being inserted into the infant's mouth

5.3.4 Age related differences in infant toothbrushing skills demonstration

methods used by mothers

In addition to examining age related differences in maternal and infant toothbrush holding and use, data were analysed to examine differences in the methods used by mothers to demonstrate to infants how to use the toothbrush correctly to brush their teeth. The two main methods examined were i) infant observation of mother demonstrating toothbrushing either with infant sat facing the mother, or the infant observing the mothers reflection in a mirror, ii) infant's individual learning through manual exploration of the toothbrush.

A number of codes were generated to describe the toothbrushing skills demonstration methods used by mothers during toothbrushing episodes to teach infants how to use their toothbrush. These four codes were taken from a recent study examining effectiveness of tool use learning strategies in infants (Gardiner et al., 2012);

- Infant observation of mother only exhibited
- Infant manual exploration of toothbrush only
- Both infant observation of adult and infant manual exploration of toothbrush.
- Neither method of learning exhibited

Table 5.15 depicts frequency by age group of each of these four codes. As data were not normally distributed, a 4X3 Chi Square Test was conducted. Outcome of this test was χ^2 1.261; df 2; p .532, meaning there was no significant difference between the three age groups in numbers of dyads using different infant toothbrushing skills teaching style.

Although no age related differences were found, Table 5.15 demonstrates that the most common infant toothbrushing skills teaching method exhibited by dyads was a combined method that incorporated two techniques. These were, allowing the infant to observe the mother toothbrushing, and the mother allowing the infant to manually explore the toothbrush and use it themselves.

5.15- Frequencies of toothbrush use skills demonstration methods by age group

Demonstration method	Age Group		
	12 months (n=12) Frequency (%)	18 months (n=12) Frequency (%)	24 months (n=12) Frequency (%)
None	1 (8%)	2 (17%)	2 (17%)
Infant observation of mother only	2 (17%)	0 (0%)	0 (0%)
Infant manual exploration of toothbrush only	3 (25%)	3 (25%)	3 (25%)
Both infant observation of mother and manual exploration of toothbrush	6 (50%)	7 (58%)	7 (58%)

5.4 DISCUSSION

This study sought to examine age related differences in dyadic toothbrushing behaviours in three age groups of infants (12, 18 and 24 month olds). It was hypothesised that as age group increased the duration and frequency of maternal use of the toothbrush would decrease, and infant use of the toothbrush would increase. Additionally, duration and frequency of infant attempts to hold the toothbrush whilst the mother was attempting to use it to brush the infant's teeth was hypothesised to increase with age. It was also hypothesised that as age increased, there should be a greater duration of shared toothbrush control, with each member of the dyad holding and using their own separate toothbrush. These hypotheses were generally supported by the data as some significant differences were found between the age groups. These significant differences were both in terms of maternal holding and use of the toothbrush, and infant holding and use of the toothbrush. Some age related differences were also found between the groups in shared toothbrush control behaviours. Significant findings from the study are now discussed in more detail.

5.4.1 Overview of the main findings

i) Examination of overall toothbrushing duration

Although the total toothbrushing episode duration time for each of the three age groups was approximately two minutes, which is the length of time recommended by dental professionals (NHS, 2009), the total amount of time in which the toothbrush was inserted into the infant's mouth fell short of these recommendations. However, the published guidelines do not make it entirely clear whether the two minute duration relates to the

time the toothbrush should be inserted in the mouth making contact with the teeth, or, whether this two minute duration refers to both time the toothbrush is inserted and not inserted into the mouth. For each of the age groups (12, 18 and 24 months) the total durations of time the toothbrush was inserted into the infant's mouth were 47, 41 and 51 seconds respectively, less than half the recommended brushing time. No significant difference was found between the groups in either total toothbrushing duration or duration of time the toothbrush was inserted into the infant's mouth. As would be expected, the number of erupted primary teeth was higher in the 24-month age group than in the 12 and 18 month age groups. It was therefore surprising that the total duration of time the toothbrush was inserted into the infant's mouth did not significantly increase with age, as it would be intuitive to presume that as the number of primary teeth increased, the longer it would take to ensure that all tooth surfaces were cleaned with the toothbrush.

ii) Age related differences in maternal holding and use of the toothbrush

A number of significant differences were identified between the three age groups in terms of maternal holding and use of the toothbrush during toothbrushing episodes included in the analyses. There was a significant *decrease* in the frequency and duration of maternal holding and use of the toothbrush between the ages of 12 – 18 months. This significant decrease was found in maternal holding and use of the brush that i) *did not* result in the toothbrush being inserted into the infant's mouth, ii) maternal holding and *use* of the toothbrush that *did* result in the toothbrush being inserted into the infant's mouth and also, iii) *total* amount of maternal toothbrush holding and use. However, it was also found that between the ages of 18 – 24 months there was a significant *increase*

in the frequency and duration of maternal holding and use of the toothbrush, but only in toothbrush holding and use that resulted in the toothbrush being inserted into the infant's mouth.

This finding may reflect the fact that as infants develop, they develop more teeth, which may necessitate the need for the caregiver to brush the infant's teeth for a greater duration and frequency in order to ensure that all the tooth surfaces are covered. It would therefore appear from the data derived from this study that maternal use of the toothbrush decreases between the ages of 12 – 18 months, but then increases between the ages of 18 – 24 months, but only when the mother is inserting it into the infant's mouth. Therefore, between the ages of 18 – 24 months there does not seem to be a significant increase or decrease in maternal use of the toothbrush when it is *not* being inserted into the infant's mouth. This perhaps indicates that the amount of mother use of the toothbrush decreases up until 18 months and then reaches a plateau.

iii) Age related differences in infant holding and use of the toothbrush

A number of significant differences were also identified between the three age groups in terms of infant toothbrush use. There was a significant increase in the frequency and rate per min of infant use of the toothbrush between the ages of 18 – 24 months, both when the toothbrush i) was not simply held but also inserted into the infant's mouth, with the infant attempting to engage in self-toothbrushing and ii) when the toothbrush was held but was not inserted into the infant's mouth. There was also a significant increase in the *total* amount of infant toothbrush use. This may indicate that it may be at around 18

months that infants might first develop a drive for autonomous toothbrush holding and self-toothbrushing.

However, as the data regarding maternal use of the toothbrush indicates, there may also be an increase in maternal use of the toothbrush in which the brush is inserted into the infant's mouth, during these ages in addition to an increase in infant use of the toothbrush. This may reflect an increase in dyadic toothbrush use more generally as the infant develops dentally and in other ways, such as in terms of fine motor skills including object manipulation.

iv) Age related differences in shared toothbrush control

Two main types of joint brushing were examined in the study, namely, when the mother and infant were i) both using the same toothbrush, and when they were ii) using two separate toothbrushes. There did not appear to be any age related differences in instances of the mother and infant holding the same toothbrush with the mother's hand over the infant's. This would indicate that there were no age related differences in mothers using this technique to demonstrate to infants correct toothbrush use skills. However, when the mother and infant were both using the same toothbrush and the infant's hand was over the mother's, there was a significant *decrease* in the frequency, duration, mean duration of each occurrence and rate per minute of this behaviour from the age of 12-months onwards. However, this was only during incidences when the toothbrush was not inserted into the infant's mouth. This could potentially indicate that at the age of 12-months, infants demonstrate the toothbrush 'grabbing' behaviours reported by mothers in the qualitative interview study reported in Chapter Three of the

thesis, when their mother is attempting to brush the infant's teeth with the toothbrush. However, after this age, the incidence of this infant 'grabbing' of the toothbrush appears to decline.

This decrease in infant attempts to hold the toothbrush appeared to coincide with an *increase* between these ages in the duration, mean duration of each occurrence and rate per minute of each member of the dyad holding *separate* toothbrushes. However, this was only in instances when neither of the dyad members inserted the brush into the infant's mouth. It might therefore be suggested that between 12 – 18 months dyadic joint toothbrush use around the *same* brush starts to be replaced by dyadic joint use around *separate* brushes, but only when the toothbrush is being held, and is not being inserted into the infant's mouth.

However, between the ages of 18 – 24 months, there appeared to be a significant decrease in the frequency, duration, mean duration of each occurrence and rate per minute of instances when both members of the dyad were using *separate* toothbrushes. These decreases occurred either when the mother was inserting the brush into the infant's mouth, or when neither member of the dyad inserted the toothbrush into the infant's mouth. This kind of shared toothbrush control could be thought of as indicative of 'modelling', with the mother demonstrating behaviour to their infant that the infant is supposed to copy. This kind of modelling behaviour has been identified as key to the learning of new skills in the early years, (Bandura, 1977b, 2001; Barrett et al., 2007; Meltzoff, 2007).

One potential explanation for this apparent decrease in the occurrence of 'modelling' type behaviours between 18 – 24 months could be that between these ages, infants may be being allowed more autonomous use of the toothbrush and self-toothbrushing, with caregivers playing less of an active role in the procedure. This idea may be supported by the fact that the present study found some evidence of a significant increase in infant use of the toothbrush between these ages. However, as the data regarding maternal use of the toothbrush indicates, there also appears to be an increase in maternal use of the toothbrush during these ages in addition to an increase in infant use. As previously stated, this may reflect an increase in dyadic brushing behaviours more generally between the ages of 18 – 24 months, as the infant develops dentally and in other ways. Other areas of development between these ages may be related to development of executive functions such as working memory, attention and problem solving, gross motor skills development including crawling and walking, and also fine motor skills including object manipulation.

v) Age related differences in infant toothbrushing skills teaching methods

The final analyses reported relate to the different infant toothbrushing skills teaching methods exhibited by dyads. These methods were either i) no teaching method exhibited, ii) infant observation of their mother engaging in toothbrushing, iii) infant being allowed to manually explore the toothbrush, and iv) a combination of both infant observation of mother and manual exploration of the toothbrush. There did not appear to be any significant difference between the three age groups in method used. However, it was clear from the data that the majority of dyads exhibited both infant observation of mother and infant manual exploration of the toothbrush and that it was through using a

combination of these two techniques that mothers taught toothbrushing skills to their infant.

5.4.2 Interpretation of the main findings

The findings relating to toothbrushing duration times reveal that toothbrushing times fall short of the recommended two minutes duration (e.g. NHS, 2009). However, the findings also pose some questions about what is precisely meant by ‘two minutes’. Although some of the dyads in the present study may have engaged in toothbrushing sessions that lasted approximately two minutes, the toothbrush may not have been inserted into the infant’s mouth for the entire two minute duration. Therefore, the teeth were not actually brushed for the full two minute duration. This might indicate that the recommendations may need to be clarified to stipulate whether the two minutes refers to the length of the toothbrushing episode or the duration of time the brush makes contact with the tooth surfaces.

Additionally, the developmental trajectories built from the statistical analyses presented in the Results section allow findings to be identified that reveal how control of holding the toothbrush during dyadic toothbrushing with infants may transfer from solely the mother to the infant, during the second year of life. The main findings would indicate that between the ages of 12 – 24 months, toothbrush use behaviours fall below the recommended dental guidelines and dyadic interactions around toothbrush use change significantly. At 12 months, although brushing times fall below the recommended guidelines, mothers did appear to be playing a more significant role in toothbrushing

than in the older groups, either by the mother displaying significant use of the toothbrush, or by the mother and infant engaging in joint toothbrush use. Joint toothbrush use behaviours, either with each member of the dyad using the same brush, or both using separate brushes and engaging in modelling type behaviour, appeared to decrease until the age of 18 months.

After the age of 18 months, up until 24 months, a significant increase in maternal use of the toothbrush that resulted in the mother also inserting the brush into the infant's mouth was found. At the same time a significant increase in infant use of the toothbrush also occurred. These increases in both mother and infant use of the toothbrush appeared to occur alongside a decrease in each member of the dyad engaging in joint toothbrush use in which each member of the dyad used a separate toothbrush.

This may indicate that before 18 months, dyadic toothbrush use may be characterised by the mother using the toothbrush the majority of the time, with the only infant use of the toothbrush occurring in the context of joint use. This was with the mother either having their hand over the infant's whilst using the same toothbrush or the mother attempting to engage in modelling by providing the infant with their own brush to use whilst the mother used a separate toothbrush. But then after 18 months, dyadic toothbrush use may be more characterised by a 'turn-taking' method, given the evidence of a potential increase in separate mother and infant use of the same toothbrush and potential decrease in joint use of separate toothbrushes.

5.4.3 Comparison of main findings with previous research findings

The findings from this cross-sectional observational study largely concur with those from the only other previously conducted observational study of dyadic toothbrush use in the early years (Zeedyk et al., 2005). As Zeedyk et al. (2005) found, the brushing duration times in their sample fell below the 2 minute recommendations from the dental experts at 56 seconds, which is in line with findings from this observational study. Additionally, Zeedyk et al. (2005) also found that a great deal of the toothbrush use observed in their group of 18 dyads containing a child approximately 2.5 years old, was conducted by the child with the caregiver having very little or no involvement in holding and using the toothbrush. The findings from the present study demonstrate that between 12 – 18 months maternal use of the toothbrush significantly decreased and between the ages of 18 – 24 months infant use of the toothbrush significantly increased. This could mean that by the age of 2.5 years, the amount of infant use of the toothbrush may increase to such a point that the caregiver no longer plays a particularly significant role in the toothbrush use process.

Another way in which the findings from the present study extend those of Zeedyk et al. (2005) is to provide some indications as to how the joint toothbrush use behaviours identified as most common in the Zeedyk et al. (2005) study may develop. The present study has identified that joint toothbrush use of some description may be common before the age of 18 months, but then after this age a ‘turn-taking’ method tends to predominate. In the Zeedyk et al. (2005) study this turn-taking method appeared to be the most common amongst the families participating in the study, with 25 out of a total of 45 recorded toothbrushing episodes provided by the 18 families participating

depicting this style of brushing. The remaining 20 episode depicted 5 in which the caregiver exclusively held and used the toothbrush and 15 in which the child exclusively held and used the toothbrush.

The findings from the present study may also concur with the wider literature on turn-taking (Brownell et al., 2006) and infant drive for autonomy (Erikson, 1968; Helwig, 2006). Before the age of 18 months, infants may generally be content to imitate adults and copy their actions, perhaps explaining why before this age infants in this study largely engaged in joint toothbrush use behaviours with their caregiver. This is with each member of the dyad using either the same toothbrush or separate toothbrushes. However, after this age when the drive for autonomy becomes stronger, the infants included in this study may have become dissatisfied with simply enacting the same action as their caregiver. As infants develop to the age of around 18 months, they may want to actually use the toothbrush themselves; they may not require or desire the simultaneous enactment of toothbrush use behaviours by their caregiver. They may feel they use the toothbrush to engage in self-toothbrushing on their own.

5.4.4 Limitations to the Study

The most immediate limitation to the study is that the sizes of each age group were small (12 dyads in each group), due to time constraints and difficulties recruiting participants from a community sample. The sample of mothers participating were also all self-selecting, and could therefore be seen to be motivated, capable mothers given they were willing and motivating to take part in a research study. So whether the interactions

around toothbrushing observed within the participating dyads would also be seen in mothers who might be less motivated in unknown. Mothers in this study may have been coping relatively well with enforcing maternally controlled toothbrushing with their infants, so if less motivated mothers were observed, more difficulties around mother-infant dyadic interactions around toothbrushing may have been observed. A further limitation lies with the behaviours that were coded for in the coding schedule. The data collected could have been used to examine more closely such variables infant temperament and behaviours and how these might be associated with maternal behaviours around retaining control of using the toothbrush during dyadic toothbrushing.

A further limitations lies with the fact that data were only collected from each dyad across a period of one week, which provides a 'snapshot' of dyadic behaviours during a narrow window of time. If for example infants had been unwell that one-week period, or perhaps mothers may have been unwell or unusually stressed or busy, this might have meant that the dyadic behaviours observed within that week-long period may not have been representative of that dyads 'usual' behaviour. Additionally, although cross-sectional data have been generated to describe developmental trajectories of toothbrushing use behaviours through infancy, these trajectories are only artificial. Longitudinal research following the same group of infants from 12 to 24 months would be required if truly natural developmental trajectories of changes in dyadic toothbrush use during toothbrushing episodes are to be generated.

5.4.5 Further Study

Due to the relatively small sample and the fact that the study had a cross-sectional design, it would be beneficial to repeat the study with larger samples and follow-up each group longitudinally. Conducting a microgenetic study in this way would allow natural trajectories of the development of these behaviours to be explored. The study presented in this chapter was not conducted as a longitudinal study as it was conducted as the third in a series of four sequential studies and was designed as a result of the findings from these earlier studies, in particular the qualitative interview study presented in chapter Three. It was also intended as a pilot to obtain a 'snap shot' of *potential* age associated difference in toothbrush holding and use, so a cross-sectional methodology is an appropriate method of doing this in a relatively time-effective manner. Now that age associated differences appear to have been found in this cross-sectional study, longitudinal study, which is more time-intensive, can now be conducted to confirm these age associated differences.

An additional way in which the present study could be extended would be to examine more closely how styles of social interaction develop around toothbrushing. Although some preliminary data has been generated that indicates the ways in which behaviours such as joint toothbrush use and modelling may develop, these issues merit further investigation. For example, it would be potentially valuable to examine maternal and infant verbal interaction in the form of utterances and reciprocal conversation, and how these relate to the development of physical dyadic interactions around toothbrush use.

Another style of social interaction that merits further study is that related to infant behavioural difficulties during toothbrushing, such as defiance and non-compliance. These behavioural difficulties have also been reported very briefly in other interview studies with caregivers of young children (Amin and Harrison, 2009; Hoeft et al., 2009; Huebner and Riedy, 2010; Mofidi et al., 2009; Riedy et al., 2001), quantitative questionnaire studies (Olley et al., 2011a; Spitz et al., 2006), and have been recognised as a potential difficulty by the American Association for Pediatric Dentistry (AAPD, 2011b). In order to investigate these more closely, further observational research could be conducted, perhaps longitudinal in nature, in order to determine at precisely what age defiance and non-compliance during toothbrushing may begin. Additionally, psychometric measures could be used alongside observations of dyadic interactions during toothbrushing to examine associations between observed toothbrushing behaviours and caregiver confidence and parenting style (Baumrind, 1989; Coolahan et al., 2002) for example.

The findings from this study, along with those from the qualitative interview study reported in Chapter Three have been used to develop an evidence-based dyadic toothbrushing picture book intervention for use with 24-month old infants. This intervention is informed by the evidence from the literature indicating that many young children may be engaging in autonomous self-toothbrushing (BDHF, 2008; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005) and the further evidence for this gained from the present study. This picture book intervention is intended to increase the duration and frequency of caregiver control of holding and using the toothbrush during dyadic toothbrushing episodes, and decrease the duration and frequency of infant

control of holding and using the toothbrush. Specifically, this intervention draws upon the 'exposure' (Monahan et al., 2000; Zajonc, 1968, 2001) and 'imitation' (Simcock and DeLoache, 2006; Simcock and DeLoache, 2008; Simcock and Dooley, 2007), paradigms, to encourage infants to imitate a novel action sequence depicting dyadic toothbrushing. This intervention takes the form of a picture book that encourages turn-taking during toothbrushing in which the caregiver uses the toothbrush the majority of the time during individual toothbrushing episodes. The development of this intervention is reported in the Chapter Six of the thesis.

CHAPTER SIX: DEVELOPMENT AND EVALUATION OF A PICTURE

BOOK INTERVENTION TO IMPROVE EARLY DYADIC

TOOTHBRUSHING ROUTINES

6.1 Introduction

A range of influences on emergence of toothbrushing as a dyadic process with infants have been considered throughout the thesis, and throughout, potential influences have been conceptualised using Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Some of the influences of central interest have been conceptualised as lying at the level of the microsystem of the model within the caregiver-infant dyad, including caregiver cognitions, and caregiver and infant behaviours. One key influence on dyadic toothbrushing is the drive that infants and young children exhibit to engage in autonomous self-toothbrushing. The published literature (BDHF, 2008; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005) and also the data collected in the studies reported in Chapters Three and Five of the thesis suggest that this drive may act as a barrier to effective infant toothbrushing conducted via caregiver control of holding and using the toothbrush.

These published dental guidelines state that during the early years, caregivers should brush their children's teeth for them, or at least closely supervise their young children whilst they brush their teeth (AAPD, 2011a; BDHF, 2010; NHS, 2009). It may be necessary for adults to brush children's teeth for them during the early years as young children may

not have the appropriate skills required to ensure their teeth are brushed to an adequate level of hygiene prior to this age. The level of fine motor skills required to manipulate an object such as a toothbrush, in order to ensure that every teeth surface is cleaned effectively with the brush, may be too advanced of this period of development. In order to hold a toothbrush in such a way that use of it confers optimal tooth cleaning in childhood, a distal oblique grasp has been suggested to be the most effective, but even in children aged 8 – 12 years, learning to use this grasp type for toothbrushing may be difficult (Sharma et al., 2012).

Adequate adult supervision is also important as toothbrushes may be damaging to young mouths, potentially causing trauma to the oral cavity if used incorrectly (Belfer et al., 1995; Matsusue et al., 2011). Therefore, caregivers may need to be supported to ensure they retain control of holding and using the brush to clean their child's teeth for them, instead of allowing their child to have principal control of holding and using the brush, in order to ensure their child's teeth are brushed properly.

However, one key finding that has been identified both from the previously published research (Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005) and also from the empirical work reported so far, relates to potential dyadic influences coming from *infants* that may pose potential challenges to dyadic toothbrushing with infants in which caregivers maintain control of using the toothbrush. This work has revealed behavioural difficulties that infants may sometimes exhibit during dyadic toothbrushing episodes, such as non-compliance and more specifically, infants wanting to brush their own teeth themselves. The empirical work reported in the thesis

so far would suggest that this infant drive to engage in self-toothbrushing may result in caregivers having some difficulties in retaining control of holding and using the toothbrush to brush their infant's teeth for them during dyadic toothbrushing episodes. This finding has come from qualitative interview and observational research reported in Chapters Three and Five respectively and demonstrates that many infants may be engaging in self-toothbrushing even at 24-months and younger.

Therefore, it may be timely to develop an intervention to increase caregiver's control of holding and using the toothbrush, and decrease infant's control of holding and using the toothbrush. The work so far reported in the thesis has suggested that toothbrushing is a truly dyadic process, with the behaviours of each member of the caregiver-infant dyad influencing the behaviour of each other. Therefore, such an intervention may conceivably focus on toothbrushing as a *dyadic process* and aim to influence the behaviour of both the *caregiver and infant* within a dyad. Specifically, previous work has suggested that in dyads containing infants, using a picture book format may successfully influence behaviour of caregivers and infants, especially in relation to health care behaviours (e.g. Burke, Kuhn, & Peterson, 2004; Houston-Price, Burton et al., 2009). Research has demonstrated that by 18 to 24-months, infants are able to imitate novel action sequences from media such as television and picture books (Simcock and DeLoache, 2006; Simcock and DeLoache, 2008; Simcock and Dooley, 2007). The evidence-base around the use of such picture book interventions is now discussed with reference to the mechanism of action of such interventions and how they might be applied to toothbrushing behaviours in caregiver-infant dyads.

6.1.1 Picture Book Interventions and their Applications

Picture book interventions have been demonstrated to provide significant improvements for a range of populations and also be cost-effective (Papworth, 2006). This is particularly important given the current economic climate in which many health and social services, including early intervention services, are experiencing budget cuts (Appleby et al., 2009; HMTreasury, 2010).

Picture and story book interventions may allow a child to become more familiar and comfortable with an activity by introducing them to the finer details of the activity and how they are expected to behave during the activity. Picture book interventions have been demonstrated to increase children's understanding of the socio-emotional aspects of illness, injury and health (Turner, 2006) and improve children's behaviour during important health routines such as sleep routines (Burke et al., 2004). They have also been demonstrated to improve problematic child behaviours such as resistance to bedtime and also resistance to other health behaviours such as handwashing (Hagiwara and Myles, 1999).

Of particular relevance are recent studies of picture book interventions that have been successfully employed to increase children's acceptance of nutritious foods such as fruits and vegetables (Houston-Price et al., 2009a; Houston-Price et al., 2009b). Two separate studies (Houston-Price et al., 2009a; Houston-Price et al., 2009b), demonstrated that in 30 infants aged 1 year 10 months (range 1 year 8 months – 1 year 11 months) and 20 infants aged 2.32 years (range 21.4 – 24.7 years) respectively, exhibited a preference for

fruits and vegetables following visual exposure to these fruits and vegetables via a two-week exposure period to a picture book containing photos of these fruits and vegetables. Both these studies used an observational methodology to evaluate these interventions and found that when offered a choice between the fruit and/or vegetables exposed to using the picture books and other foods, infants displayed aversion to foods to which they had not been exposed but a preference to the fruits and vegetables they had been exposed to.

Additionally, and of more relevance to child *dental health* behaviours, in the 1990s a picture book intervention was used to communicate dental health information to a group of 397 8-9 year old school children in Italy (Mazzocchi and Moretti, 1997). This picture book intervention provided pictorial and written information on dental plaque, nutrition, oral hygiene and the importance of toothbrushing with a fluoride toothpaste. Plaque index examinations were conducted on children that had been allocated to intervention and control groups, both before exposure to the intervention and after. Multivariate analysis revealed that intervention group children had significantly lower plaque index scores after exposure to the intervention compared to baseline plaque scores ($p < .005$). This would suggest that exposure to the intervention improved children's dental hygiene behaviours, such as toothbrushing, which resulted in improved dental hygiene and lower plaque.

However, this kind of dental hygiene book intervention has never previously been developed for use with younger children or infants. How effective such a picture book intervention may be in modifying a pre-existing infant behaviours during dyadic

toothbrushing is unknown. It is possible that although picture book interventions may successfully increase infant liking of a new food, it may not be appropriate for modifying such a pre-existing behaviour. However, it is possible that the infant drive to engage in self-toothbrushing identified in the literature (BDHF, 2010; Hoefft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005), and also within the studies reported in this thesis, may be altered in response to a picture book designed to support them to tolerate a higher frequency and duration of *caregiver* control of the toothbrush during dyadic toothbrushing. The literature around the mechanisms underpinning behavioural change in response to exposure to a picture book intervention is now discussed.

6.1.2 Modelling and Imitation- Potential Mechanisms for Tool Use and Self Care Skills Development

Perhaps one of the factors that motivate infants to want to engage in autonomous self-care tasks is their ability to observe and learn from others via observation and social learning (e.g. Nielsen, 2006). It is via such social learning that infants may learn how to manipulate tools and use them in self-care tasks such as self-feeding (Bober et al., 2001; Carruth and Skinner, 2002; Carruth et al., 2004), and perhaps self-toothbrushing. Observation of others carrying out these tasks may contribute to them desiring to carry out these tasks autonomously (Dix et al., 2007; Erikson, 1968; Helwig, 2006; Newman and Newman, 2008).

Studies have shown that although 18 to 24-month old infants almost never spontaneously use novel tools to obtain out of reach objects, following observation of a competent other demonstrating using a tool, they will imitate this action sequence (Chen et al., 2000; Esseily et al., 2010). Additionally, studies have suggested that pre-schoolers may more readily imitate actions demonstrated by 'reliable' or 'expert' models as opposed to individuals perceived as being less reliable (Rakoczy et al., 2009). Furthermore, even when task irrelevant actions are demonstrated by a model, at the age of five years, children are more likely to imitate these task irrelevant actions in addition to task relevant actions when the model is an adult rather than a child (Wood et al., 2012). These studies suggest that during the early years, young children may exhibit a drive to imitate actions performed by adults or models perceived as 'expert', even when actions performed may not be relevant to the task in hand. Research has also demonstrated that by 18 to 24-months, infants are able to imitate novel action sequences from media such as television and picture books (Simcock and DeLoache, 2006; Simcock and DeLoache, 2008; Simcock and Dooley, 2007).

A potential determinant for how well infants are able to imitate such action sequences from media such as television and picture books is the degree of iconicity of the images representing the action sequence on the medium used (Simcock and DeLoache, 2006). The degree of iconicity refers to the extent to which the images presenting an event in a medium are analogous to the same event in real-life. So for example, presenting infants with colour photographs of a novel action sequence results in greater correct imitation of the action sequence than presenting the same action sequence in black and white pencil drawings (Simcock and DeLoache, 2006).

Another possible determinant in how well infants are able to imitate a novel action sequence from a medium is the frequency of exposure to the novel action sequence (Simcock and DeLoache, 2008). It has been suggested that the mechanism by which infants are able to imitate novel action sequences may be accounted for by the 'exposure paradigm' (Monahan et al., 2000; Zajonc, 1968, 2001). This theory postulates that rather than 'familiarity breeding contempt', familiarity with a stimulus may lead to liking of a stimulus by young children. This effect has been demonstrated in the pre-schooler eating behaviour studies previously referred to, in which infants were exposed to books composed of pictures of foods such as fruit and vegetables (Houston-Price et al., 2009a; Houston-Price et al., 2009b). These studies found that when infants were exposed to such stimuli, when tested later, they showed a preference to the foods they have been visually exposed to over other foods. This effect has been demonstrated as being robust and as manifesting after just 2 weeks of daily exposure to the stimuli (Houston-Price et al., 2009a). However, the effectiveness of such interventions may be significantly compromised if caregivers do not use the intervention in the way it is designed to be used, so for example if caregivers do not read the book with their infant as frequently as they are advised to.

6.1.3 Age Associated Considerations when using Picture Book Interventions

The Houston-Price et al. studies (Houston-Price et al., 2009a; Houston-Price et al., 2009b) have provided some indications that infants of approximately 2-years old can imitate novel action sequences from pictures to change their food preferences. Additionally, the Italian study outlined (Mazzocchi and Moretti, 1997) has provided some preliminary indications that picture book interventions may improve dental hygiene behaviours, such

as toothbrushing behaviours, of primary school-aged children. However, it is not known whether a similar exposure approach to changing dyadic toothbrushing behaviours may be appropriate for younger children that are a similar age to the Houston-Price et al. studies. Despite this, developmental literature and theory provide some insights into the appropriateness of picture book interventions for infants, and more specifically, the appropriateness of the technique for changing infant behaviour during dyadic toothbrushing.

An aspect of development that may impact on the appropriateness of picture book interventions for 24-month olds is their ability to imitate novel action sequences presented in such interventions. At 24-months old may be able to imitate complex action sequences from a picture book intervention as at this age infants are very mobile, being able to walk and run (Carruth et al., 2004). They also have the ability to grasp and manipulate objects for self-directed actions (Claxton et al., 2009). They are also likely to be engaging in self-feeding behaviours (Carruth et al., 2004) and be driven by 'mastery motivation' regarding tool-related self-care tasks (Jennings, 2004). Children aged 24-months may also have also developed a strong sense of self and will exhibit a drive to engage in activities in an autonomous manner (Erikson, 1968; Helwig, 2006), perhaps including copying novel action sequences presented in a picture book intervention.

A further consideration when using picture book interventions with young children may lie with their language development. If a book intervention includes a narrative which is intended to be read to an infant by a caregiver, e.g. caregiver, an infant's language skills, and in particular, *receptive* language skills, or *understanding* of words, may be

particularly important in them understanding the narrative within a book intervention. Studies of early language skills have described children who are not talking by 24-months as 'late-talkers' who require clinical intervention (Whitehouse et al., 2011). Therefore, assuming typical development, at approximately 24-months old children's speech and language development may be at a level that will enable them to understand narrative if used to describe events occurring in the pictures contained within a book. This may enable them to follow the 'story' within the book when read to them by an adult.

Although picture books may provide an appropriate platform for interventions designed to alter infant behaviours such as those during *dyadic toothbrushing with infants*, when developing interventions to alter such *health behaviour*, it may also be important to consider the literature around *evidence-based health behaviour change techniques*. These techniques may improve effectiveness of a picture book intervention intended to change infant health behaviours, such as dyadic toothbrush use. It is possible that these techniques might be effective in supporting *caregivers* to change their behaviours during dyadic toothbrushing, and help them to increase the extent to which they are in control of holding and using the toothbrush during dyadic toothbrushing.

6.1.4 Using Evidence-Based Behaviour Change Techniques to Develop Health Behaviour Change Interventions

In order to instigate changes in caregiver-infant dyadic behaviours during dyadic toothbrushing with infants a number of behaviour change techniques (BCTs) should be utilised in order to enhance the effectiveness of behaviour change interventions. A

recent systematic review of the literature identified a total of 26 evidence-based behaviour change techniques (Abraham and Michie, 2008) based on such principals of reinforcement, rehearsal, operant conditioning amongst others. This review identified that these behavioural change techniques have previously been successfully employed in health behaviour change interventions. However, to label these change techniques as solely 'behavioural' is somewhat inaccurate. Many of the techniques identified in the Abraham & Michie (2008) review might more properly be termed 'cognitive-behavioural' as they change human behaviours via the modification of the cognitions that underlie those behaviours. For example, the technique identified in the Abraham & Michie (2008) taxonomy labelled 'prompt specific goal setting', may exert an influence on behaviour through the cognitive process of increasing motivation via goal setting.

The techniques identified by Abraham & Michie (2008) may potentially be useful in supporting caregivers to change their behaviours during dyadic toothbrushing with infants, if they are included alongside a picture book technique designed to motivate infants to imitate a novel action sequence during toothbrushing. However, health behaviour change is complex, and a recent special edition of the journal *Health Psychology Review* highlighted the importance of a number of aspects of health behaviour change science that should be addressed when developing interventions (Michie and Johnston, 2012). For example, the precise behaviour that is the focus for change needs to be identified, in addition to defining what the desired 'change' should be. So for example, in relation to dyadic toothbrushing with infants, the precise behaviours of interest could be caregiver and infant holding and use of the toothbrush.

The definition for desired 'change' of these behaviours could be an increase in caregiver holding and use of the brush and a decrease in infant holding and use.

Another consideration is the selection of 'active ingredients' for the intervention, these being evidence-based health behaviour change techniques that are included in an intervention in order to change specified behaviours (Michie and Johnston, 2012). For example, a number of techniques could be appropriate for changing early dyadic toothbrush holding and use in toothbrushing episodes. Example of these techniques are summarised in Table 6.1, with some techniques targeting specifically, i) the caregiver, ii) the infant, or iii) both the caregiver and infant. These techniques should be clearly described when reporting findings from intervention development and evaluation studies in order to allow replication of intervention evaluation. Finally, there should also be clearly reported links between behavioural interventions, change techniques, and theoretical mechanisms for change (Michie and Johnston, 2012).

Table 6.1- Evidence-based health behaviour change techniques for 'intervention to increase maternal toothbrush control in dyadic toothbrushing' (from Abraham & Michie, 2008)

Change technique	Rationale
Prompt practice	Target: Mother Instructions included with the picture book will outline to mothers that they should read the picture book with their infant as many times as possible during the 2-week picture book intervention exposure period.
Prompt self-talk	Target: Mother Instructions included with the picture book will outline to mothers that they can recite the narrative included in the picture book whilst brushing their infant's teeth/ wash their infant's hands in order to talk both themselves and their infant through the process.
Provide general encouragement	Target: Infant In the story within the picture book the character of the infant is allowed to have a go at brushing his own teeth/ washing his own hands at the end of the episode as a reward for allowing his mother to brush his teeth/ wash his hands at the beginning of the episode.
Provide contingent rewards	Target: Infant Mother allows infant to have a go at brushing their own teeth/ washing their own hands at the end of each episode (as the characters are depicted as doing in the narrative of the picture book).
Model or demonstrate the behaviour	Target: Mother and Infant The narrative provides a model for how both the mother and the infant should ideally behave during toothbrushing/ handwashing.
Provide opportunities for social comparisons	Target: Mother and Infant The picture book provides an opportunity for both members of the dyad to make social comparisons of their own behaviours with those of the characters in the book.

A number of the evidence-based health behaviour change techniques from the Abraham & Michie (2008) taxonomy that are reported in Table 6.1 are now incorporated into a novel picture book intervention to increase maternal toothbrush control in dyadic toothbrushing episodes with 24-month old infants. This intervention is designed to support caregivers to increase infant acceptance of maternally-controlled bedtime toothbrushing in which the caregiver has almost exclusive control of the toothbrush. The purpose of the intervention is to achieve an increase in the frequency and duration of caregiver control of holding and using the brush during toothbrushing episodes following a 2-week intervention exposure period. The intervention is also hoped to achieve a decrease in frequency and duration of infant control of holding the brush during toothbrushing episodes following a 2-week intervention exposure period.

The picture book medium provides a novel action sequence for infants to imitate, that might allow them to become more accepting of principally maternal control of holding and using the toothbrush during dyadic toothbrushing. This novel action sequence depicts a dyadic toothbrushing episode engaged in by a caregiver-infant dyad in which throughout the episode the caregiver has principal control of holding and using the toothbrush to clean their infant's teeth for them. Then, at the end of the action sequence the infant is depicted as being allowed to have control of holding and using the toothbrush to briefly brush their own teeth once the caregiver has ensured the infant's teeth are cleaned effectively.

Infant acceptance of maternal-control of the toothbrush throughout the toothbrushing episode is hoped to be brought about through a number of features of the picture book intervention. These include, the evidence-base around infant imitation of novel action sequences (Simcock and DeLoache, 2006; Simcock and DeLoache, 2008; Simcock and Dooley, 2007), the health behaviour change techniques (Abraham and Michie, 2008) incorporated into the picture book and the use of a motivating reward which is depicted towards the end of the novel action sequence in the picture book. This motivating reward is allowing the infant the opportunity to hold the toothbrush themselves and have a go at brushing their own teeth at the end of the episode. This motivating reward should indulge the infant's drive for autonomy and allow them to begin developing the skills necessary for future self-toothbrushing. In this way, the intervention aims to increase frequency and duration of maternal control of holding and using the toothbrush whilst retaining some infant control of holding and using the brush.

Infants aged approximately 24-months old are identified for the study as previous research have indicated that at 24-months infant behaviour may be amenable to change due to exposure to such interventions (Houston-Price et al., 2009a; Houston-Price et al., 2009b). Additionally, previous research has indicated that by 24-months, infants should be able to imitate novel action sequences depicted in picture books (Simcock and DeLoache, 2006).

In addition to evaluating the effect the intervention might have on dyadic toothbrushing behaviours, the effect the intervention has on maternal self-efficacy (PSE) for dyadic toothbrushing will be examined using the newly developed toothbrushing PSE scale, the

development of which is reported in Chapter Four. The predictive validity of the new scale is also assessed through comparing scores on the PSE scale with observed dyadic toothbrushing behaviours.

This study makes an original contribution to the field as never before has any form of intervention had as its principal target for behavioural change the retention of caregiver control of holding and using the toothbrush during dyadic toothbrushing episodes with infants. Additionally, this is the first study to develop and evaluate a *picture book intervention* to support caregivers to retaining control of holding and using the toothbrush when engaging in dyadic toothbrushing with their infants. Additionally, no previous intervention around dyadic toothbrushing with infants been informed by the evidence-based health behaviour change techniques described in the recently published taxonomy of such techniques (Abraham and Michie, 2008). Nor has any previous intervention around dyadic toothbrushing with infants employed a methodology as rigorous as that employed in the present study. The present study includes the use of an observational methodology to evaluate the intervention, and the inclusion of infant receptive and expressive language assessments at baseline to ensure equivalence of study groups in infant language as this may act as a confound in a study of an intervention which includes a written narrative.

Additionally, the present study is the first of its kind to include not only 'intervention' and 'control' groups, but also a 'placebo control' group. This is due to the fact that the classic study design of comparing a 'treatment' group to a 'no-treatment' group carries some ethical problems, and also may impact upon study fidelity and reliability of findings. This is mainly due to the 'expectancy effect' in which participants in a 'treatment' group of a study expect to experience benefit from an intervention and so do experience benefit. Therefore, it is recommended that intervention evaluation studies compare two interventions, an 'intervention' and also 'placebo' intervention', that have similar perceived value, but involve different assumptions about the possible outcomes of the interventions and/or mechanisms of outcome (Hyman and Shore, 2000).

6.1.5 Hypotheses

The specific hypotheses stated are;

- i) Families in a toothbrushing picture book intervention group will exhibit (from observational data) a greater frequency and duration of maternal-control of the toothbrush during bedtime episodes, recorded after a 2-week intervention period, than handwashing 'placebo control' and 'no treatment' control groups. This will be accompanied by a smaller frequency and duration of infant-control of the toothbrush during bedtime episodes, recorded after a 2-week intervention period, than handwashing 'placebo control' and 'no treatment' control groups.
- ii) Any increase in frequency and duration of maternal-control of the toothbrush in bedtime toothbrushing episodes following a 2-week intervention period in a toothbrushing picture intervention group, will be sustained after a 2-week follow-up

period. This will be accompanied by a decrease in frequency and duration of infant- control of the toothbrush in bedtime toothbrushing episodes following a 2-week intervention period in a toothbrushing picture intervention group, will be sustained after a 2-week follow-up period.

iii) Mothers in the toothbrushing picture book intervention group will exhibit an increase in PSE related to toothbrushing (as measured by the newly developed toothbrushing PSE scale).

6.2 METHOD

6.2.1 Design

A pre-test, post-test intervention study with ‘intervention’, ‘placebo control’ and ‘no treatment’ control groups and follow-up period, incorporating both observational measures and psychometric measures at three data collection time point- i) baseline, ii) post-intervention, iii) 2-week post-intervention follow-up.

Independent variables

The *independent variables* are firstly intervention group allocation and additionally expressive and receptive language score as measured using the Oxford Communicative Development Inventory (CDI, 2009; Hamilton et al., 2000). This language assessment is used as a screening tool to ensure comparable language skills across the three intervention allocation groups as language may act as a possible confounder given the nature of the intervention tested, that is, a picture book with a written narrative.

Dependent variables

Dependent variables are measured via both observational data from dyadic toothbrushing episodes and psychometric assessments conducted a total of three times, at i) baseline, ii) post-intervention, iii) 2-week post-intervention follow-up. Psychometric measures include total PSE score as measured using the new dyadic toothbrushing in infancy PSE scale as, the development of which is reported in Chapter Four of the thesis. Additionally, total score on the General Self-Efficacy (GSE) Scale (Schwarzer et al., 2008) is used as a further dependent variable. Dependent variables from observational data are

measured using *one single observation* at each of the study data collection points (pre- and post-test and follow-up) and include the following;

Maternal behavioural measures:

Frequency of maternal holding/use of toothbrush when not inserted into infant's mouth

Frequency of maternal holding/use of toothbrush when inserted into infant's mouth

TOTAL *frequency* of maternal holding/use of toothbrush

Duration of maternal holding/use of toothbrush when not inserted into infant's mouth

Duration of maternal holding/use of toothbrush when inserted into infant's mouth

TOTAL *duration* of maternal holding/use of toothbrush

Infant behavioural measures:

Frequency of infant holding/use of toothbrush when not inserted into infant's mouth

Frequency of infant holding/use of toothbrush when inserted into infant's mouth

TOTAL *frequency* of infant holding/use of toothbrush

Duration of infant holding/use of toothbrush when not inserted into infant's mouth

Duration of infant holding/use of toothbrush when inserted into infant's mouth

TOTAL *duration* infant holding/use of toothbrush

Figure 6.1 depicts study design for the intervention and placebo control groups and

Figure 6.2 depicts study design for the no treatment control group.

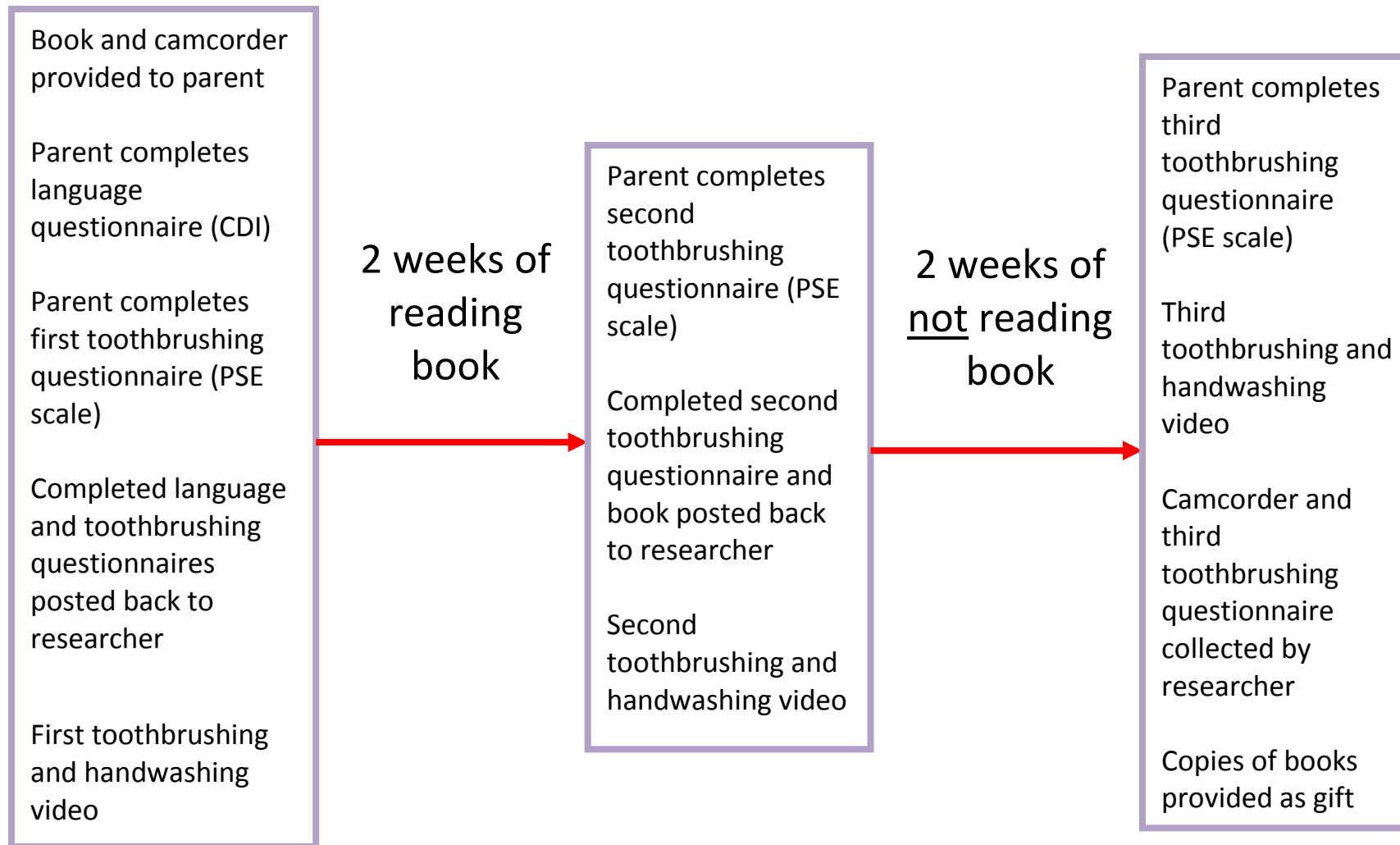


Figure 6.1- Study activities for the two picture book intervention groups

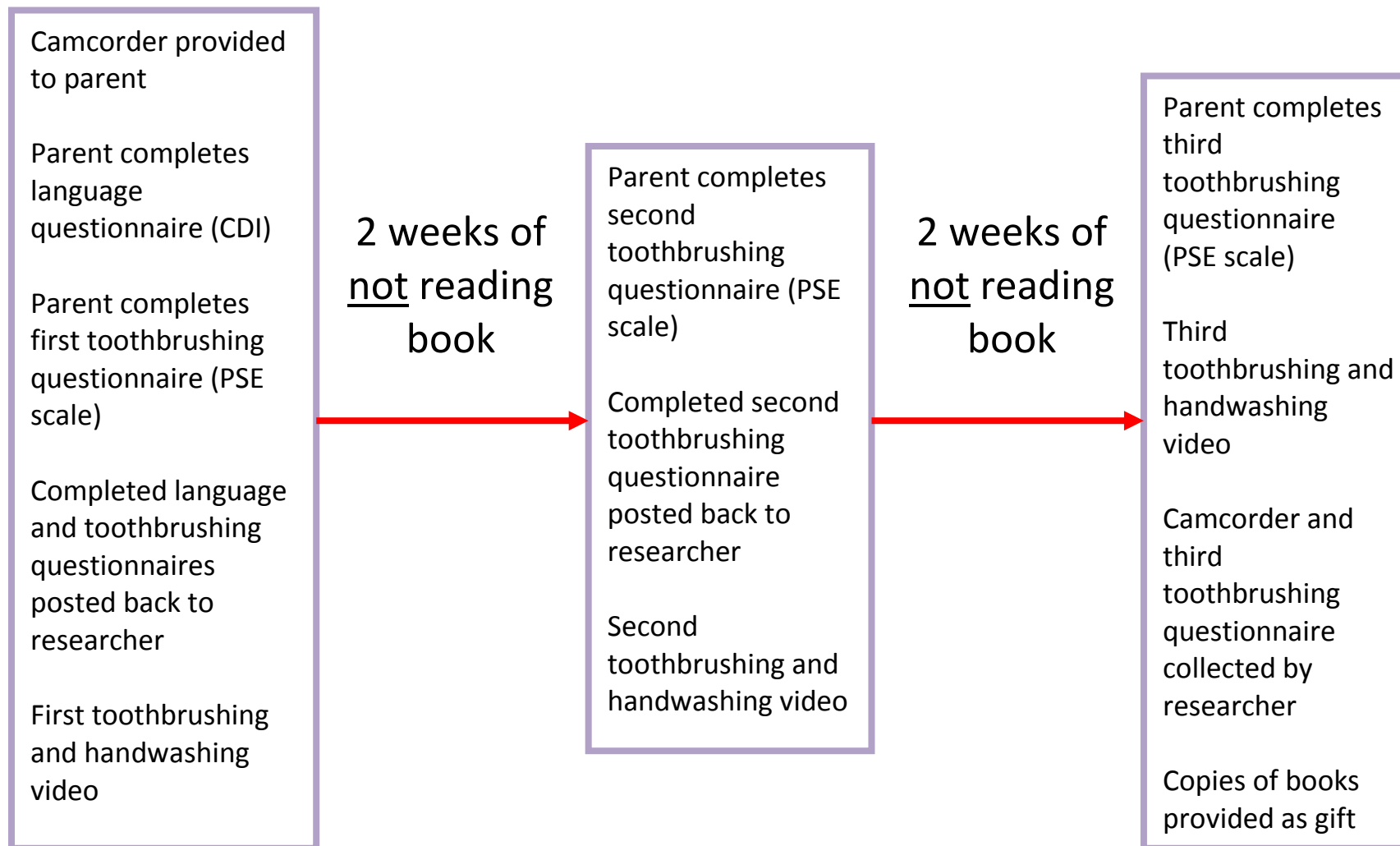


Figure 6.2- Study activities for the 'no treatment' control group

6.2.2 Participants

Relevant ethical approval was gained to recruit 33 participating first-time mothers of infants aged 24 months into the study. Ethical permission to conduct this study was granted on 07/07/2011 by the University of Salford Research Ethics Committee Ref: REP11/088. A total of 33 mother-infant dyads participated, with 11 dyads in each of the study groups;

- i) Toothbrushing picture book intervention group receiving a book depicting containing photos and narrative depicting a dyadic toothbrushing episodes,
- ii) Handwashing picture book 'placebo control' intervention group receiving an equivalent book to those in the toothbrushing intervention group, but with photos and narrative depicting a dyadic handwashing episode. This was included to identify if any potential behavioural changes were simply due to an 'expectancy effect' from receiving an intervention that was not specific to the toothbrushing picture book intervention,
- iii) 'No treatment' control group receiving no picture book intervention.

Mothers were recruited within local Children's Centres and day nurseries and online via local mother's forums, Facebook and Twitter and resided in the Greater Manchester area in regions of the city representing a range of socio-economic backgrounds. In order to obtain more detailed demographic information of the sample in the study, type of occupation of mothers and level of education was evaluated. In order to evaluate employment types of mothers, the 'Registrar General's Scale of Social Class and Socio-economic Groups' was used to classify employment into the following categories; I) Professional, II) Managerial/Technical, IIIa) Skilled (non-manual), IIIb) Skilled (manual), IV)

Partly Skilled, V) Unskilled, VI) Other. The rationale for using this scale of social class was provided in Chapter Three section 3.2.2 'Participants'. Table 6.1 summarises demographic characteristics of mothers and infants in the sample.

Table 6.2- Demographic details of mothers in each of the three age groups (n= 11 per group)

	Toothbrushing book (n = 11)	Handwashing book (n = 11)	'No treatment' control (n = 11)
Infant Age	Mean 26.45 months (sd 2.38)	Mean age 25.64 (sd 2.25)	Mean 25.66 (sd 2.20)
Infant gender	6 male, 5 female	6 male, 5 female	5 male, 6 female
Maternal Age in years	Mean 34.92 (sd 6.50; range 25.67 – 45.00)	Mean 34.93 (sd 5.32; range 28.67 – 41.67)	Mean 33.23 (sd 4.98; range 25.17 – 40.58)
Maternal ethnicity	9 White-British (82%) 1 Caribbean (9%) 1 Chinese (9%)	11 White-British (100%)	10 White-British (91%) 1 African (9%)
Maternal marital status	7 Married (64%) 4 Co-habiting (36%)	10 Married (91%) 1 Co-habiting (9%)	10 Married (91%) 1 Co-habiting (9%)
Maternal current employment status	5 Part-time employment (46%) 4 Full-time employment (36%) 2 Full-time carer (18%)	5 Part-time employment (46%) 4 Full-time carer (36%) 2 Full-time employment (18%)	8 Part-time employment (73%) 1 Full-time employment (9%) 1 Full-time education (9%) 1 Full-time carer (9%)
Maternal employment type	4 Professional (37%) 3 Skilled, non-manual (27%) 3 Other (e.g. full-time carer) (27%) 1 Managerial/ technical (9%)	4 Skilled, non-manual (36%) 3 Other (e.g. full-time carer) (28%) 2 Professional (18%) 2 Managerial/technical (18%)	3 Professional (27%) 3 Managerial/technical (27%) 3 Skilled, non-manual (27%) 2 Other (e.g. full-time carer) (19%)
Maternal educational record	7 Higher education (64%) 2 Further education (18%) 2 Secondary education (18%)	8 Higher education (73%) 2 Further education (18%) 1 Secondary education (9%)	7 Higher education (64%) 3 Further education (27%) 1 Secondary education (9%)

6.2.3 Materials

Study documentation and assessment measures

The following materials were required for the study including a participant information sheet to inform participants about the study (see Appendix N), as well as a revised version of the newly developed toothbrushing PSE scale (see Appendix O). This revised version had unreliable items removed following the statistical standardisation reported in Chapter Four of the thesis and had 10-items to measure general self-efficacy added to it from the General Self-Efficacy (GSE) Scale (Schwarzer et al., 2008). Additionally, a measure of infant receptive and expressive language development, the Oxford Communicative Development Inventory (CDI, 2009; Hamilton et al., 2000), was also required (see Appendix P for sample pages of the CDI). Additionally, a demographic details questionnaire (see Appendix B) was required in order to allow information such as employment status and ethnicity to be gathered.

Intervention and data collection equipment

Copies of the 'intervention to increase maternal toothbrush control in dyadic toothbrushing' were required (see Appendix Q for example pages) and a 'placebo' handwashing picture book intervention (see Appendix R for example pages). Canon Legria FS306 camcorders and 2 gigabyte memory cards were required along with Joby Gorillapod® Original tripods and sets of camcorder use instructions (see Appendix M) to aid collection of observational data. Observer® XT software was also required for analyses of collected observational data.

6.2.4 Assessment Measures

A number of assessments were conducted in the study. These were as follows;

- i) Observational assessment of mother-infant bedtime dyadic toothbrushing and hand-washing episode. This assessment was conducted by the mother in order to ensure the observations were as naturalistic as possible. This assessment was conducted in order to detect any potential changes in duration and frequency of maternal-control of the toothbrush during toothbrushing in each of the 3 study groups. A number of the behavioural codes that were included in the coding schedule used in the observational study in Chapter Five were used to code observational data in this intervention study. These included those codes related to either maternal or infant control of holding and using the toothbrush, both when toothbrush holding and use resulted in the brush being inserted into the infants mouth, or resulted in the brush not being inserted into the infants mouth (see Section 6.2.1 'Design' for full list of behavioural codes used). As this is the first evaluation of the intervention, and it is not as yet known whether it will successfully increase maternal control of holding and using the toothbrush during dyadic toothbrushing sessions, general maternal control of holding and using the brush is assessed. That is, both maternal control of the brush that *does* and *does not* result in the brush being inserted into the infants mouth. More refined evaluation focussing on specifically maternal toothbrush control that solely results in the toothbrush being inserted into the infant's mouth may be appropriate once the effectiveness of the intervention at increasing maternal control of the brush has been established.

- ii) These behavioural codes correspond to the images included in the dyadic toothbrushing picture book intervention images which show either the caregiver or the infant included in the images being in control of holding and using the toothbrush at any one time. One single observational assessment was conducted at each of the following time points; pre-intervention, post-intervention (after 2-week intervention exposure period) and at follow-up (2-weeks after completion of the intervention exposure period) with all 3 study groups. Additionally, data from these observational assessments was used to assess predictive validity of the newly developed dyadic toothbrushing in infancy PSE scale by correlating observed behaviours with scores on the scale.
- iii) A revised version of the dyadic toothbrushing in infancy PSE scale, amended to remove unreliable items following the scale development study reported in Chapter Four of the thesis (see Appendix O) was also used to assess participating mothers. Development of this PSE scale is reported in Chapters Three and Four of the thesis. This assessment was conducted in order to ascertain whether the intervention had an effect on broader PSE for dyadic toothbrushing. PSE assessments were conducted pre-intervention, post-intervention (after 2-week intervention exposure period) and at follow-up (2-weeks after completion of intervention exposure period) with all 3 study groups in order to assess effectiveness of the toothbrushing picture book intervention and also to assess predictive validity of the newly developed toothbrushing PSE scale using observational data. The revised version of the PSE scale also had a 10-item measure of General Self-Efficacy (GSE) Scale (Schwarzer et

al., 2008) included within the items. This is included to allow assessment of the concurrent validity of the new dyadic toothbrushing in infancy PSE scale.

iv) The Oxford Communicative Development Inventory (see Appendix P) (CDI, 2009; Hamilton et al., 2000), which is a UK adaptation of the MacArthur-Bates CDI (Fenson et al., 2007) was used to assess receptive and expressive language skills of all infants at baseline and also to check infants in each of the three study groups had equivalent language skills. Due to the inclusion of a narrative in the picture book interventions, level of language skills of infants could have confounded response to the interventions. This 416 item caregiver-report assessment provides a measure of receptive and expressive language development between the ages of approximately 11 – 26 months. Although there is no available data on reliability and validity of the Oxford CDI, reliability of the MacArthur-Bates CDI items have been demonstrated to be $\alpha > .65$, and validity to be $\alpha > .50$ for concurrent and $\alpha > .50$ for predictive (Fenson et al., 2007). The Oxford CDI website (CDI, 2009) also provides a vocabulary size calculator that estimates vocabulary size from raw CDI score (Mayor and Plunkett, in press): <http://babylab.psy.ox.ac.uk/research/oxford-cdi/vocabulary-size-estimator-1>

6.2.5 Procedure

All Families: Following consent and enrolment to the study, families from all 3 groups were visited at home, where they were provided with a copy of the newly developed toothbrushing PSE scale and the Oxford CDI (Hamilton et al., 2000). At the first visit participating mothers were provided with these to measure baseline PSE and infant language skills, along with a freepost enveloped for returning their completed PSE scale and CDI.

During this first visit, each participating mother was also provided with a camcorder and instructions on how to use it (see Appendix M). Where necessary, the researcher helped each mother to set up the camcorder in an appropriate location within the household. Participating mothers were asked to record a total of 3 hygiene routines with their infant (comprised of toothbrushing and handwashing) at 2-weekly intervals over a 4-week study period. In addition to recording 3 hygiene routines over the 4-week study period, participating mothers were also required to complete the dyadic toothbrushing in infancy PSE scale a total of 3 times; at baseline during the first visit by the researcher (see above), post-intervention after a 2-week intervention exposure period, and finally after a 2-week follow-up period.

Intervention Groups: For the intervention groups ('intervention to increase maternal toothbrush control in dyadic toothbrushing' and handwashing 'placebo control' intervention), a picture book was also provided during the first visit by the researcher (either toothbrushing or handwashing) and a 2-week long daily exposure period to the picture book interventions was began. Each picture book intervention contained in its

first page standardised instructions on how to best use the picture book. Participants were advised to read the picture book with their infant each evening before bedtime, for a period of 2-weeks. See Appendix Q and R for the pages from these books.

Participants were also provided with a freepost envelope and instructed that after 2-weeks they would be text or phoned by the researcher (depending on the preference) and asked to post their picture book back to the researcher. See Figure 6.1 for an outline of study activities for the 'intervention to increase maternal toothbrush control in dyadic toothbrushing' and 'placebo' handwashing picture book intervention study groups and Figure 6.2 for an outline of activities for the 'no treatment' control group.

The Picture Book Interventions: The picture book interventions included in the study were, i) 'intervention to increase maternal toothbrush control in dyadic toothbrushing', a bedtime toothbrushing picture book containing photos of an approximately 24-month old infant having their teeth brushed by their caregiver, and ii) a handwashing picture book containing photos of the same approximately 24 month old infant having their hands washed by their caregiver. Prior to the formal start of the study, each of the two picture books were be piloted for a period of 2-weeks with two separate families to assess face validity and infant acceptance of the books. Each of the picture book interventions included the following common elements;

1. Each picture book intervention was in line with section 1.4 of the Early Learning Foundation Stage, 'Health and Well-Being' which states that infant's health is an important part of their emotional, mental, social, environmental & spiritual well-being. The picture book intervention was intended to support infants in developing an

understanding of the importance of toothbrushing/ handwashing for keeping them healthy.

2. Each picture book incorporated a number of evidence-based health behaviour change techniques (Abraham and Michie, 2008) as depicted in Table 6.2.

3. Each picture book intervention was also composed of a set of instructions for mothers on how to use the book, a number of colour photos depicting toothbrushing or handwashing with a corresponding narrative describing the events in the photos, page numbers, contents and index pages (in line with requirements for non-fiction books).

4. Colour photos were used to depict toothbrushing/ handwashing in the picture books as opposed to drawings. This is due to research already discussed in the thesis that has demonstrated infants are more able to imitate novel action sequences from pictures when the pictures reflect real life.

6.3 RESULTS

This section now provides findings from analyses conducted in order to examine the three hypotheses set relating to;

- i) Group related differences in frequency and duration of maternal holding and use of the toothbrush in tooth-brushing episodes following a 2-week intervention period. Additional analyses are also provided relating to group related differences in infant holding and use of the toothbrush.
- ii) The maintenance of group related differences in frequency and duration of maternal holding and use of the toothbrush 2-weeks after the termination of a 2-week intervention period. Additional analyses are also provided relating to group related differences in infant holding and use of the toothbrush.
- iii) Group related differences in PSE following a 2-week intervention period and a further 2-week follow-up period.

As all data were found to be non-normally distributed using Shapiro-Wilks Tests ($p \leq .05$), analyses presented are non-parametric, with all ANOVA's depicting Kruskal-Wallis tests.

6.3.1 Descriptive Statistics

As the picture book intervention contained text, each of the three study groups was assessed at the start of the study with the Oxford Communicative Development Inventory (CDI), in order to examine baseline differences between the groups in expressive and receptive language development. Table 6.3 provides CDI data for each of the three study groups. Scores are provided for expressive and receptive language for i) raw score on the CDI, ii) percentage score on the CDI, iii) estimated vocabulary size calculated using the CDI vocabulary size estimator

<http://babylab.psy.ox.ac.uk/research/oxford-cdi/vocabulary-size-estimator-1>

extrapolated from the CDI score. No significant differences were identified between the three study groups in either expressive or receptive language development.

Table 6.3- Expressive and receptive language scores for each of the three study groups at baseline

	Toothbrushing Group (n=11)	Handwashing Group (n=11)	Control Group (n=11)	df	F Ratio	P
Receptive raw score	375.78 (39.78)	340.57 (75.09)	371.12 (44.27)	2, 31	.959	.400
Receptive %	90.27 (9.55)	81.86 (18.05)	89.19 (10.62)	2, 31	.951	.402
Receptive size	681.00 (104.12)	597.57 (174.98)	669.62 (115.88)	2, 31	.887	.427
Expressive raw score	324.00 (91.12)	264.71 (123.48)	347.75 (58.56)	2, 31	1.559	.234
Expressive %	80.43 (21.94)	63.62 (29.68)	84.96 (14.62)	2, 31	1.707	.208
Expressive size	563.22 (206.80)	439.71 (29.68)	611.25 (147.26)	2, 31	1.429	.262

6.3.2 Group differences in frequency and duration of maternal control of holding and using the toothbrush

Tables 6.4 and 6.5 depict data for frequency and duration respectively of maternal control of holding and using the toothbrush when i) the toothbrush is inserted into the infant's mouth, ii) is *not* inserted into the infant's mouth, and ii) *total* duration of time maternal control of holding and using the toothbrush (both when brush inserted and not inserted into the infant's mouth). Each table depicts baseline data, data after a 2-week intervention exposure period, and also a 2-week post-intervention exposure follow-up period, and provides data from analyses between the three study groups at each of the three time points.

Table 6.4- Group differences in frequency of maternal control of the toothbrush during observed dyadic toothbrushing episodes

		Toothbrushing Group (n=11) Mean (sd)	Handwashing Group (n=11) Mean (sd)	No treatment Group (n=11) Mean (sd)	df	F	P
Baseline	Toothbrush <u>not inserted</u> into infant's mouth	5.91 (6.02)	3.91 (4.06)	6.18 (4.85)	2, 31	1.155	.561
	Toothbrush <u>inserted</u> into infant's mouth	4.82 (5.40)	3.36 (3.72)	5.09 (4.06)	2, 31	1.060	.588
	TOTAL frequency	10.73 (11.38)	7.27 (7.76)	11.27 (8.83)	2, 31	1.013	.603
Post-intervention	Toothbrush <u>not inserted</u> into infant's mouth	5.18 (4.87)	3.45 (3.42)	4.36 (3.72)	2, 31	.639	.726
	Toothbrush <u>inserted</u> into infant's mouth	4.36 (4.27)	2.82 (3.12)	3.45 (3.42)	2, 31	.764	.683
	TOTAL frequency	9.55 (9.05)	6.27 (6.51)	7.82 (7.07)	2, 31	.815	.665
2-week follow-up	Toothbrush <u>not inserted</u> into infant's mouth	4.64 (3.70)	5.09 (3.36)	3.64 (3.01)	2, 31	1.186	.553
	Toothbrush <u>inserted</u> into infant's mouth	3.73 (3.55)	3.91 (2.70)	2.55 (2.98)	2, 31	1.600	.449
	TOTAL frequency	8.36 (7.20)	9.00 (5.98)	6.18 (5.88)	2, 31	1.611	.447

Table 6.5- Group differences in duration of maternal control of the toothbrush during observed dyadic toothbrushing episodes

		Toothbrushing Group (n=11) Mean (sd)	Handwashing Group (n=11) Mean (sd)	No treatment Group (n=11) Mean (sd)	df	F	P
Baseline	Toothbrush <u>not inserted</u> into infant's mouth	33.65 (37.91)	25.36 (25.88)	34.97 (40.09)	2, 31	.336	.846
	Toothbrush <u>inserted</u> into infant's mouth	29.28 (36.72)	26.99 (24.38)	29.05 (23.33)	2, 31	.385	.825
	TOTAL duration	62.93 (70.47)	52.35 (41.56)	64.02 (61.33)	2, 31	.107	.948
Post-intervention	Toothbrush <u>not inserted</u> into infant's mouth	30.27 (31.01)	15.07 (11.65)	21.92 (21.01)	2, 31	.669	.716
	Toothbrush <u>inserted</u> into infant's mouth	27.41 (26.52)	20.13 (20.77)	19.79 (20.01)	2, 31	.258	.879
	TOTAL duration	57.68 (55.70)	35.20 (29.30)	41.71 (37.34)	2, 31	.704	.703
2-week follow-up	Toothbrush <u>not inserted</u> into infant's mouth	24.01 (19.23)	28.26 (30.99)	20.70 (17.90)	2, 31	.208	.901
	Toothbrush <u>inserted</u> into infant's mouth	31.95 (27.73)	27.58 (24.50)	24.84 (28.64)	2, 31	.809	.667
	TOTAL duration	55.96 (44.17)	55.84 (49.45)	45.54 (39.24)	2, 31	.422	.810

Data depicted in Tables 6.4 and 6.5 demonstrate that there were no significant differences between the three study groups at any of the three study data points (baseline, post intervention, follow-up).

In order to ascertain whether there were significant changes in frequency and duration of maternal control of holding and using the toothbrush *within* each group across the four-week study period, Friedman tests, the non-parametric equivalent of repeated-measures one-way ANOVA's, were conducted. These data are presented in Tables 6.6 – 6.8.

Table 6.6- Mother only holding and use across the four-week study period in the toothbrushing picture book group

		df	F Ratio	P
Mother only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	.439	.803
	duration	2, 31	.727	.695
Mother only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	1.135	.567
	duration	2, 31	3.200	.202
TOTAL mother only holding and use of the toothbrush	frequency	2, 31	1.000	.607
	duration	2, 31	1.273	.529

Table 6.7- Mother only toothbrush control across the four-week study period in the handwashing book group

		df	F Ratio	P
Mother only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	2.263	.323
	duration	2, 31	6.333	.042
Mother only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	2.579	.275
	duration	2, 31	.884	.643
TOTAL mother only holding and use of the toothbrush	frequency	2, 31	1.512	.469
	duration	2, 31	4.233	.120

Table 6.8- Mother only toothbrush control across the four-week study period in the 'no treatment' control group

		df	F Ratio	P
Mother only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	.780	.677
	duration	2, 31	2.930	.231
Mother only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	6.667	.036
	duration	2, 31	6.229	.044
TOTAL mother only holding and use of the toothbrush	frequency	2, 31	1.756	.416
	duration	2, 31	2.837	.242

Significant differences were found in *duration* of maternal control of holding and using the brush that did not result in the toothbrush being inserted into the infant's mouth in the *handwashing* picture book group. Kruskal-Wallis tests revealed that the significant difference lay between post-intervention and 2-week follow-up assessments ($p = .035$), with maternal holding and use significantly increasing between this period.

Additionally, differences were found in the 'no-treatment' control group across the 4-week study period in both frequency and duration of maternal control of holding and using the brush that resulted in the brush being inserted into the infant's mouth. Frequency and duration were significantly higher at baseline than at 2-week post-intervention follow-up (both $p = .02$).

6.3.3 Group differences in frequency and duration of infant control of holding and using the toothbrush

Tables 6.9 and 6.10 depict data for frequency and duration respectively of infant control of holding and using the toothbrush when i) the toothbrush is inserted into the infant's mouth, ii) is *not* inserted into the infant's mouth, and ii) *total* duration of time infant has control of holding and using the brush (both when brush inserted and not inserted into the infant's mouth). Each table depicts baseline data, data after a 2-week intervention exposure period, and also a 2-week post-intervention exposure follow-up period, and provides data from analyses between the three study groups at each of the three time points.

Table 6.9- Group differences in frequency of infant control of the toothbrush during observed dyadic toothbrushing episodes

		Toothbrushing Group (n=11) Mean (sd)	Handwashing Group (n=11) Mean (sd)	No treatment Group (n=11) Mean (sd)	df	F	P
Baseline	Toothbrush <u>not inserted</u> into infant's mouth	3.09 (3.94)	2.45 (2.62)	4.18 (3.37)	2, 31	1.906	.386
	Toothbrush <u>inserted</u> into infant's mouth	2.55 (3.53)	2.18 (2.52)	3.00 (2.57)	2, 31	1.187	.552
	TOTAL frequency	5.64 (7.42)	4.63 (5.05)	7.18 (5.90)	2, 31	1.406	.495
Post-intervention	Toothbrush <u>not inserted</u> into infant's mouth	4.36 (7.03)	3.45 (3.53)	3.55 (2.54)	2, 31	.528	.768
	Toothbrush <u>inserted</u> into infant's mouth	4.18 (6.79)	3.00 (3.44)	3.09 (2.70)	2, 31	.443	.801
	TOTAL frequency	8.55 (13.74)	6.45 (6.83)	6.64 (5.20)	2, 31	.274	.872
2-week follow-up	Toothbrush <u>not inserted</u> into infant's mouth	3.45 (3.62)	3.27 (2.57)	2.27 (2.33)	2, 31	.694	.707
	Toothbrush <u>inserted</u> into infant's mouth	3.00 (3.13)	3.09 (2.47)	1.64 (2.34)	2, 31	2.407	.300
	TOTAL frequency	6.45 (6.69)	6.36 (4.82)	3.91 (4.61)	2, 31	1.473	.479

Table 6.10- Group difference in duration of infant control of the toothbrush during observed dyadic toothbrushing episodes

		Toothbrushing Group (n=11) Mean (sd)	Handwashing Group (n=11) Mean (sd)	No treatment Group (n=11) Mean (sd)	df	F	P
Baseline	Toothbrush <u>not inserted</u> into infant's mouth	21.55 (28.01)	9.67 (9.87)	2 5.35 (25.89)	2, 31	2.256	.324
	Toothbrush <u>inserted</u> into infant's mouth	16.20 (27.68)	16.50 (20.24)	27.58 (25.15)	2, 31	2.394	.302
	TOTAL duration	37.75 (43.64)	26.17 (26.82)	52.93 (41.06)	2, 31	2.348	.309
Post-intervention	Toothbrush <u>not inserted</u> into infant's mouth	16.39 (23.75)	13.93 (13.51)	22.81 (21.57)	2, 31	1.474	.479
	Toothbrush <u>inserted</u> into infant's mouth	26.16 (35.28)	17.09 (21.61)	26.65 (26.84)	2, 31	.977	.614
	TOTAL duration	42.55 (55.97)	31.02 (25.87)	49.46 (37.14)	2, 31	1.515	.469
2-week follow-up	Toothbrush <u>not inserted</u> into infant's mouth	17.57 (17.83)	16.51 (13.64)	14.37 (17.80)	2, 31	.642	.725
	Toothbrush <u>inserted</u> into infant's mouth	20.94 (29.59)	24.68 (21.53)	23.90 (25.54)	2, 31	.774	.679
	TOTAL duration	38.51 (41.55)	41.19 (33.99)	38.27 (39.69)	2, 31	.268	.874

Data depicted in Tables 6.9 and 6.10 demonstrate that there were no significant differences between the three study groups at any of the three study data points (baseline, post intervention, follow-up).

In order to ascertain whether there were significant changes in duration and frequency of infant control of holding and using the toothbrush *within* each group across the four-week study period, Friedman tests, the non-parametric equivalent of repeated-measures one-way ANOVA's, were conducted. These data are presented in Tables 6.11 – 6.13.

Table 6.11- Infant only holding and use across the four-week study period in the toothbrushing picture book group

		df	F Ratio	P
Infant only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	1.515	.469
	duration	2, 31	.950	.622
Infant only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	1.459	.482
	duration	2, 31	.200	.905
TOTAL infant only holding and use of the toothbrush	frequency	2, 31	2.000	.368
	duration	2, 31	1.805	.406

Table 6.12- Infant only holding and use across the four-week study period in the handwashing picture book group

		df	F Ratio	P
Infant only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	3.941	.139
	duration	2, 31	1.590	.452
Infant only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	1.800	.407
	duration	2, 31	2.737	.255
TOTAL infant only holding and use of the toothbrush	frequency	2, 31	5.056	.080
	duration	2, 31	1.282	.527

Table 6.13- Infant only holding and use across the four-week study period in the 'no treatment' control group

		df	F Ratio	P
Infant only- toothbrush <u>NOT inserted</u> into infant's mouth	frequency	2, 31	5.590	.061
	duration	2, 31	2.600	.273
Infant only- toothbrush <u>inserted</u> into infant's mouth	frequency	2, 31	8.432	.015
	duration	2, 31	2.513	.285
TOTAL infant only holding and use of the toothbrush	frequency	2, 31	5.600	.061
	duration	2, 31	4.200	.122

The only significant differences found in the 'no treatment' control group. Significant differences were found across the 4-week study period in frequency of infant only control of holding and using the toothbrush that resulted in the toothbrush being inserted into the infant's mouth. Post hoc Kruskal-Wallis analyses revealed that in the 'no treatment' control group, frequency of infant control of holding and using the toothbrush that resulted in the toothbrush being inserted into the infant's mouth was higher after 2-week post-intervention follow-up than at baseline ($p = .011$) and after the 2-week intervention period ($p = .020$).

6.3.4 Group differences in dyadic toothbrushing in infancy PSE and maternal GSE

Table 6.14 depicts data for mothers dyadic toothbrushing in infancy PSE and general self-efficacy (GSE). Shapiro-Wilk tests revealed that all data were normally distributed ($p > .05$). Each table depicts baseline data, data after a 2-week intervention exposure period, and also a 2-week post-intervention exposure follow-up period, and provides data from analyses between the three study groups at each of the three study data points. At all three time points, GSE for each of the three study groups was slightly higher than the 29.28 mean score derived from normative data from a sample of 1600 heterogeneous adults (Schwarzer, 2008). No significant differences were found between the three groups at any of the three study time points in GSE or PSE.

Table 6.14- Group differences in mother's dyadic toothbrushing in infancy PSE and GSE

		Toothbrushing	Handwashing	No treatment			
		Group (n=11)	Group (n=11)	Group (n=11)	df	F	P
		Mean (sd)	Mean (sd)	Mean (sd)			
Baseline	TOTAL PSE	65.78 (7.51)	63.43 (12.54)	58.75 (13.39)	2, 31	.847	.443
	TOTAL GSE	31.75 (5.99)	34.67 (3.56)	32.83 (3.06)	2, 31	.688	.516
Post-intervention	TOTAL PSE	70.00 (8.34)	67.00 (13.07)	60.00 (13.30)	2, 31	1.535	.241
	TOTAL GSE	32.12 (5.06)	33.17 (4.26)	30.71 (1.98)	2, 31	.608	.555
2-week follow-up	TOTAL PSE	69.14 (11.65)	66.80 (10.90)	64.50 (14.83)	2, 31	.219	.806
	TOTAL GSE	33.43 (4.69)	32.60 (4.56)	30.60 (1.82)	2, 31	.729	.500

6.3.5 Correlations between dyadic toothbrushing in infancy PSE and GSE

In order to examine the associations between dyadic toothbrushing in infancy PSE and GSE, correlations were conducted between dyadic toothbrushing in infancy PSE and GSE scores for each of the three study data points. As Shapiro-Wilks tests revealed all data were normally distributed ($p \geq .05$), parametric Pearson's correlations were conducted. Table 6.15 provides data for correlations between dyadic toothbrushing in infancy PSE and GSE scores. No significant correlations were found between dyadic toothbrushing in infancy PSE and GSE scores at either baseline, post-intervention, or at follow-up indicating weak associations between dyadic toothbrushing in infancy PSE and GSE. Additionally, correlations were conducted for change scores between baseline - post 2-week intervention period ($r = -.131, p = .603$), and post 2-week intervention period - 2-week post-intervention follow-up ($r = .104, p = .691$). No significant correlations were found.

Table 6.15- Correlations between dyadic toothbrushing in infancy PSE and GSE at the three study points and correlations between changes in PSE and GSE scores

		Mean Score (sd)	Correlation coefficient	P
Baseline	PSE	62.75 (11.16)	.069	.771
	GSE	32.95 (4.54)		
Post-intervention	PSE	65.55 (11.96)	.167	.468
	GSE	31.95 (3.96)		
2-week follow-up	PSE	66.94 (12.03)	.445	.073
	GSE	32.35 (3.96)		

6.3.6 Correlations between observed toothbrushing behaviours and dyadic toothbrushing in infancy PSE and GSE

In order to ascertain whether scores on the dyadic toothbrushing in infancy PSE scale or scores on the GSE scale were associated with observed toothbrushing behaviours, correlations were conducted between changes in observed behaviours and changes in self-efficacy scores. Separate correlations were conducted for change scores between baseline - post 2-week intervention period, and post 2-week intervention period - 2-week post-intervention follow-up.

As Shapiro-Wilks tests revealed observational data to be non-normally distributed, non-parametric Spearman's Rho correlations were conducted. Tables 6.17 and 6.17 depict the findings from these correlations. Significant correlations are indicated as ** $p \leq .01$; * $p \leq .05$.

Table 6.16- Correlations between changes in observed toothbrushing behaviours and changes in self-efficacy scale scores (PSE and GSE) between baseline and post 2-week intervention period

Behavioural Measure		Correlation coefficient (P value)	
		Infant Toothbrushing PSE	GSE
Mother only- toothbrush <u>NOT inserted</u> into infant's mouth	Frequency	-.275 (.216)	-.023 (.929)
	Duration	-.225 (.315)	-.081 (.748)
Mother only- toothbrush <u>inserted</u> into infant's mouth	Frequency	.316 (.152)	-.054 (.832)
	Duration	.046 (.839)	.259 (.299)
TOTAL mother only holding and use of the toothbrush	Frequency	-.206 (.357)	.084 (.740)
	Duration	-.196 (.383)	.236 (.346)
Infant only- toothbrush <u>NOT inserted</u> into infant's mouth	Frequency	.074 (.743)	-.299 (.228)
	Duration	-.114 (.614)	-.363 (.138)
Infant only- toothbrush <u>inserted</u> into infant's mouth	Frequency	-.004 (.986)	-.388 (.112)
	Duration	.071 (.754)	-.032 (.899)
TOTAL infant only holding and use of the toothbrush	Frequency	.071 (.752)	-.329 (.182)
	Duration	-.163 (.372)	-.172 (.494)

The correlational analyses in Table 6.16 reveal no significant correlations between changes in dyadic toothbrushing in infancy PSE scale or scores on the GSE scale between baseline and the post 2-week intervention period.

Table 6.17- Correlations between changes in observed toothbrushing behaviours and changes in self-efficacy scale scores (PSE and GSE) between post 2-week intervention period and 2-week post-intervention follow-up.

Behavioural Measure		Correlation coefficient (P value)	
		Infant Toothbrushing PSE	GSE
Mother only- toothbrush <u>NOT inserted</u> into infant's mouth	Frequency	-.150 (.552)	.154 (.554)
	Duration	-.125 (.620)	-.105 (.688)
Mother only- toothbrush <u>inserted</u> into infant's mouth	Frequency	-.008 (.975)	.044 (.865)
	Duration	.007 (.977)	-.287 (.264)
TOTAL mother only holding and use of the toothbrush	Frequency	-.066 (.795)	.110 (.674)
	Duration	-.111 (.662)	.235 (.364)
Infant only- toothbrush <u>NOT inserted</u> into infant's mouth	Frequency	-.079 (.755)	-.317 (.216)
	Duration	-.023 (.928)	-.377 (.136)
Infant only- toothbrush <u>inserted</u> into infant's mouth	Frequency	.076 (.766)	-.257 (.320)
	Duration	.007 (.977)	-.287 (.264)
TOTAL infant only holding and use of the toothbrush	Frequency	-.025 (.921)	-.316 (.217)
	Duration	.006 (.980)	-.345 (.175)

The correlational analyses in Table 6.17 reveal no significant correlations between changes in dyadic toothbrushing in infancy PSE scale or scores on the GSE scale between post 2-week intervention period and 2-week post-intervention follow-up.

6.4 DISCUSSION

This study sought to examine the effectiveness of a picture book intervention in increasing the frequency and duration of maternal holding and use of the toothbrush during dyadic toothbrushing episodes with infants aged 24-months. This picture book intervention was also intended to reduce the frequency and duration of infant holding and use during dyadic toothbrushing episodes. This study also additionally sought to provide preliminary predictive validity data for a new dyadic toothbrushing in infancy PSE scale. This section now provides a discussion of the main findings from the study with reference to previously published research findings, and also suggests a number of limitations to the study and ideas for further research.

6.4.1 Overview of the Main Findings

i) Effectiveness of the toothbrushing picture book intervention

Overall, the toothbrushing picture book did not appear to have the desired effect, i.e. it did not appear to significantly increase the frequency and duration of maternal holding and use of the toothbrush during dyadic toothbrushing episodes with infants. When compared with two control groups (a 'placebo' handwashing intervention group and 'no treatment' control group), the toothbrushing picture book group did not significantly differ from these control groups on frequency and duration of *maternal* holding and use of the toothbrush during dyadic toothbrushing episodes with infants. A lack of significant differences were identified between the toothbrushing picture book group and the two control groups at baseline, post 2-week intervention exposure period, and also 2-week follow-up period. Additionally, when compared with the two control groups, there also

did not appear to be any significant differences between the toothbrushing picture book group and the two control groups in frequency and duration of *infant* holding and use of the toothbrush.

When frequency and duration of maternal holding and use of the toothbrush was examined in the toothbrushing picture book intervention group across the 4-week study period, there did not appear to be any significant changes in maternal holding and use of the brush. There were however some unexpected changes across the 4-week intervention period in both maternal and infant holding and use of the toothbrush, in each of the two control groups.

In the 'placebo' control handwashing picture book intervention group, there appeared to be a significant increase in the duration of maternal holding and use of the brush that did result in the brush being inserted into the infant's mouth, between the post-intervention and 2-week follow-up period. Additionally, in the 'no treatment' control group, there appeared to be a significant decrease in frequency and duration of maternal holding and use of the toothbrush that resulted in the brush being inserted into the infant's mouth, between baseline and post the 2-week intervention exposure period. Further significant changes in the 'no treatment' control group were found in relation to frequency of infant holding and use of the toothbrush that resulted in the brush being inserted into the infant's mouth. Frequency of this was significantly higher at post 2-week intervention period than at baseline or 2-week follow-up.

Overall these findings would suggest that the ‘intervention to increase maternal toothbrush control in dyadic toothbrushing’ did not have a significant effect on the duration and frequency of maternal and infant holding and use of the toothbrush during dyadic toothbrushing sessions with infants. The unexpected findings from the two control groups could be spurious, and accounted for by unmeasured factors such as infant behavioural and developmental factors, or simply due to the fact that the sample size was relatively small, with just 11 dyads in each of the three study group.

The main findings related to the effect of the toothbrushing picture book intervention are relatively clear, that is, dyads exposed to the toothbrushing book did not appear to significantly differ in frequency and duration of either maternal or infant holding and use of the toothbrush when compared to dyads not exposed to the toothbrushing picture book. Neither did the frequency and duration of maternal or infant holding and use of the toothbrush change significantly over the 4-week study period, in the toothbrushing picture book exposed group.

ii) Predictive validity of the toothbrushing PSE scale

No group differences were found between the three study groups in either dyadic toothbrushing in infancy PSE or GSE at any of the three study assessment points. There were also no significant associations between scores for dyadic toothbrushing in infancy PSE or GSE. Additionally, correlational analyses revealed no significant correlations between changes in dyadic toothbrushing in infancy PSE scale or scores on the GSE scale between baseline and the post 2-week intervention period. Further, there were no significant correlations between changes in dyadic toothbrushing in infancy PSE scale or

scores on the GSE scale between post 2-week intervention period and 2-week post-intervention follow-up. These findings would indicate that the intervention had no significant effect on either dyadic toothbrushing in infancy PSE or GSE, and that the scores on the scales designed to measure these two forms of self-efficacy had no significant association with one another. Additionally, the predictive validity of the dyadic toothbrushing in infancy PSE scale was not established as observed behaviours were not significantly associated with scores on this scale.

6.4.2 Comparison of main findings with previous research findings

Unfortunately the significant findings generated in the Houston-Price et al. (Houston-Price et al., 2009a; Houston-Price et al., 2009b) were not replicated in this study. In the Houston-Price et al. studies, infants aged approximately 2-years were seen to have their food preferences altered due to exposure to pictures of fruits and vegetables. In their observational study, infants were more likely to prefer fruits and vegetables when they had been exposed to pictures of these fruits and vegetables for a period of 2-weeks. Additionally, the developmental literature has previously demonstrated that by 24-months, infants should be able to imitate sets of novel action sequences when exposed to these novel action sequences via pictures (e.g. Brito et al., 2012; Simcock and DeLoache, 2006; Simcock and Dooley, 2007). Furthermore, in their infant dental health picture book intervention, Mazzochi & Moretti (1997), demonstrated that the dental health behaviours of primary school aged children could be altered using a similar method.

The reasons why the toothbrushing behaviours in infants in the present study did not appear to be altered due to exposure to the toothbrushing picture book are unknown. Perhaps toothbrushing and the behaviours expected of an infant during dyadic toothbrushing which should be conducive to maternal control of holding and using the brush to predominate, are too complex to be altered via such a simple intervention method. Most dental health interventions, and particularly those designed to alter children's behaviour around toothbrushing, are multi-component, incorporating perhaps not just an exposure method, such as the one used in this intervention, but also reward and reinforcement using methods such as sticker charts.

It was also unknown how regularly mothers read the picture book with their infant during the 2-week intervention exposure period. Although mothers were asked to complete a tick chart at the back of the book to provide a record of how many times they had read the book, not all mothers remembered to do this. Therefore, it may be possible that although mothers were asked to read the book with their infant every evening for the 2-week exposure period, this may not have happened. This is especially likely in light of how busy mothers are when caring for infants whilst simultaneously managing other responsibilities such as household chores, caring for other family members and being in full- or part-time employment.

6.4.3 Limitations to the Study

The principal limitations of this study relate to the sample size used, which both in terms of assessing the effectiveness of the 'intervention to increase maternal toothbrush control in dyadic toothbrushing', and also in assessing the predictive validity of the toothbrushing PSE scale, may have impacted upon the findings generated. Firstly, in studies of interventions a power calculation would usually be conducted in order to estimate the minimum sample size required in order to be able to detect a change in any study group due to intervention effects. As this was a pilot study, and also due to time and resource constraints only a small sample was included in the study. Therefore, intervention effects may not have been detected due to the sample size being too small. The sample size issue is also relevant to the toothbrushing PSE scale predictive validity element of the study as the total sample of 33 is rather small for a scale development or validation study. However, as with the intervention effect element to the study, the predictive validity element was intended to generate only pilot data.

A further limitation, which has been relevant to all the studies presented in the thesis, is that the sample included a group of motivated, self-selecting mothers from Greater Manchester. This might mean that this group of mothers participating in the study may have been coping relatively well with retaining control of the toothbrush during dyadic toothbrushing, compared to mothers who may have been less motivated and perhaps might have been coping less well. This might have meant that mothers in this study were in fact controlling use of the toothbrush as much as is feasibly possible with 24-month infants who may be exhibiting a strong drive towards engaging in self-toothbrushing. If

this is the case the intervention may not have been able to increase maternal control of holding and using the toothbrush.

Additionally, and alluded to in the previous section, the degree of compliance with the intervention was unknown, as most mothers forgot to complete the exposure recording sheet at the back of the picture book. However, even if these exposure sheets had been completed, it still would not have provided a completely reliable record of the number of time each mother read the picture book with their infant due to the unreliability of self-reports, which has been an underlying recurring theme throughout the thesis.

One other limitation may relate to the accuracy of the CDI expressive and receptive language assessment that was used to examine baseline differences between the three study groups. The accuracy of maternal self-reports have been raised about the reliability of the CDI to estimate an infant's true language development. In two studies of groups of 29 and 113 infants, mothers underestimated the number of words their infant had knowledge of (Houston-Price et al., 2007). This may indicate that the CDI may not provide as accurate an assessment of an infant's receptive and expressive language skills as other professionally-administered assessments. Therefore, although the CDI data collected at the beginning of this picture book intervention study indicated no significant baseline differences in either receptive or expressive language between the three study groups, this finding may not be reliable. If any undetected language level differences did exist between the three study groups at baseline, then this could have acted as a confound, potentially affecting the findings related to toothbrushing behaviours within each group. For example, if the toothbrushing picture book group had in fact had lower levels of

receptive and expressive language at baseline than the two control groups, this may have affected how the toothbrushing picture group responded to the intervention.

6.4.4 Further Study

The principal way in which this study could be extended through further work is by the inclusion of further components into the 'intervention to increase maternal toothbrush control in dyadic toothbrushing' in order to increase its complexity and therefore its effectiveness. Health behaviour change is a difficult and complex process, and the likelihood of a multi-component intervention being effective may be higher than a single component intervention such as the toothbrushing picture book intervention developed and evaluated in this study. The decision was made to include just the picture book component to the intervention in the study in order to provide a starting point to deduce the minimum level of intervention complexity. For example, if the picture book intervention had changed dyadic toothbrushing holding and using behaviour significantly, then this simple intervention technique could be provided to caregivers on its own.

The data from the study demonstrated that simply using the picture book component on its own did not result in behaviour change, however. Therefore, it may be worthwhile to add extra components in a step-wise manner, evaluating the effectiveness of the intervention at each step, in order to ascertain the minimum number of components required before behaviour change was achieved. Such extra components might include reward charts, demonstration to caregivers of best dyadic toothbrushing practices, or direct maternal advice for dealing with infant non-compliance during dyadic

toothbrushing episodes. It may also be informative to assess the effectiveness of the intervention on older children, as the inclusion of text in the intervention picture book may have meant that the complexity of the text had a confounding effect, affecting infant's response to it. Further development of the intervention should also include larger samples following power calculations to ascertain the minimum sample size required to detect behavioural change as a result of the intervention.

CHAPTER SEVEN: OVERALL DISCUSSION OF FINDINGS FROM THE STUDIES PRESENTED IN THE THESIS

7.1 Introduction

This thesis has sought to explore influences on the emergence of toothbrushing as a dyadic process with dyads containing novice mothers and first-born infants. These influences were considered in light of how they may be perceived as barriers or facilitators of the establishment of toothbrushing as a dyadic process, and conceptualised throughout the thesis using Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

The thesis has had a more specific focus on microsystem influences pertaining to the caregiver-infant dyad, as the wider developmental psychology literature has indicated that it is at the level of the dyad that many of the most immediate influences on general infant development may lie. Such dyadic influences include infant temperament and behaviours (e.g. Caspi et al., 2003), and caregiver cognitions and infant-care behaviours (e.g. Bornstein et al., 2011). Additionally, the dental health behaviour literature has indicated that it is at the level of the dyad where many influences on early dental health behaviours may lie, including child behaviours (AAPD, 2011b; Amin and Harrison, 2009; Huebner and Riedy, 2010), and caregiver cognitions such as parental self-efficacy (PSE) (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010).

A total of four innovative studies have been presented in the thesis, each employing a different methodology to examine influences on the emergence of toothbrushing with infants. Findings from these studies provide unique insights into these influences and how they may contribute to the emergence of toothbrushing as a dyadic process through infancy. Most of these influences have been found to lie at the level of the caregiver-infant dyad, which is conceptualised as being located within the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). However, other influences lying at more distal levels of the model have also been found.

A number of these dyadic influences have been identified as acting as potential facilitators of the emergence of toothbrushing as a dyadic process, and some influences have been identified as potential barriers to enforcing dyadic toothbrushing. Some of the identified barriers may potentially contribute to the routines developing in such a way that it may be ineffective in providing optimal protection against dental caries in early childhood. Potential methods of identifying caregivers who may be at risk of having difficulties enforcing effective dyadic toothbrushing in order to protect their infant from caries have therefore been developed as part of the work presented in the thesis.

This discussion chapter now presents the overall findings from the studies presented in the thesis in relation to how they provide an original contribution to the already published literature, literature which still requires substantial contributions in order to increase the evidence-base around influences on dental caries in infancy. Limitations of the research presented are also explored, along with potential avenues for future

research. How the findings from the thesis contribute to informing future research, clinical practice and public policy around infant and child dental health are also discussed.

7.2 Main Findings- Microsystem Influences on Emergence of Toothbrushing as a Dyadic Process through Infancy

The main focus of the thesis was to explore influences on the emergence of toothbrushing as a dyadic process through infancy with dyads containing novice mothers and first-born infants. Therefore, a summary of how the thesis has contributed to the evidence-base around this is first provided, with findings conceptualised using Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). There is tentative evidence in the previously existing literature that influences from the caregiver-child dyad located in the microsystem of the ecological model, including difficult child temperament and behaviours, may cause enforcing dyadic toothbrushing routines to be problematic (AAPD, 2011b; Amin and Harrison, 2009; Huebner and Riedy, 2010). The literature also provides some indications that caregiver cognitions, such as PSE, may play a key role in enabling caregivers to overcome difficulties in the establishment toothbrushing as a dyadic process (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010).

These previously published findings have largely been corroborated by the studies presented in the thesis, and most importantly have been significantly extended. Several original findings have been generated via the empirical work reported in the thesis that

contribute to a clearer understanding of these microsystem influences on the emergence of toothbrushing as a dyadic process through infancy, specifically those located at the level of the caregiver-infant dyad. A discussion of each of the thesis findings around microsystem influences on the emergence of toothbrushing as a dyadic process is now provided. Infant level influences are discussed first, followed by parent level influences.

7.2.1 Infant Level Influences on Dyadic Behaviours during Toothbrushing

Some of the key findings from the thesis studies relate to the ways in which developing infant behaviours may influence the emergence of toothbrushing as a dyadic process. Mothers in the qualitative interview study presented in Chapter Three reported that as their infant's developed, their behaviours during dyadic toothbrushing episodes grew increasingly more difficult. Infants were reported as displaying such non-compliant, difficult behaviours as defiance, tantrums, biting and grabbing the toothbrush, and refusing to open their mouth. Additionally, within the interview study and the cross-sectional observational study presented in Chapter Five, it was found that infants at around 18-months of age were engaging in self-toothbrushing in which they had principal control of holding and using the toothbrush to brush their own teeth. Both from the qualitative interview and observational studies, new evidence has been provided that indeed many infants are brushing their own teeth at a substantially younger age than the currently recommended age of seven-years (AAPD, 2011b; BDHF, 2010; NHS, 2009).

There have been suggestions in the literature that this may be a problem, and that many children may be engaging in autonomous self-toothbrushing at a younger age than they could conceivably be able to do this effectively (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). From the observational study presented in the thesis, this self-toothbrushing did not appear to be common in infants aged 12-months, but by 18-months, and through to 24-months, infant toothbrush holding and use during self-toothbrushing appeared to become increasingly common. This finding concurs with those from previous observational studies (Martins et al., 2011; Zeedyk et al., 2005) that suggest that by 2.5 years, many infants may have significant control of holding and using the brush during dyadic toothbrushing.

Data from the observational study reported in the thesis make an original contribution, as although two previous dyadic toothbrushing observational studies have been conducted (Martins et al., 2011; Zeedyk et al., 2005), neither of these two studies have examined how the routine begins from the first year of life. Each of these previous studies included dyads containing infants over 24-months. The observational study presented in the thesis therefore extends the literature by indicating that self-toothbrushing may manifest at the age of around 18-months. However, the observational study presented in the thesis also demonstrates that initial infant grabbing of the toothbrush may occur at as young an age as 12-months. This 'grabbing' behaviour may act as important precursor behaviour to full infant autonomous self-toothbrushing.

Taken together the findings from the studies reveal how these infant influences may contribute to some of the issues identified in previous work around early self-toothbrushing in early childhood (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). Findings from the thesis studies suggest that at as young an age as 12-months, infant's developing increasing drive for autonomy (Dix et al., 2007; Erikson, 1968; Newman and Newman, 2008) may extend to toothbrushing. The thesis findings also suggest that this may then develop into full self-toothbrushing behaviours as infants develop through infancy to the age of 24-months. This was reported by mothers interviewed as sometimes making it more difficult for them to enforce caregiver control of holding and using the toothbrush during dyadic toothbrushing as the dental guidelines recommend (NHS, 2009; AAPD, 2011b). This drive for autonomous self-toothbrushing was also reported by mothers as sometimes being a cause of conflict within the mother-infant dyad, contributing to infant behavioural difficulties with defiant, non-compliant behaviours that caused the process of dyadic toothbrushing with infants to be stressful.

How caregivers manage difficulties with infant behaviours during dyadic toothbrushing may lead to a break-down of the routines in infancy, causing the behaviour to emerge in such a way that it is not aligned with the dental guidelines. Such infant behaviour issues have never before been examined in such detail. Previously published work (AAPD, 2011b; Amin and Harrison, 2009; Huebner and Riedy, 2010) has provided tentative insights into dyadic influences on toothbrushing with infants, but has not set out to systematically examine precisely *how* these dyadic influence the emergence of toothbrushing as a dyadic process through infancy. At present, the difficulties that

developing infant behaviours may cause for caregivers as they are attempting to establish and maintain early, effective, dyadic toothbrushing routines have not been sufficiently acknowledged in dental guidelines provided to caregivers. This may be in part be due to the previous lack of evidence-base around these issues, and may have previously resulted in caregivers being unprepared for such infant behavioural difficulties around dyadic toothbrushing.

None of the previously published work has intended to study how infant behaviour may influence the emergence of toothbrushing as a dyadic process through infancy, from their *inception in the first year of life*, which was one of the main aims of the thesis. The findings from the thesis studies therefore extend the literature and provide key, detailed insights into the early influences on the emergence of toothbrushing and how these may contribute to early self-toothbrushing. The new evidence provided by the thesis studies therefore contributes to anticipatory guidance being made available to novice mothers that may allow them to be prepared for the difficulties their first-born infant's behaviour may cause to enforcing effective dyadic toothbrushing that are conducted by the caregiver.

It is worthy of note however, that not all infants may be engaging in self-toothbrushing. Some mothers in the studies presented in the thesis played a significant role in brushing their infant's teeth, and were able to perhaps overcome any difficulties caused by infant behaviour, retaining principal control of holding and using the toothbrush during dyadic toothbrushing. The reason why some caregivers may be able to overcome these problems, and some may not, may be related to caregiver influences such as caregiver

parenting practices and also caregiver cognitions such as PSE (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010). These potential caregiver influences are now discussed, with specific reference to the *maternal* influences explored with mothers participating in the studies reported in the thesis empirical chapters.

7.2.2 Mother Level Influences on Dyadic Toothbrushing- Self-Efficacy and Parenting Behaviours

In addition to examining *infant* level influences on the emergence of toothbrushing as a dyadic process through infancy, one of the key aims of the thesis studies was to explore the potential roles of *maternal* influences. Additionally, the role of PSE in influencing the establishment and maintenance of the routine was specifically explored as the published literature has indicated that this caregiver cognition may be associated with both child dental care behaviours and dental health status (Adair et al., 2004; Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007b; Huebner and Riedy, 2010). Such caregiver influences may be conceptualised as lying at the level of the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006).

Data from the qualitative interview study supported the suggestion that PSE may be implicated in the emergence of toothbrushing as a dyadic process through infancy. Some of the novice mothers included in the study reported that they had confidence in their ability to succeed in establishing toothbrushing as a dyadic process with their first-born

infant, and that this confidence was important to their being able to overcome barriers to the routines being enforced in the face of difficulties. Mothers in the study cited difficult infant behaviours as often being key barriers they faced, and that they had to have true confidence in their parenting skills in order to be able to overcome these specific difficulties.

Using the qualitative interview data to develop scale items, a psychometric scale to measure novice mothers PSE for establishing toothbrushing as a dyadic process with infants was developed and subsequently found to be statistically reliable and contain five key components. The five components of the dyadic toothbrushing in infancy PSE scale each contained a number of items that measured novice mothers PSE for coping with different kinds of challenges when establishing toothbrushing as a dyadic process with first-born infants. These included such issues as incorporating the best-practice dental guidelines into dyadic toothbrushing, coping with conflict situations around difficult infant behaviours, and utilising positive parenting practices.

Although this scale was developed using the current state-of-the-art methods for psychometric scale development, the predictive validity of this scale was not established through comparison of scale scores with dyadic toothbrush holding and use behaviours during observed toothbrushing episodes. Observational data for predictive validity assessment of the scale were provided by observational data collected to evaluate the 'intervention to increase maternal toothbrush control in dyadic toothbrushing' evaluated in Chapter Six of the thesis. In order to establish predictive validity of the dyadic toothbrushing in infancy PSE scale, changes in total PSE scores on the scale were

calculated across the two, 2-week intervention study periods; baseline to post 2-week intervention period, and post 2-week intervention period to 2-week post-intervention follow-up. Then, changes in PSE scores were correlated with changes in frequency and duration of mother and infant control of holding and using the toothbrush during dyadic toothbrushing episodes across the two, 2-week intervention study periods. There were no significant correlations identified between changes in dyadic toothbrushing in infancy PSE scale scores and changes in frequency and duration of mother and infant control of holding and using the toothbrush during observed dyadic toothbrushing episodes.

In addition to providing indications as to how cognitions such as PSE may be associated with dyadic toothbrushing behaviours, the studies presented in the thesis also revealed some of the parenting behaviours that may be used to overcome some of the infant behaviour difficulties described in the previous section. In the qualitative interview study, mothers reported using a range of positive parenting techniques, such as rewarding compliant behaviour, making dyadic toothbrushing with infants enjoyable for their infant, and also indulging their infant's drive for autonomous self-toothbrushing by allowing them to have a go at brushing their own teeth at the end of toothbrushing episodes.

The findings related to mother's cognitions and behaviours around dyadic toothbrushing extend the previously published literature as never before have these been explored in such detail with mothers of infant's in their first year of life. Previous studies have tended to include caregivers of older children (e.g. Amin and Harrison, 2009; Huebner and Riedy, 2010), and have also never solely focussed on *novice mothers of first-born infants*. By including novice mothers who have no previous experience of establishing dyadic

toothbrushing with infants, the studies presented in the thesis provide a unique insight into the challenges when attempting to navigate this particular child-care task for the first time. This therefore provides an impression of the full gamut of difficulties potentially experienced by caregivers when establishing toothbrushing as a dyadic process with infants when they do not have the benefit of previous experience. This information may be important for preparing novice caregivers for the kinds of parenting skills required when they encounter challenges during the establishment toothbrushing as a dyadic process with infants, and may contribute to the development of anticipatory guidance and intervention strategies.

Taken together, the findings around *dyadic level* influences on the emergence of dyadic toothbrushing provide some indications for anticipatory guidance for caregivers around some of the challenges they may face when attempting to enforce dyadic toothbrushing throughout infancy. These dyadic influences, lying within the microsystem of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) would appear to be key to dyadic toothbrushing being enforced to effectively prevent early childhood caries (ECC). However, findings from the studies presented in the thesis suggest other influences on dyadic toothbrushing, which may be conceptualised as lying at more distal level of the ecological model. These more distal influences are also now discussed.

7.3 Influences on Dyadic Toothbrushing from More Distal Levels of the Ecological Model

In addition to the influences already discussed that have been conceptualised as lying at the level of the mother-infant dyad within the microsystem of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), other influences that lie at more distal levels of the model were also explored throughout the thesis. Although the central focus of the thesis was the microsystem, and the mother-infant dyad more specifically, these more distal influences warrant discussion.

In the qualitative interview study presented in Chapter Three, findings would indicate that health care professionals, including health visitors and dentists, may be providing very little advice to caregivers about infant toothbrushing. Such professional advice may be conceptualised as lying at the exosystem of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Aside from informing caregivers at what age infant toothbrushing should start, very little anticipatory guidance is available around infant toothbrushing. For example, how caregivers might best navigate their way through some of the more challenging aspects of infant development that may act as barriers to effectively conducted, caregiver-controlled dyadic toothbrushing, does not appear to be a source of advice that caregivers currently receive.

Indeed, the findings from the interview study reported in Chapter Three would indicate that the principal sources of support and advice around infant toothbrushing come from caregiver's family and friends, conceptualised as lying at the mesosystem and exosystem

of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006). Additionally, intergenerational transmission of toothbrushing practices also appeared to influence the self-reported toothbrushing practices of mothers in the interview study. The transmission of toothbrushing practices through the generations could be conceptualised as lying at the level of the chronosystem of the ecological model.

It would appear that findings from the studies reported in the thesis need to be communicated to professionals working with mothers and infants, as currently mothers do not appear to be being provided with information and guidance around the potential challenges they may face during dyadic toothbrushing with their developing infant. Advice in the form of anticipatory guidance around how to overcome these challenges to infant toothbrushing, such as caregiver retention of control of the toothbrush, may be informed by the findings across the thesis studies. Indeed, a key aim of the thesis was to develop methods of changing dyadic behaviour during infant toothbrushing to improve effectiveness of infant toothbrushing in the prevention of caries. The findings around this thesis aim are now discussed.

7.4 Changing Dyadic Behaviours during Toothbrushing in Infancy

In addition to seeking to understand the various influences on the emergence of toothbrushing as a dyadic process through infancy, the studies presented in the thesis also sought to develop methods to both identify and then support caregivers at risk of having difficulties establishing and maintaining the routine. These aims were fulfilled

firstly via the development of a novel early dyadic toothbrushing in infancy PSE scale, which was intended to allow the identification of novice caregivers with low PSE for establishing toothbrushing as a dyadic process with infants. Initial analyses reveal this scale to have good internal and test-retest reliability and have a strong factor structure containing five factors that make sense theoretically.

In addition, as previously noted, the published literature has identified the possibility that young children may be engaging in autonomous self-toothbrushing (BDHF, 2008; Hoeft et al., 2009; Huebner and Riedy, 2010; Martins et al., 2011; Zeedyk et al., 2005). This finding has been extended via the data obtained from the observational study reported in the thesis, which has demonstrated for the first time that as young as 18-months old, infants may be engaging in self-toothbrushing. This self-toothbrushing is characterised by infants holding and using the brush in dyadic toothbrushing episodes more frequently, and for a greater duration than the dental guidelines recommend. The early self-toothbrushing identified in the studies presented in the thesis therefore seems to be one that could be a target for change via a behavioural intervention. Therefore, a picture book intervention was developed to attempt to increase the frequency and duration of maternal holding and use of the brush and decrease infant holding and use of the brush, during dyadic toothbrushing episodes.

Infant-conducted toothbrushing is unlikely to result in their teeth being cleaned to an adequate level of hygiene to provide optimal protection against caries. This is due to the fact that infant fine motor skills are unlikely to be developed enough in order to be able to engage in the complex toothbrush manipulation required for effective toothbrushing.

Indeed, previous research has found that even at the age of 10-years children may not have adequately developed fine motor skills for effective toothbrushing (Sharma et al., 2012).

The paradigms used to inform this picture book intervention were the exposure (Monahan et al., 2000; Zajonc, 1968, 2001) and imitation paradigms (Simcock and DeLoache, 2006; Simcock and DeLoache, 2008; Simcock and Dooley, 2007), which suggest that when infants are exposed to a novel action sequence via pictures, they should be able to model the behaviour on it and imitate it. Although this paradigm has previously been successful in altering infant's preferences for foods (Houston-Price et al., 2009a; Houston-Price et al., 2009b), by causing them to prefer fruits and vegetables they have been exposed to pictures of, the paradigm did not appear to be suitable for altering infants behaviours during dyadic toothbrushing.

Exposing infants aged 24-months to a picture book in which a photo story of a male infant engaged in toothbrushing with his caregiver did not appear to significantly alter the behaviour of dyads participating in the study. The photo story depicted the caregiver having principal control of holding and using the toothbrush during a toothbrushing episode, only allowing the male infant to hold and use the brush to attempt to brush his own teeth at the end of the toothbrushing episodes.

Exposure to this book did not increase the frequency and duration of maternal control of the toothbrush during video recorded toothbrushing episodes taken at fortnightly intervals over a 4-week study period. Nor did it appear to decrease the frequency and

duration of infant holding and use of the brush. Additionally, when compared to a handwashing 'placebo control' picture book group and a 'no treatment' control group, there did not appear to be any significant differences between the groups following exposure to the toothbrushing picture book in either mother or infant holding and use of the brush. This would suggest that though the exposure and imitation paradigms may be suitable for causing infants to have a *preference*, for example for one kind of food over another (Houston-Price et al., 2009a; Houston-Price et al., 2009b), they are not suitable for altering dyadic toothbrushing behaviours. This could be due to the fact that more sophisticated behavioural change techniques are required for altering what could be conceived as a relatively complex behavioural repertoire. However, the lack of negative findings could also be attributed to methodological limitations to the study, which are an inherent part of any complex behavioural research. Some of the limitations across all the thesis studies are now discussed.

7.5 Limitations to the Studies Presented in the Thesis

As with most research, the studies presented in the thesis have inherent, and sometimes unavoidable, limitations that should be considered when drawing conclusions from the research findings reported in the previous section. Although more specific limitations to each empirical study have been discussed in each of the empirical chapters, there are some general limitations that are relevant across all the empirical studies. These limitations mainly relate to issues of measurement of cognitions, attitudes, beliefs and behaviours when researching caregiver-infant dyads, as caregivers may wish to reflect and exhibit the most social desirable aspects of their parenting role, and the relationship

they have with their infant. Additionally, self-selection of participants and generalisability of findings when researching a specific population are also highlighted as issues.

Firstly, self-reports of cognitions, attitudes, beliefs and behaviours may often be unreliable due to the natural human tendency to present a positive image of oneself to the world, and this issue may be particularly relevant when asking caregivers to report on their experiences of being a caregiver (e.g. Morsbach and Prinz, 2006). All the mothers that took part in the studies presented in the thesis may understandably have been motivated to present themselves as competent and confident mothers, who cared for their infant using positive, warm parenting practices. That is not to say that mothers would have necessarily significantly over-exaggerated their reports of their parenting abilities. Indeed, most mothers were happy to discuss experiences they had around caring for their infant that had proved to be difficult and challenging.

In order to overcome some of the difficulties around unreliability of self-reports more objective methods were also employed in the studies reported in the thesis, including an observational methodology. Using this methodology generated reliable data to demonstrate the degree of infant control of holding and use of the toothbrush during dyadic toothbrushing episodes and the age at which these behaviours may first manifest. Observational data also provided some preliminary predictive validity data for the newly developed early toothbrushing PSE scale. However, observational methods also carry some methodological issues, which have been discussed in Chapter Five, and mainly relate to how naturalistic human behaviour can be when an individual knows that at some point their behaviour will be observed and analysed (Gardner, 2000; Paterson et

al., 2008). This may mean that even observational methods may also be subject to a social desirability bias effect.

Despite the difficulties that mothers discussed, all mothers who took part in the studies were self-motivated and proactive mothers who, despite residing in some socially-deprived areas, were well educated and provided a self selected sample for the studies presented in the thesis. This meant that largely the studies did not include more hard to reach mothers, who may not be as well educated and who also reside in socially deprived environments in which the highest rates of early childhood dental caries are found (Pine et al., 2004a). However, this has been found to be a difficulty in much of the research related to social inequalities in child development and health with hard to reach families (Gorin et al., 2008).

Questions may also be raised as to how generalisable the findings across the thesis studies may be to wider populations. All the studies were conducted within areas of Salford and Greater Manchester, with most mothers participating being relatively well-educated and from a British culture. Therefore, it is difficult to tell whether the thesis findings would be relevant to mothers living in other cultures and countries. Additionally, as mothers were focused on throughout the studies, how relevant the findings are to fathers is unknown. Mothers from other cultures and fathers may report different barriers to and facilitators of establishing and maintaining dyadic toothbrushing routines with infants to those identified within the thesis.

Although the discussed limitations were identified within the studies, these limitations may actually serve a useful purpose as they provide indications of how the research reported in the thesis may be extended and improved in future work. How the findings from the studies may inform future research is now discussed, along with how the findings may also inform clinical practice and policies around early dyadic toothbrushing routines.

7.6 Implications of Thesis Findings for Future Research, Practice and Policy

The findings from the studies presented in the thesis have a number of implications for future research, practice and policy for infant dental health care and dyadic toothbrushing with infants. Firstly, one of the key contributions made by the studies presented in the thesis is to highlight just how potentially difficult a parenting task it can be to establish toothbrushing as a dyadic process with infants, especially in dyads containing novice mothers. This is often due to the tendency of infants to exhibit sometimes difficult and challenging behaviours that may make any child-care task difficult for caregivers, with dyadic toothbrushing with infants apparently being no exception. More specifically, the studies presented in the thesis demonstrate that it may be difficult for caregivers to enforce within dyadic toothbrushing routines their own maternal control of holding and using the toothbrush to clean their infant's teeth for them. Many infants, by the age of 18-months, may engage in significant autonomous self-toothbrushing, and although the reasons for this have been explored within the thesis studies, the full implications of this infant self-toothbrushing to infant dental health is as yet unknown.

It would therefore be beneficial to further understand the extent to which infants are capable of effectively brushing their own teeth at this age, and whether they have the abilities to be able to clean them to an adequate level of hygiene to prevent dental caries. Increasing the evidence-base around the point in development children may acquire the fine motor and cognitive skills to be able to brush their own teeth, is a key area of research that deserves more attention.

Additionally, the studies taken collectively have provided a number of key targets for behaviour change interventions, including caregiver cognitions such as general and task-specific PSE, infant behaviour and more specifically, infant tolerance of caregiver holding and use of the toothbrush during dyadic toothbrushing. Although the picture book behavioural intervention developed, evaluated and presented in the thesis did not successfully alter the frequency and duration of either mother or infant holding and use of the toothbrush during dyadic toothbrushing episodes, the paradigm that informed the intervention may still prove to be useful.

It may be useful to further develop the intervention by examining possible interaction effects of the picture book intervention with other evidence-based health behaviour change techniques such as reinforcement and reward, which have been used in previous toothbrushing interventions with young children (e.g. Pine et al., 2004a). The fact that such a simple intervention as that developed and evaluated in the thesis studies did not alter behaviour in any way demonstrates just how difficult health behaviour change may be to achieve. More complex methods such as motivational interviewing (MI) have been suggested to be effective in changing dyadic toothbrushing behaviours (Freudenthal and

Bowen, 2010; Weinstein et al., 2004; Weinstein et al., 2006), so further work could incorporate a multi-component intervention including perhaps a picture book component, along with reinforcement and reward methods such as sticker charts, and more intensive caregiver-targeted cognitive change techniques such as MI. Greater focus on caregiver's self-efficacy and techniques to increase this such as MI, perhaps should be incorporated into future interventions, especially in light of the previously published literature highlighting the importance of this cognition to dyadic toothbrushing (Amin and Harrison, 2009; Finlayson et al., 2005; Finlayson et al., 2007a; Huebner and Riedy, 2010), and also the new contribution made to the literature by the studies presented in the thesis.

Additional research may also include more focussed study of infant behaviour difficulties and how these may be perceived as barriers to establishing toothbrushing as a dyadic process through infancy. Some insights were gained from the qualitative interview and observational data collected from the studies presented in the thesis, with mothers reporting these behaviours and also observational data revealing the nature of some of these behaviours. More systematic research into these difficult infant behaviours might include examining their relation to more severe behavioural difficulties, and whether clinical conditions such as oppositional defiant disorder may be associated with a greater probability of infant behavioural difficulties during dyadic toothbrushing. Further research may also concentrate on the parenting strategies used to manage such infant behavioural difficulties during dyadic toothbrushing, and the strategies used to optimise the chances that such difficulties have a minimally disrupting effect on the maintenance

of the routines. Findings from such research may then also inform the design of components for inclusion in future behavioural interventions.

It would also be informative to replicate the research reported in the thesis with populations other than first-time mothers residing in Greater Manchester. For example, the qualitative and observational studies could be conducted with mothers from other cultures, perhaps living in other countries, to examine whether there is cultural variation in how mothers establish and maintain toothbrushing routines with infants. Additionally, fathers could also be included in future research to explore if mothers and fathers might approach this infant-care task differently. The infant toothbrushing PSE scale would also benefit from being standardised with these additional populations.

In terms of clinical practice and policy, the findings from the studies presented in the thesis may inform future recommendations for dyadic toothbrushing with infants. Firstly, and more generally, there could be much greater awareness of the challenges that caregivers may face when attempting to establish dyadic toothbrushing as a dyadic process with infants, as currently there does not seem to be much, if any, reference to this, either by the dental or child developmental communities. Greater efforts could be made to provide caregivers with specific advice as to how developmental changes during infancy may affect dyadic toothbrushing, for example, how the developing drive for autonomy from the age of around 18-months may cause potential difficulties.

Preparing caregivers for how these developmental changes may affect dyadic toothbrushing with infants may allow anticipatory guidance to be provided, which may equip caregivers with the knowledge and skills to be able to navigate through these developmental changes, and maintain toothbrushing routines in the face of them. Currently the only advice available to caregivers appears to relate to the age at which dyadic toothbrushing should be established in infancy, what kind of toothbrush to use, the parts per million of fluoride recommended to be used with infants, and the age at which children can brush their own teeth unsupervised.

In summary, the findings presented in the thesis have highlighted a number of key dyadic influences on infant toothbrushing, lying at the level of the microsystem of the ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006), in addition to other influences lying at more distal levels, including professional and non-professional advice. Specific developmental changes that may occur throughout infancy may cause caregivers to experience enforcing dyadic toothbrushing routines which is conducted by the caregiver as opposed to the infant, to be challenging. This fact does not appear to have been adequately recognised in either the previously published literature or the published dental guidelines. Lack of awareness of these difficulties could result in caregivers experiencing such difficulties to feel that through their finding enforcing the routine as increasingly challenging that they are in some way failing as a caregiver. The fact that such difficulties are 'normal', experienced by many caregivers, and in many respects are an expected part of development through infancy, could be made more clear to caregivers by health care professionals.

7.7 CONCLUSIONS

The main conclusions that can be drawn from the studies presented in the thesis are as follows;

- A number of maternally perceived barriers and facilitators of the establishment of toothbrushing with infants have been identified, with these barriers and facilitators conceivably providing sources of influences on the emergence of toothbrushing as a dyadic process.
- Some influences on the emergence of toothbrushing as a dyadic process may be conceptualised as lying at more distal levels of Bronfenbrenner's ecological model (Bronfenbrenner, 1979b; Bronfenbrenner, 2005; Bronfenbrenner and Morris, 2006) such as the exosystem such as professional guideline, and chronosystem such as caregiver's own experiences of toothbrushing as a child.
- A number of these influences may be located within the mother-infant dyad, and include maternal cognitions such as PSE, and infant behaviour.
- A specific source of maternal influence included PSE, which may mediate a number of potential challenges to dyadic toothbrushing with infants, and so the current psychometric scale development guidelines were synthesised to construct a process to develop a *task-specific* scale to measure PSE for dyadic toothbrushing.
- This dyadic toothbrushing in infancy PSE scale was found to have good internal and test-retest reliability and contain a five component structure reflecting five different sources of influence on dyadic toothbrushing. This scale may potentially allow identification of caregivers who may have low self-efficacy for establishing and maintaining dyadic toothbrushing with their infant.

- A specific source of infant influence may be the increasing drive to engage in object and tool manipulation, resulting in early self-toothbrushing at as young an age as 18-months old.
- By 24-months, mothers may be playing only a minimal role in supervising infant brushing, having very little control of holding and using the brush during dyadic toothbrushing.
- Such early self-toothbrushing was identified as a target for an evidence-based picture book intervention intended to increase maternal, and decrease infant, frequency and duration of control of holding and using the brush during dyadic toothbrushing.
- The intervention did not appear to significantly affect frequency or duration of either maternal infant control of holding and using the brush during dyadic toothbrushing. Nor did this intervention appear to significantly affect maternal general self-efficacy or PSE as measured by the dyadic toothbrushing in infancy PSE scale.
- Therefore, more research is required to develop interventions to support caregivers to retain control of the toothbrush during dyadic toothbrushing. This may be especially relevant given the increasing infant drive for autonomy through the period of infancy and also the increasing infant drive to manipulate objects and tools such as toothbrushes.

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APPENDICES

Appendix A- Participant information sheet from qualitative interview study (Chapter Three)



University of Salford
A Greater Manchester University



**National Institute for
Health Research**

INFORMATION SHEET- The Salford Family Health Routines Study.

Name of Researcher: Sarah Elison

Supervisors: Dr Sarah Norgate, Dr Lindsey Dugdill, Prof Cynthia Pine

You are invited to take part in a research study, but before you decide whether you would like to take part, we would like you to read this information sheet. This information sheet explains why we are doing this research and what it will involve. Please read this information sheet carefully and discuss it with your family and friends if you wish. You do not have to make up your mind straight away.

If you have any questions about the research and would like to talk to someone about these, please feel free to contact me (Sarah Elison) by phone or e-mail:

☎ 0161 295 5093

✉ s.n.elison@salford.ac.uk

Why are we doing this research?

Our research group is very interested in finding out how families in Salford can be best supported to ensure they are as healthy as possible. Often, for families with young children it can be difficult to establish healthy routines such as regular mealtimes, exercise and tooth-brushing habits. For this reason, we are collecting detailed information from families such as yours about the difficulties they might have when trying to establish and maintain healthy routines with young children.

Who can take part?

We are asking first-time mums to take part. We would like these first-time mums to have a baby who is between 24 - 30 months old.

What would be involved if I decide to take part?

Some of the information we are collecting will come from individual one-to-one interviews which can either be conducted at you home or at you local Children's Centre, depending on your preference. Obviously, we would like to take up as little of your time as possible as we realise that you might be very busy with work and looking after other family members. Therefore, interviews should only take about 1 hour to complete. However, if you would like to continue talking to the researcher for longer than an hour we would be more than happy for you to do so.

What will happen to the information collected in the study?

With your permission we would like record the discussion that take place in your interview and then type this up into a written copy (transcript). This information will then be analysed and the findings written up into a report. When we write up your interview we will change the names of yourself and will also change the names of anyone you might talk about in your interview. If you would like, we will give you a written copy of your interview so that you can check that we have written it up accurately.

The information you provide to us will be stored securely at the University of Salford and will remain completely confidential. Nothing in the stored information or written report will allow anyone to identify who you are.

Do I have to take part in this study?

Participation in this study is completely voluntary and you can withdrawal at any time if you wish to do so.

What we hope to achieve with this research.

Very little is known about the kinds of difficulties families face when caring for young children and how these difficulties might prevent them from having healthy routines. That is why we would like ask you about any difficulties you might have experienced. We hope to then use this information to find ways of helping parents who might need extra support when trying to establish routines with their children. However, you may also have helpful suggestions of things that have helped your family to stick to healthy routines, so we would very much like to find out more about these and pass this information on to families throughout Salford.

Our wish for the future is that the correct support is provided to all families in Salford to help them be as healthy and happy as possible. We would like to find ways of identifying families who would benefit from extra support and guidance when they are trying to establish healthy routines with their children. The information we gain from this study will enable us to design ways of identifying such families.

Who are the researchers and who is funding the research?

The research team is based at the University of Salford in the Faculty of Health and Social Care. The research is being funded by the National Institute for Health Research. This study has been approved by the University of Salford Research Governance and Ethics Committee.

Please feel free to contact me if you would like to take part in the study or have any questions.

✉ s.n.elison@salford.ac.uk ☎ 0161 295 5093

Appendix B- Demographic details questionnaire

TODAYS DATE ____ day / ____ month / ____ year

1. Mothers name _____
2. Mothers date of birth ____ day / ____ month / ____ year
3. Mothers e-mail address _____
4. Mothers phone number _____

5. Child's name _____
6. Child's date of birth ____ day / ____ month / ____ year
7. Child's gender: male female
8. Age child got first tooth (months) _____
9. Number of teeth erupted _____

10. (IF APPLICABLE- more than one box can be ticked)

Who usually looks after your child during a typical day?

- | | | | |
|------------------|------------------------------------------|---------------------|--------------------------|
| Mother at home | <input type="checkbox"/> | Father at home | <input type="checkbox"/> |
| Sister/brother | <input type="checkbox"/> | Child's grandparent | <input type="checkbox"/> |
| Other relative | <input type="checkbox"/> | Friend/neighbour | <input type="checkbox"/> |
| Paid childminder | <input type="checkbox"/> | Nursery school | <input type="checkbox"/> |
| Day nursery | <input type="checkbox"/> | Playgroup | <input type="checkbox"/> |
| Other | <input type="checkbox"/> (specify) | | |

11. (IF APPLICABLE- more than one box can be ticked)

Who does your child live with most of the week?

- | | | | |
|--------------|------------------------------------------|------------------------------------------|--------------------------|
| Mother | <input type="checkbox"/> | Mother and partner (in same house) | <input type="checkbox"/> |
| Father | <input type="checkbox"/> | Mother and partner (in different houses) | <input type="checkbox"/> |
| Grandparents | <input type="checkbox"/> | | |
| Other | <input type="checkbox"/> (specify) | | |

12. How many children are living in your house now?

13. Who else lives in your house?

Partner (e.g. husband, wife etc) Child's grandparent(s)

Child's aunt(s) Child's uncle(s)

Family friend(s) Lodger(s)

Other (specify)

14. What is your marital status?

Married/civil partnership Single

Divorced / separated? Widowed

Living with partner (not married)

15. Parent 1 occupation (IF APPLICABLE- more than one box can be ticked)

In full-time employment please state job.....

In part-time employment please state job.....

In full-time education In part-time education

Full-time carer Currently unemployed

Other (specify)

16. Parent 2 occupation (IF APPLICABLE- more than one box can be ticked)

In full-time employment please state job.....

In part-time employment please state job.....

In full-time education In part-time education

Full-time carer Currently unemployed

Other (specify)

17. At what level did Parent 1 finish their full-time education?

Primary school Secondary school

Further education (college) Higher education (university)

No formal education

Other (specify)

18. At what level did Parent 2 finish their full-time education?

Primary school Secondary school

Further education (college) Higher education (university)

No formal education

Other please specify

19. What is the postcode of your home address?

20. What is your ethnic group? Please choose one section from (a) to (e), then place a cross in the appropriate box to indicate your cultural background

a. White

- British
- Irish
- Other please specify.....

b. Mixed

- White and Black Caribbean
- White and Black African
- White and Asian
- Other please specify.....

c. Asian or Asian British

- Indian
- Pakistani
- Bangladeshi
- Other please specify.....

d. Black or Black British

- Caribbean
- African
- Other please specify.....

e. Chinese or other Ethnic Group

- Chinese
- Other please specify.....

Appendix C- Interview schedule with corresponding levels of ecological model from qualitative interview study (Chapter Three).

PRIOR TO INTERVIEW- FILL OUT CONSENT AND DEMOGRAPHICS FORMS.

General Introduction:

My name is Sarah and I am a researcher at the University of Salford. I am interested in exploring parent's views on what it is like caring for a new baby.

Introduction

I would like to talk to you about some of the things mums have to do when they are caring for a baby, and I'm especially interested in how mum's cope with caring for their baby's/child's dental health. There are no right or wrong answers to these questions, and I am interested to hear about your experiences in caring for your child's teeth.

Is it still ok with you all if we tape this conversation? We need to do this in order to capture the full conversation afterwards in case I forget anything important you say.

This should not be here for more than 30 minutes. If you want to stop the interview or take a break at any time, please do so let me know and we can do that.

Do you have has any questions? If not, I am ready to begin when you are.

Introduction of Main Topic:

1. Chronosystem (time); Microsystem (family)

Now if it's ok, I would like to begin by asking you to take a moment to think back to when you were small and to see if you have any memories about brushing your teeth that stand out?

Prompts: Can you remember how old you were at this point?

What, if anything, from your own childhood experience has influenced your habits with your child's brushing?

Does anyone remember going to the dentist when they were little?

2. Chronosystem (time); Microsystem (family)

What are your own tooth-brushing routines now as an adult?

3. Macrosystem (culture); Exosystem (media, friends)

What are your ideas on what healthy teeth are like?

What does oral health mean to you? Is it important to you? Why?

4. Microsystem

Now I'd like you to think about what sort of things you have had to do to take care of your child on a day to day basis.

Prompt: for example, have you started caring for the baby's dental health/teeth yet?

If yes, at what age did you start caring for your baby's teeth?

What do you do to take care of your baby's teeth?

If no, when do you think you'll start caring for your baby's teeth?

5. Microsystem (family, health services, peers); Exosystem (friends, neighbours, social/welfare services)

Has anyone spoken to you about caring for your baby's dental health yet?

Prompts: If yes, who gave you this advice?

What did the advice consist of?

Did you find this helpful?

Prompt: if not, ask the reasons why they didn't?

If yes,

6. Is there any advice you'd seek about looking after your child's dental care?

What do you want to know and why?

7. Microsystem; Exosystem

Thinking more about looking after your baby's teeth.

What things might help or hinder you being able to brush your baby's teeth at night?

In the morning? Any other time?

Things to listen out for in their comments:

- difficult child behaviours
- not wanting to wake baby up to brush teeth before bed if they are already asleep
- difficulties remembering
- lack of knowledge/advice
- general life stress, e.g. financial problems etc
- lack of time
- maternal tiredness
- maternal depression
- lack of social support
- pressure from family/friends

8. Microsystem; Exosystem

Facilitators:

Helpful partner, grandparent

Already established good routine because??

Good baby

9. Microsystem; Exosystem

General Motherhood Tasks and Coping:

Has anyone offered you any advice about baby care generally?

If so who has given you this advice?

What was that advice and did it help?

If not, would you welcome advice about caring for your baby,

If yes, who from, at what point, home or clinic etc

10. Microsystem; Exosystem

Facilitators of Coping:

What helps you the most in caring for your baby?

Is there anything that sometimes makes it difficult to care for your baby?

Potential facilitators for those who are due to give birth??

FINISH:

I would like to thank you for giving your time today. Is there anything else you would like to say, or questions to ask, or suggestions for my work?

You will be able to have a transcript of the interview if you wish?? Check if they want this or mind you sending it??

Appendix D- Sample transcript from qualitative interview study (Chapter Three)

Interview 15

R- Researcher; P- Participant

R. I just want to find out about what you remember about brushing your teeth when you were little.

P. I had really bad problems with my teeth when I was younger. My saliva was too acidic and it rotted my teeth. I was at the dental hospital every week having fillings, teeth out, but my milk teeth, my front ones, just rotted. So they worked out that my saliva was too acidic. And I had to have work at the dental hospital, you know, up Mancy way? Well, I just used to brush my teeth constantly cos I was at the dentist every week.

R. did you have any teeth taken out when you were little?

P. yeah, all the time. I did have quite a few out. But they couldn't figure out why my teeth were rotting. But I did have a really sweet tooth.

R. so what sort of things would you eat?

P. always sweets and jam butties. Jam was the worst thing when I was a kid.

R. and how's about brushing your teeth? Do you remember your mum or dad brushing them for you, do you remember that far back?

P. no, I don't remember that far back me. I do remember doing them every morning before school, and every night before bed.

R. were your parents quite strict about that?

P. yeah, they used to check. Cos there's me, and I've got a older sister and a younger brother, and we're all close age groups. So we used to be checked.

R. and did you used to go to the dentist for check ups as a kid?

P. yeah, and I had a fear, I had a fear of the dentist, cos the assistant put a hoover in my mouth, the sucky thing. But she sucked my tongue and I panicked and I kicked the dentist. So then they referred me to the dental hospital. And every time I had a check up I had to have that happy air.

R. and did you go for 6 monthly check ups, or annual check ups?

P. I was weekly. Cos my teeth were that bad. I remember my mum saying to me that my saliva was too acidic, so that's why I had to go every week.

R. and how are you now as an adult?

P. well, I go for 6 monthly check ups, but I never brush my teeth at night to be honest cos I always fall asleep on the sofa. But I do make sure I do them every morning.

R. have you had any treatment at the dentist recently?

P. well when I was pregnant with (child) I went and I had to have a filling. But I went back to have my filling and I was too far pregnant to have my filling. So I didn't have my filling done when I was pregnant. But I went back just after and then I had my filling done. I've not had anything done since. Actually I'm due a check up. I've not been since (child) got his first tooth and o took him.

R. how old was he when he got his first tooth?

P. he got two at once, then he got another two. He's had them in two's. But last time he got his four molars at once. That's why he's up half the night, he doesn't sleep.

R. so has been teething really badly then?

P. yeah, and Calgel didn't work, and nothing works.

R. so how old was he when he got his first ones?

P. he was probably about 5 or 6 months, when he got his bottom two. He's got 4 at the top, 4 at the bottom and 4 molars. He's got 12 up to now, so he's only got another 8 to go.

R. so how did his teething affect him then?

P. well, he didn't sleep, he got a sore bum, ratty, moody, up half the night. Screaming, his sleep routine when totally to pot. It was the worst experience ever. It was worse than giving birth. And they don't know, you can't explain to them, so it's just horrible. But even like lolly's and ice pops, and I think teething rings are rubbish. But nothing worked for him, nothing. Apart from me rocking him in the night.

R. have you managed to get his sleep routines back on track since?

P. no. and I think he's getting more at the moment, so we'll have to see how he goes.

R. did you manage to get him into sleep routines before the teething then?

P. yeah, we sleep trained him. But then we went on holiday, so then we came back he was all....I must admit he's in bed by 6 or 7 every night. But you can guarantee by 11 he's up. So I have to go back in and put his dummy back in. and then about half 3, 4 o'clock he's up again.

Now a few weeks ago it ended up that I could just give him the bottle or his dummy in his cot and he would shut up. So I take him into our room and put him on our bed.

R. so how does that affect you? Are you tired?

P. I can sleep through anything. But no, I'm alright, it doesn't affect me.

R. do you manage to get some sleep?

P. oh yeah. There's day when it takes me ages to wake up in the morning, but after about 3 brews, I'm alright!

R. and how about other routines, like eating patterns and stuff. How have they been?

P. his eating patterns shocking. Like this is what he eats, he eats bread. And it's got to be nice bread, like French stick. He eats fish fingers, he'll eat eggs, he'll eat any potato products. But I used to make everything from scratch. And he used to eat anything. But now that's all he eats.

R. so what happened then? He used to eat your home cooked food and then he stopped.

P. yeah, he just suddenly stopped. And he went through a stage of only eating bread. And I cannot get him to try any fruit or anything.

R. has anybody given you any advice about what to do about it?

P. well, at the end of the day, we've been told by the health visitor, what he eats he eats. What he doesn't he doesn't. He's only just started eating fried egg butties, he's only just started eating dippy eggs. But I think the more you make a big deal of it, the more it becomes a big deal. So, I don't.

R. so what do you do then?

P. well you see the hard thing is we don't eat around the table, cos I start work at 5, (partner) comes home at 6, so we have someone who comes in, like either his nanna or his grandma, who sits with him. So he has his tea about half 4, 5 o'clock...

R. before you go out to work?

P. yeah. So, but weekends we eat round the table.

R. so did you get any advice or anything from like your parents about how to bring him up?

P. well my mum has just said that he'll grow out of it. And (partners) mum has said that he was a nightmare and he was a really slow eater. It used to take him ages to eat anything. He's still

pretty slow at eating, but they've not really, I've not really asked them cos I think if you make an issue of it, it becomes an issue. If you don't make an issue of it, like sometimes he looks at my tea when I'm having it and I go 'do you want some' and he's like 'don't like it'. But I say well you don't know until you try it. But he just sort of shrugs it off. But, what he eats, he eats.

R. and did you get any more general advice from professionals like the health visitor? Not just about with tooth-brushing or diet, but just general how to cope...?

P. I think I've only seen the health visitor once with (child). There's no health visitors. So they can't get round to you. the only think I have an issue with with (child) at the moment is he's dead naughty...

R. why, what's he doing?

P. if you say no to him, he just laughs at you. He try's to get stuff off the table, he gets into that cupboard, he can open the baby gate on his bedroom door...

R. how do you cope with that then?

P. my head falls off. I don't know what to do. But I think that's just in his character, he's curious, he's inquisitive. He's investigative, he's at that age...but he seems worse than the other kids I've seen.

R. how is he when you try and brush his teeth then?

P. he brushes the door. All this, this is toothpaste, he brushes his teeth down here you see (kitchen), but in the morning he kind of does it himself. At night I just like pin him down and just give them a quick, you know. But I sing like a daft song, like that one on CBeebies. Or I do that song, you know the one in Grease...'brusher, brusher, brusher...'

R. yeah, I know that one! But how come he brushes the door!?

P. I have no idea. I find his toothbrush everywhere, I don't think he wants his toothbrush. But I go 'brush your peggy's!' And I put it in and he sucks the toothpaste off and he goes off with it. And then a day later I find it outside near the bin.

R. and have you started taking him to the dentist?

P. yeah, but he's frightened to death.

R. why's that then?

P. I have no idea. All the dentist has done is count his teeth, but you can't get him to the doctors and you can't get him to take medicine. But like we went to France last year for our

holiday and (child) was really sick. So we took him to the doctors and the doctor said that he had a really bad throat and nose infection. So they gave us like this nose thing, like a nasal spray and some antibiotics and their version of Calpol. But no, like my friend said that her oldest is a nightmare when it comes to taking medicine. But it took three of us to pin him down to take one lot of medicine. But his temperature was dangerous, so we had a cold compress on. So I go to the doctors, but he wouldn't take anything. But touch wood, even though his diets crap and he doesn't eat very well, he's never ill.

R. and are his teeth alright as well?

P. yeah, he's just got one chipped one, but other than that he's not got anything wrong.

R. so did anyone like the dentist or anyone give you any advice about his dental health, like when to start brushing his teeth or anything?

P. yeah, the dentist, I said to him, 'I need to get (child) registered now cos he's got his first tooth' so he said 'start brushing it'. And I said 'but it's only one'! But he said 'no, honestly, get a little toothbrush and start brushing it'. But other than that I've not really had anything.

R. so did you find that starting brushing early helped him to get used to it?

P. well he his used to it but he doesn't like me grabbing him. But I've got to do it so it's just tough. But like at the nursery, they brush their teeth in the nursery at half 10 and half 3 and they have an egg timer.

R. well I've got one last question for you. I'm trying to get advice from mum's like you to pass on to other mum's in Salford. So if you could give one bit of advice to other mum's about how to cope, what would it be?

P. just don't spoil them and don't let them run your life. Like my sister-in-law, her little girl is 4. But I tell you if she was mine...she is a nightmare. If my son acted like her, like I do time out.

R. actually I should ask you how you cope with tantrums.

P. I put him on him on a time out chair and tell him don't come near me until you've stopped crying. But it's only for 5 minutes. But he's been walking since 9-months, so he sometimes bolts off it. And before now I've found him eating next doors cat food. And stones, he eats stones. So I just don't take my eyes off him.

Appendix E- Table of quotes from qualitative interview study (Chapter Three)

Theme/ Location on Ecological Model	Sub-themes	Examples of quotes
Maternal cognitions Micro-system	Maternal confidence	<p><i>“No one is going to come and hold my hand, there’s only me that can do it.”</i> (Participant 2)</p> <p><i>“I don’t know whether it’s to do with your attitude. Like they’re teething, it’s not their fault. And you’re going to have some rough nights, oh well. But I think you can kind of cope with most things, as long as you have that head on.”</i> (Participant 7)</p> <p><i>“...at first you feel so under-confident, or at least I did. But it’s all about learning to trust yourself more, like you can do the job. You have got the skills and stuff to do it.”</i> (Participant 8)</p>
	Maternal control	<p><i>“How you arrive at that destination I think people have more control over that than they appreciate.”</i> (Participant 1)</p> <p><i>“When people feel discouraged and despair it’s when they feel they have no control over the situation, like things are going to be like this forever.”</i> (Participant 1)</p> <p><i>“...it’s like stick with ‘no’. Like don’t give in really. That is the main thing and I think she got used to brushing her teeth cos I stuck to it every day.”</i> (Participant 10)</p>
	Outcome	<p><i>“I think it’s like anything else. If you know what to expect then it makes it easier when it happens.”</i> (Participant 7)</p>

	expectancies	<i>"I'd already got to the 'it's kind of common sense'. If you already know how to look after your own teeth, kind of looking after baby's teeth is kind of logical. Like you introduce them to the brush before they realise it's something that they don't like."</i> (Participant 9)
	Maternal stress	<i>"I've been quite relaxed with things, so I knew that problems wouldn't last for ever."</i> (Participant 3) <i>"I didn't cope very well, I had quite bad post-natal depression. I found it all really overwhelming, I found I was racked with anxiety all the time. I just thought I was never going to survive."</i> (Participant 6)
	Memory	<i>"...no, it's just cos im forgetful. I know you can't really forget about it. When you're thinking of everything else, you just forget."</i> (Participant 10)
Maternal behaviours	Allowing compromise	<i>"...then I say 'but if you don't brush your teeth, then you don't get a story'. 'Oh well, well I'll brush my teeth then'. Job done."</i> (Participant 9)
Micro-system	Brushing early	<i>"Like you introduce them to the brush before they realise it's something that they don't like."</i> (Participant 9)
	Creating a game	<i>"But I've just try to make a game of it. So we say 'eee' for brushing the front teeth and then 'aaah', and then when she has her mouth open I get in and brush the back ones."</i> (Participant 1)

		<p><i>"I've found that's one of the best things for helping you. if she's messing about, I'll brush my teeth at the same time and we'll have a bit of a race to see who can get round their mouth the quickest."</i> (Participant 5)</p> <p><i>"But I sing like a daft song, like that one on CBeebies. Or I do that song, you know the one in Grease... 'brusher, brusher, brusher...'"</i> (Participant 15)</p>
	Routinisation	<p><i>"I think routine is vital."</i> (Participant 7)</p> <p><i>"...it was just kind of like part of bath, teeth, stories, and bed. It was just kind of the routine that we did it. And we still have the same routines now. Bath and teeth, stories and bed."</i> (Participant 9)</p> <p><i>"It's just persistence really. Like make sure you do it every day so they get used to it. So that they know what's going to happen."</i> (Participant 10)</p>
	Discipline	<p><i>"...in terms of the routines like the tooth-brushing, there have been times when I've said 'if you don't do it, I will brush them for you'."</i> (Participant 5)</p> <p><i>"...just give him a few chances and then it's like 'do it or you'll lose your stories'. But if it's too bad then it's like 'we'll count to 3 and then daddy's going to hold you down and do it for you'. Which happens occasionally."</i> (Participant 8)</p>

		<p><i>"I put him on him on a time out chair and tell him don't come near me until you've stopped crying. But it's only for 5 minutes."</i> (Participant 15)</p>
	Restraining child	<p><i>"...this sounds awful, but there are times when you have to literally hold him down to do it!"</i> (Participant 3)</p> <p><i>"But you've just got to do it haven't you? Even if you have to hold their head, and then they just get used to it."</i> (Participant 8)</p> <p><i>"...he has to like hold her in a head lock and she just screams...it's awful!"</i> (Participant 14)</p>
	Shared tooth-brushing	<p><i>"Then she gets to have a go, and then we rinse the tooth brush. And then I have another go, and she gets another go, and we rinse the tooth-brush and it goes on."</i> (Participant 1)</p> <p><i>"...that's when you have to do, like with anything. Bit of both. You have your go and then I'll have my go."</i> (Participant 7)</p>
Infant behaviours Micro-system	Closed mouth	<p><i>"But with actually brushing her teeth she doesn't like to have her mouth open for very long, so it's always quick and simple."</i> (Participant 1)</p> <p><i>"Sometimes she'd just clamp her mouth closed, and that's it..."</i> (Participant 4)</p>

		<i>"...it was just too faffy, like when they're so young, trying to get a toothbrush into their mouth, that can be a little bit hard..."</i> (Participant 7)
Infant sleeping		<i>"I've skipped brushing his teeth cos he's in the car, he's falling asleep, so I'm like, 'I'm not waking you up to brush your teeth'."</i> (Participant 2) <i>"I must admit I didn't do it twice a day cos she'd be asleep."</i> (Participant 10)
Disliking toothpaste taste		<i>"Like I think that sometimes she doesn't like the taste of the toothpaste, it becomes a bit of a problem."</i> (Participant 5)
Handling tooth-brush		<i>"Well when she's had enough she'll try taking the toothbrush away from me, so she won't let me do it anymore."</i> (Participant 1) <i>"...when he wants to do it himself. But you know if they do that then they're not going to do it properly. So that's a bit annoying."</i> (Participant 7) <i>"...when he was more like a baby he be going like and trying to get hold of it."</i> (Participant 8)
General dislike of tooth-brushing		<i>"He never likes having his teeth brushed anyway. But I never brush his teeth for the full 3 minutes, you can't. I probably brush his teeth for about 20 seconds..."</i> (Participant 2)

		<p><i>"...if he's upset about something it's really hard to get him to that tooth-brushing stage, like if there's a bit of trouble." (Participant 3)</i></p> <p><i>"...he just struggles. Like I get the toothbrush in his mouth and I literally just go like, dead quick. But that's as much as I can do, cos he just like struggles about. Yeah, he's a nightmare." (Participant 6)</i></p>
<p>Sources of advice</p> <p>Exosystem</p>	<p>Professional</p>	<p><i>"I think most of the advice came from the health visitor and also a weaning class I used to go to, about brushing and stuff like that." (Participant 1)</i></p> <p><i>"...the health visitor did actually say not to use a child's toothpaste but to use an adult toothpaste." (Participant 4)</i></p> <p><i>"I went to the weaning thing and one of the things at the weaning was about dental. I don't remember it being particularly effective in telling me what to do, possibly cos we'd already started." (Participant 9)</i></p> <p><i>"I used to take her to baby clinic every week when she was young, and then when she hit 6 months it was once a month...then they'd say 'ooh has she got her teeth yet, you should go to the dentist, to get her used to it'. They were really good." (Participant 14)</i></p> <p><i>"...the dentist, I said to him, 'I need to get (child) registered now cos he's got his first tooth' so</i></p>

		<p><i>he said 'start brushing it'. And I said 'but it's only one'! But he said 'no, honestly, get a little toothbrush and start brushing it'."</i> (Participant 15)</p>
	Non-professional	<p><i>"I think it's just me doing research myself, like I'm always on the internet, like on forums and stuff."</i> (Participant 2)</p> <p><i>"...quite a lot of my friendship group have kids of around similar ages, so that's where a lot of it comes from."</i> (Participant 8)</p> <p><i>"...do what you feel's right. That's the kind of, all my friends who've had kids have said, 'do what you feel comfortable with'."</i> (Participant 9)</p>
Social support		<p><i>"...you don't want to feel like you're the only one, it feels better when you know that other people have been through the same thing."</i> (Participant 3)</p>
Exosystem		<p><i>"...the main thing I found helped me was going to all the mother and baby groups. That totally helped me, cos you'd get there and there'd be other people looking dead bleary eyed and knackered. So you'd think 'oh it's not just me'."</i> (Participant 6)</p> <p><i>"Cos it can be really hard for new mum's especially if your friends aren't off having kids. Cos you do need to have friends who are having the same experience as you. So it's a perfect opportunity going to mum and toddler groups."</i> (Participant 7)</p>

<p>Family history</p> <p>Chronosystem</p>	<p><i>“Probably, for me it’s just the norm and expected to brush your teeth twice a day. Whereas I’ve spoken to people over past few years and they only brush their teeth once day which is very strange to me. So culturally it’s from childhood, definitely.”</i> (Participant 1)</p> <p><i>“It’s about your parents teaching you the right things. Like their parents haven’t taught them the right things, you do as you see.”</i> (Participant 2)</p> <p><i>“...but inevitably, it’s whatever you’ve been taught as a child yourself, you just pass it on.”</i> (Participant 5)</p>

Appendix F- Reflective Diary from qualitative interview study (Chapter Three)

Reflective Account

Below is an account of reflections on the impact of the researchers pre-existing knowledge and experiences on the present qualitative interview study:

One possible source of subjective bias within the research was the fact that I approached the qualitative interview study with the intention of collecting the data for very specific reasons; i) to provide information to develop scale items for a psychometric scale to measure infant toothbrushing parental self-efficacy, and ii) to provide information to develop a cognitive-behavioural parenting skills intervention to support parents who may be having difficulties establishing twice-daily toothbrushing routines with their infant's.

I also embarked upon the study with specific theoretical assumptions about the influences on infant toothbrushing. These are as follows;

- *The importance of parental self-efficacy (PSE) to the establishment of infant toothbrushing routines. This assumption was based upon previous research findings about childhood toothbrushing routines (Adair et al., 2004; Amin & Harrison, 2009; Finlayson et al., 2005; Finlayson, Siefert et al., 2007b; Huebner & Riedy, 2010) more specifically, the importance of PSE to parenting skills and child developmental outcomes more generally (Coleman & Karraker, 2003; Teti & Gelfand, 1991) and the importance of general self-efficacy to the development of healthful behaviours (Bandura, 2004).*
- *Another theoretical assumption underpinning the research was that the various barriers to, and facilitators to infant toothbrushing routines would be located upon the levels of the*

ecological model of human development (Bronfenbrenner, 1979; Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006). These levels correspond to the immediate home environment, the wider community and social environment and the impact of family history and culture. Based upon developmental research and the principles of the ecological model, the parent-child dyadic relationship is seen as being the most significant influence on development in the early years of life.

Although these theoretical assumptions may have contributed to a degree of subjective influence upon the process of data collection, analyses and interpretation, certain factors did contribute to objectivity within the research process. This mainly was related to the fact that as the researcher I do not yet have any children of my own, so did not have any prior experiences of establishing toothbrushing routines with children.

Reflections on the data collection process:

The process of data collection in qualitative research can be fraught with researcher bias and subjectivity, and even systematic attempts to reduce bias do not result in complete elimination of a 'researcher effect'. Often when conducting interviews it can be difficult to be completely satisfied that you are not asking leading questions or probing participants for information that 'fits' into the theoretical model you are hoping will explain your data. I tried to overcome the possibility of this by using a set of pre-devised interview questions that were open-ended and were used in every interview. However, in each interview situation, the questions often had to be asked in different orders, as mothers would spontaneously start talking about one topic and then move onto another, which sometimes did not fit with the order of topics covered by the

interview questions. Additionally, the content of these interview questions was based upon the ecological model's levels and findings from two previously conducted interview studies about childhood dental health routines (Amin & Harrison, 2009; Huebner & Riedy, 2010). Therefore, the interviews conducted within the present study were not open, but sought to uncover very specific information based upon previous theory and research findings. However, as far as possible, mothers were encouraged to also discuss any other relevant information they wanted to and were not restricted to simply discussing the topics covered by the interview questions.

Sometimes I felt that I was not managing to elicit the depth of information I needed from the interviews and so found it necessary to 'probe' mothers by asking about more specific information. This process, though deemed to be acceptable and necessary in qualitative research, concerned me in that I felt there was a risk that mothers would then provide information based upon some form of acquiescence if they felt that they were required to provide the 'correct' answer to my questions. However, on the whole I found that mothers were quite honest with their answers to these more specific probing questions and simply admitted if the issues I was probing them about were not relevant to their experiences and situation.

I also became concerned that the mothers that were agreeing to participate in the study were not entirely representative of the population that were the focus of the research, i.e. mothers living in socially deprived wards in Salford. It quickly became apparent that the mothers that were motivated to take part in the study were well educated, proactive mothers who thought that their infant's dental health was important. However, although at first it concerned me

that I was not encountering any mothers who reported that they had failed to establish twice-daily toothbrushing routines with their infant (and therefore may not be getting access to the full range of information that I needed), the mothers I interviewed did convey information about the difficulties they had experienced whilst getting these routines in place. Whether this information includes the full range of likely difficulties that mother's face when trying to establish these routines is unknown.

I also found that in a couple of the interviews, I felt that some mothers did not 'open up' sufficiently for me to access the depth of information I hoped to gain from them. In one interview in particular (Participant 11) the mother being interviewed seemed ill at ease, despite having previously spoken very openly to me when I had met her at the Children's Centre a couple of days previously. Upon first meeting at the Children's Centre she spoke to me in detail about the depression she was experiencing and seemed very happy to be interviewed later that week. However, upon visiting her at her home on the day of the interview, she appeared more guarded and provided only very brief answers to the interview questions. I attempted to keep the atmosphere 'light' as I suspected that she may have been feeling perhaps embarrassed about the fact that she had previously revealed such personal information to me. However, despite these attempts, this particular mother remained fairly uncommunicative throughout the interview.



We are writing to ask you about toddler tooth-brushing routines!

Dear Parent/Guardian,

We are a team of child health researchers from the University of Salford who are interested in helping toddlers in Salford to stay healthy.



As parents, you will already know that tantrums during toddlerhood (or the 'Terrible Two's'!) are quite common and a normal part of child development. We have found through talking to parents in Salford that one cause of toddler tantrums can be health routines like tooth-brushing. So recently we have been working on finding ways to help parents in Salford get their toddlers used to tooth-brushing routines.

To help us to do this, we are asking parents of children who are around 2 years old to take part in a new study. In this study we will be asking parents to tell us about what they think about toddler tooth-brushing routines.



In this envelope you will find a short questionnaire. We would be very grateful if you could take about 5 minutes to complete this questionnaire and return it to us in the envelope provided. The envelope is freepost so you do not need to put a stamp on it.

Once we have received everyone's questionnaires, we will be contacting you again in about 2 weeks time to ask you to answer just a final few questions. These final questions should not take any longer than a couple of minutes to answer. Again, we will post these questions to you with a freepost envelope so that you can return your answered questions to us.

Participation in this study is completely voluntary, and any information you provide us with (about you or your child) will be completely confidential.

If you would like more information about the study, please contact me (Sarah Elison- Child Health Researcher) on: 0161 295 5093

Or, e-mail me at: s.n.elison@salford.ac.uk

Thank you for taking the time to read this letter. We very much appreciate your support!

A handwritten signature in black ink that reads "Sarah". The letter "S" is large and stylized, with a long horizontal stroke underneath the entire name.

Sarah Elison
Child Health Researcher

Supervisory Team
Dr Sarah Norgate
Prof Lindsey Dugdill
Prof Cynthia Pine

Appendix H- Developmental Psychology expert panel version of PSE scale from scale development study (Chapter Four)

The Toddler Tooth-Brushing Parental Self-Efficacy Scale

Below are 25 pairs of items that have been proposed for inclusion in the new Pre-Schooler Tooth-Brushing Parental Self-Efficacy Scale. Please indicate which item from each pair should be retained and which should be removed.

If you think that any of the items require amendment, please indicate in the Comments boxes under each pair of items what these amendments should be.

Thank You!

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be revised	3- item to be removed
1a	PARENTAL BEHAVIOUR- Creating a game: ...make twice-daily tooth-brushing into a fun game for a toddler?			
1b	PARENTAL BEHAVIOUR- Creating a game: ...make brushing a toddler's teeth for them twice every day into a fun game?			
Comments on Items 1a/1b				
2a	PARENTAL BEHAVIOUR- Routinisation: ...make twice-daily tooth-brushing with a toddler into a regular routine?			
2b	PARENTAL BEHAVIOUR- Routinisation: ...create a regular daily routine out of twice-daily tooth-brushing with a toddler?			
Comments on Items 2a/2b				

3a	PARENTAL BEHAVIOUR- Parental discipline: ...brush a toddler's teeth twice every day for them if they have tantrums during tooth-brushing?			
3b	PARENTAL BEHAVIOUR- Parental discipline: ...not let a toddler's tantrums get in the way of twice-daily tooth-brushing?			
Comments on Items 3a/3b				
4a	PARENTAL BEHAVIOUR- Restraining child: ...brush a toddler's teeth for them twice every day if they were struggling and moving about a lot?			
4b	PARENTAL BEHAVIOUR- Restraining child: ...brush a toddler's teeth for them twice every day if they squirmed about a lot during tooth-brushing?			
Comments on Items 4a/4b				
5a	PARENTAL BEHAVIOUR- Allowing child to have a go: ...allow a toddler to have a go at brushing their own teeth as well as brushing their teeth for them twice every day?			
5b	PARENT BEHAVIOUR - Allowing child to have a go: ...brush a toddler's teeth for them twice every day, but also let them have a go at brushing themselves if they wanted to?			
Comments on Items 5a/5b				
6a	PARENTAL BEHAVIOUR - Perseverance: ...keep trying to get a toddler used to having their teeth brushed by an adult twice every day if they didn't like it?			
6b	PARENTAL BEHAVIOUR - Perseverance: ...keep brushing a toddler's teeth twice every day when they don't like having their teeth brushed?			
Comments on Items 6a/6b				

7a	PARENTAL BEHAVIOUR - Providing rewards: ...reward a toddler if they were well behaved during twice-daily tooth-brushing?			
7b	PARENTAL BEHAVIOUR - Providing rewards: ...give a toddler a reward if they were well behaved when you were brushing their teeth twice every day?			
Comments on items 7a/7b				
8a	PARENTAL BEHAVIOUR- Child modelling parent: ...allow a child to watch you brushing your own teeth to help them get used to twice-daily tooth-brushing?			
8b	PARENTAL BEHAVIOUR- Child modelling parent: ...help a toddler to get used to twice-daily tooth-brushing by letting them watch whilst you brush your own teeth?			
Comments on items 8a/8b				
9a	PARENTAL BEHAVIOUR- Initiating brushing early: ...start brushing a baby's teeth for them twice every day as soon as they have their first tooth?			
9b	PARENTAL BEHAVIOUR- Initiating brushing early: ...start twice-daily tooth-brushing routines with a baby as soon as they have their first tooth?			
Comments on items 9a/9b				
10a	CHILD BEHAVIOUR- General dislike: ...brush a toddler's teeth for them twice every day if they didn't like having their teeth brushed?			
10b	CHILD BEHAVIOUR- General dislike: ...brush a child's teeth for them twice every day if they didn't like it?			
Comments on items 10a/10b				

11a	CHILD BEHAVIOUR- Man-handling brush: ...brush a toddler's teeth for them twice every day if they regularly tried to grab the tooth-brush from you?			
11b	CHILD BEHAVIOUR- Man-handling brush: ...still brush a toddler's teeth for them twice every day if they had a habit of trying to grab the tooth-brush from you?			
Comments on items 11a/11b				
12a	CHILD BEHAVIOUR - Child sleeping: ...wake up a sleeping toddler to brush their teeth for them?			
12b	CHILD BEHAVIOUR - Child sleeping: ...wake a toddler up to brush their teeth for them if they had fallen asleep before bedtime?			
Comments on items 12a/12b				
13a	CHILD BEHAVIOUR - Closed mouth: ...brush a toddler's teeth for them twice every day if they sometimes refused to open their mouth during tooth-brushing?			
13b	CHILD BEHAVIOUR - Closed mouth: ...brush a toddler's teeth for them twice every day if they had a habit of refusing to open their mouth during tooth-brushing?			
Comments on items 13a/13b				
14a	CHILD BEHAVIOUR - Disliking taste: ...brush a toddler's teeth for them twice every day if they didn't like the taste of the toothpaste?			
14b	CHILD BEHAVIOUR - Disliking taste: ...make sure to brush a toddler's teeth for them twice every day if they didn't like the taste of the tooth-paste?			
Comments on items 14a/14b				

15a	CHILD BEHAVIOUR- Wanting to brush themselves: ...brush a toddler's teeth for them twice every day if they sometimes wanted to brush their teeth themselves?			
15b	CHILD BEHAVIOUR- Wanting to brush themselves: ...brush a toddler's teeth for them twice every day if they sometimes wanted to be in charge of brushing their own teeth?			
Comments on Items 15a/15b				
16a	PARENTAL COGNITION- Locus of Control: ...be in control of making sure a toddler had their teeth brushed for them by an adult twice every day?			
16b	PARENTAL COGNITION- Locus of Control: ...be in charge of brushing a toddler's teeth for them twice every day?			
Comments on Items 16a/16b				
17a	PARENTAL COGNITION- Outcome expectancies: ...take care of a toddler's dental health by brushing their teeth for them twice every day?			
17b	PARENTAL COGNITION- Outcome expectancies: ...make sure a toddler's teeth stay healthy by brushing their teeth for them twice every day?			
Comments on Items 17a/17b				
18a	PARENTAL COGNITION- Stress: ...brush a toddler's teeth for them twice every day when feeling stressed out and tired?			
18b	PARENTAL COGNITION- Stress: ...feel able to brush a toddler's teeth for them twice every day when feeling stressed and tired?			
Comments on Items 18a/18b				

19a	PARENTAL COGNITION- Memory: ...remember to brush a toddler's teeth for them twice every day?			
19b	PARENTAL COGNITION- Memory: ...not forget to brush a toddler's teeth for them twice every day?			
Comments on Items 19a/19b				
20a	PARENTAL COGNITION- Parental self-efficacy: ...get a toddler used to having their teeth brushed for them by an adult twice every day?			
20b	PARENTAL COGNITION- Parental self-efficacy: ...get a toddler into the routine of having their teeth brushed for them twice a day by a grown up?			
Comments on Items 20a/20b				
21a	SUPPORT AND ADVICE- Professional advice: ...brush a toddler's teeth for them twice a day without having any professional advice about how to do this?			
21b	SUPPORT AND ADVICE- Professional advice: ...get a toddler used to having their teeth brushed for them twice every day without any professional advice about how to do this?			
Comments on Items 21a/21b				
22a	SUPPORT AND ADVICE- Non-professional advice: ...brush a toddler's teeth for them twice every day if friends and family didn't provide any advice about how to do this?			
22b	SUPPORT AND ADVICE- Non-professional advice: ...get a toddler used to having their teeth brushed for them twice every day without friends and family advising about this?			
Comments on Items 22a/22b				

23a	SUPPORT AND ADVICE- Support from co-parent: ...brush a toddler's teeth for them twice every a day without having someone at home to help (e.g. partner, husband etc)?			
23b	SUPPORT AND ADVICE- Support from co-parent: ...get a toddler used to having their teeth brushed for them twice every day if there was no-one at home to help with this (e.g. partner, husband etc)?			
Comments on Items 23a/23b				
24a	SUPPORT AND ADVICE- General social support: ...brush a toddler's teeth twice a day without much support from friends and family?			
24b	SUPPORT AND ADVICE- General social support: ...get a toddler used to having their teeth brushed for them twice every day without any support from friends and family?			
Comments on Items 24a/24b				
25a	FAMILY HISTORY- Parent's experiences as a child: ...brush a toddler's teeth for them twice every day if you hadn't been encouraged to brush your own teeth as a child?			
25b	FAMILY HISTORY- Parent's experiences as a child: ...brush a toddler's teeth twice every day for them if your own parents had encouraged you to brush your own teeth twice everyday as a child?			
Comments on Items 25a/25b				

The Toddler Tooth-Brushing Parental Self-Efficacy Scale

Multi-Disciplinary Expert Panel Version

This scale is intended for use in a UK population of 24 – 30 month old children. It is being developed to allow predictions to be made about how well parents may be coping with establishing and maintaining twice-daily tooth-brushing routines with their pre-school aged children.

Overleaf are 25 pairs of items that have been proposed for inclusion in the new Toddler Tooth-Brushing Parental Self-Efficacy Scale. Each pair of items outlines a situation in which a parent has to try to enact twice-daily tooth-brushing with 'Kelra'. Parents are asked to indicate how 'easy' or 'difficult' they think it would be (on a scale of 1 – 4) to brush Kelra's teeth in each situation.

Information that has informed the 25 situations has been generated from in-depth interviews conducted with first-time mothers of children aged 24 – 30 months living in Salford. These interviews explored maternally perceived barriers to and facilitators of establishing twice-daily tooth-brushing routines with their children. Each pair of items reflects each barrier or facilitator identified from these interviews.

One item from each pair has to be retained for use with parents in the final version of the scale. This means that one item from each pair has to be removed. We would be grateful if you could indicate which item from each pair should be retained and which should be removed.

The final version for use with parents will not provide the information in each item that is in bold typeface. This information is for you, as our expert panel, to indicate to you what each item has been designed to measure.

If you think that any of the items require amendment, please indicate in the comments boxes under each pair of items what these amendments should be. Thank You!

The Toddler Tooth-Brushing Parental Self-Efficacy Scale

In this section we will ask you how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations.

Instead of thinking about your own toddler when you answer these questions, we would like you to think about an imaginary toddler that we have called 'Keira'.

Please indicate on the scale of 'Very Easy' to 'Very Difficult' how easy or difficult you think it would be to brush Keira's teeth in the 25 situations in the grid below. Please provide only one answer to each question.

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be removed
1a	PARENTAL BEHAVIOUR- Routinisation: ...make brushing Keira's teeth twice every day into a regular routine?		
1b	PARENTAL BEHAVIOUR- Routinisation: ...create a regular routine out of twice-daily tooth-brushing with Keira?		
Comments on Items 1a/1b			
2a	PARENTAL BEHAVIOUR- Creating a game: ...make twice-daily tooth-brushing into a fun game for Keira?		
2b	PARENTAL BEHAVIOUR- Creating a game: ...make brushing Keira's teeth twice every day into a fun game for her?		
Comments on Items 2a/2b			

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be removed
3a	PARENTAL BEHAVIOUR- Parental discipline: ...brush Keira's teeth twice every day if she had tantrums during tooth-brushing?		
3b	PARENTAL BEHAVIOUR- Parental discipline: ...not let Keira's tantrums get in the way of twice-daily tooth-brushing?		
Comments on Items 3a/3b			
4a	PARENTAL BEHAVIOUR- Restraining child: ...brush Keira's teeth twice every day if she physically struggled a lot?		
4b	PARENTAL BEHAVIOUR- Restraining child: ...brush Keira's teeth twice every day if she physically struggled a lot during tooth-brushing?		
Comments on Items 4a/4b			
5a	PARENTAL BEHAVIOUR- Allowing child to have a go: ...let Keira have a go at brushing her own teeth when you're brushing her teeth for her twice every day?		
5b	PARENT BEHAVIOUR - Allowing child to have a go: ...brush Keira's teeth twice every day and then let her have a go at brushing her own teeth?		
Comments on Items 5a/5b			
6a	PARENTAL BEHAVIOUR - Perseverance: ...keep trying to get Keira used to having her teeth brushed twice every day if she didn't like it?		
6b	PARENTAL BEHAVIOUR - Perseverance: ...persevere with brushing Keira's teeth twice every day if she doesn't like having her teeth brushed?		
Comments on Items 6a/6b			

How easy or difficult do you think it would be to.....?		1- Item to be retained	2- Item to be removed
7a	PARENTAL BEHAVIOUR - Providing rewards: ...reward Keira if she was well behaved during twice-daily tooth-brushing?		
7b	PARENTAL BEHAVIOUR - Providing rewards: ...give Keira a reward if she was well behaved when you were brushing her teeth twice every day?		
Comments on Items 7a/7b			
8a	PARENTAL BEHAVIOUR- Child modeling parent: ...let Keira watch you brushing your own teeth to help her get used to twice-daily tooth-brushing?		
8b	PARENTAL BEHAVIOUR- Child modeling parent: ...help Keira to get used to twice-daily tooth-brushing by letting her watch whilst you brush your own teeth?		
Comments on Items 8a/8b			
9a	PARENTAL BEHAVIOUR- Initiating brushing early: ...start brushing Keira's teeth twice every day as soon as she has her first tooth?		
9b	PARENTAL BEHAVIOUR- Initiating brushing early: ...start twice-daily tooth-brushing routines with Keira as soon as she has her first tooth?		
Comments on Items 9a/9b			
10a	CHILD BEHAVIOUR- General dislike: ...brush Keira's teeth twice every day if she didn't like having her teeth brushed?		
10b	CHILD BEHAVIOUR- General dislike: ...brush Keira's teeth twice every day if she didn't like it?		
Comments on Items 10a/10b			

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be removed
11a	CHILD BEHAVIOUR- Man-handling brush: ...brush Kelra's teeth twice every day if she regularly tried to grab the tooth-brush from you?		
11b	CHILD BEHAVIOUR- Man-handling brush: ... brush Kelra's teeth twice every day if she had a habit of trying to grab the tooth-brush from you?		
Comments on Items 11a/11b			
12a	CHILD BEHAVIOUR - Child sleeping: ...wake Kelra up to brush her teeth if she was sleeping?		
12b	CHILD BEHAVIOUR - Child sleeping: ...wake Kelra up to brush her teeth if she had fallen asleep before her regular tooth-brushing time?		
Comments on Items 12a/12b			
13a	CHILD BEHAVIOUR - Closed mouth: ...brush Kelra's teeth twice every day if she sometimes refused to open her mouth during tooth-brushing?		
13b	CHILD BEHAVIOUR - Closed mouth: ...brush Kelra's teeth twice every day if she had a habit of refusing to open her mouth during tooth-brushing?		
Comments on Items 13a/13b			
14a	CHILD BEHAVIOUR - Disliking taste: ...brush Kelra's teeth twice every day if she didn't like the taste of the toothpaste?		
14b	CHILD BEHAVIOUR - Disliking taste: ...brush Kelra's teeth twice every day if she didn't like the taste of the tooth-paste?		
Comments on Items 14a/14b			

How easy or difficult do you think it would be to.....?		1- Item to be retained	2- Item to be removed
15a	CHILD BEHAVIOUR- Wanting to brush themselves: ...brush Kelra's teeth twice every day if she sometimes wanted to brush her teeth herself?		
15b	CHILD BEHAVIOUR- Wanting to brush themselves: ...brush Kelra's teeth twice every day if she sometimes wanted to be in charge of brushing her own teeth?		
Comments on Items 15a/15b			
16a	PARENTAL COGNITION- Locus of Control: ...be in charge of making sure Kelra had her teeth brushed twice every day?		
16b	PARENTAL COGNITION- Locus of Control: ...be in charge of brushing Kelra's teeth twice every day?		
Comments on Items 16a/16b			
17a	PARENTAL COGNITION- Outcome expectancies: ...take care of Kelra's dental health by brushing her teeth for her twice every day?		
17b	PARENTAL COGNITION- Outcome expectancies: ...make sure Kelra's teeth stay healthy by brushing her teeth twice every day?		
Comments on Items 17a/17b			
18a	PARENTAL COGNITION- Stress: ...brush Kelra's teeth twice every day when you feel stressed out and tired?		
18b	PARENTAL COGNITION- Stress: ...feel able to brush Kelra's teeth twice every day when feeling stressed and tired?		
Comments on Items 18a/18b			

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be removed
19a	PARENTAL COGNITION- Memory: ...remember to brush Kelra's teeth twice every day?		
19b	PARENTAL COGNITION- Memory: ...not forget to brush Kelra's teeth twice every day?		
Comments on Items 19a/19b			
20a	PARENTAL COGNITION- Parental self-efficacy: ...get Kelra used to having her teeth brushed by an adult twice every day?		
20b	PARENTAL COGNITION- Parental self-efficacy: ...get Kelra into the routine of having her teeth brushed twice a day by a grown up?		
Comments on Items 20a/20b			
21a	SUPPORT AND ADVICE- Professional advice: ...brush Kelra's teeth twice a day without having any professional advice?		
21b	SUPPORT AND ADVICE- Professional advice: ...get Kelra used to having her teeth brushed twice every day without any professional?		
Comments on Items 21a/21b			
22a	SUPPORT AND ADVICE- Non-professional advice: ...brush Kelra's teeth twice every day if friends and family didn't provide any advice about how to do this?		
22b	SUPPORT AND ADVICE- Non-professional advice: ...get Kelra used to having her teeth brushed twice every day without friends and family advising about this?		
Comments on Items 22a/22b			

How easy or difficult do you think it would be to.....?		1- item to be retained	2- item to be removed
23a	SUPPORT AND ADVICE- Support from co-parent: ...brush Kelra's teeth twice every day without having someone at home to help (e.g. partner, husband etc)?		
23b	SUPPORT AND ADVICE- Support from co-parent: ...get Kelra used to having her teeth brushed twice every day if there was no-one at home to help with this (e.g. partner, husband etc)?		
Comments on Items 23a/23b			
24a	SUPPORT AND ADVICE- General social support: ...brush Kelra's teeth twice a day without much support from friends and family?		
24b	SUPPORT AND ADVICE- General social support: ...get Kelra used to having her teeth brushed twice every day without any support from friends and family?		
Comments on Items 24a/24b			
25a	FAMILY HISTORY- Parent's experiences as a child: ...brush Kelra's teeth twice every day if you hadn't been encouraged to brush your own teeth as a child?		
25b	FAMILY HISTORY- Parent's experiences as a child: ...brush Kelra's twice every day if your own parent(s) had not encouraged you to brush your own teeth twice everyday as a child?		
Comments on Items 25a/25b			



The Toddler Tooth-Brushing Questionnaire

Welcome to the Toddler Tooth-Brushing Questionnaire!

You are invited to take part in a research study that we are conducting at the University of Salford.

We are trying to find ways to support parents as they establish tooth-brushing routines with their toddler-aged children. To help us to do this we are asking mum's living around Manchester who have toddlers aged around 2 years old, to complete this questionnaire.



Part 1 of the Questionnaire

Part 1 of the questionnaire will ask you how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations. The questions in Part 1 are based around an imaginary toddler called 'Keira'. We would like you to try and imagine that you are taking care of Keira, and then say how easy or difficult you think it would be to brush Keira's teeth in the different situations outlined in the questions.



Part 2 of the questionnaire

Part 2 of the questionnaire includes questions about yourself and your family, such as your age, your child's age and your contact details (e.g. address, e-mail address).

The reason that we would like to have your contact details is that we would like to contact you in about 2 week's time to ask you one final set of questions. You will be able to answer these final questions via a link we can send you in an e-mail. Or, if you'd prefer we can send you these questions in the post with a Freepost envelope you can return them to us in.

Thank you very much for your help!

Part 1: Brushing 'Keira's' Teeth



In this section we will ask you how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations.

Instead of thinking about your own toddler when you answer these questions, we would like you to think about an imaginary toddler that we have called 'Keira'.

Please indicate on the scale of 'Very Easy' to 'Very Difficult' how easy or difficult you think it would be to brush Keira's teeth in the 25 situations in the grid below. Please provide only one answer to each question.

How easy or difficult do you think it would be to.....?		Very Difficult	Quite Difficult	Quite Easy	Very Easy
1	...turn brushing Keira's teeth twice every day into a regular routine?				
2	...turn twice-daily tooth-brushing into a fun game for Keira?				
3	...brush Keira's teeth twice every day even if she sometimes had tantrums during tooth-brushing?				
4	...brush Keira's teeth twice every day even if she physically struggled during tooth-brushing?				
5	...brush Keira's teeth twice every day and then let her try to brush her own teeth?				
6	...persevere with brushing Keira's teeth twice every day even if she doesn't like tooth-brushing?				
7	...reward Keira when she was well behaved during twice-daily tooth-brushing?				
8	...let Keira watch you brushing your own teeth to help her get used to twice-daily tooth-brushing?				
9	...brush Keira's teeth twice every day if you hadn't been encouraged to brush your own teeth as a child?				

	How easy or difficult do you think it would be to.....?	Very Difficult	Quite Difficult	Quite Easy	Very Easy
10	...start brushing Keira's teeth twice every day as soon as her first tooth appears?				
11	...brush Keira's teeth twice every day if she didn't like having her teeth brushed?				
12	...brush Keira's teeth twice every day if she regularly tried to grab the tooth-brush from you?				
13	...wake Keira up to brush her teeth if she was sleeping?				
14	...brush Keira's teeth twice every day if she sometimes won't open her mouth during tooth-brushing?				
15	...brush Keira's teeth twice every day if she didn't like the taste of the toothpaste?				
16	...brush Keira's teeth twice every day if she sometimes wanted to brush her teeth herself?				
17	...be in charge of brushing Keira's teeth twice every day?				
18	...make sure Keira's teeth stay healthy by brushing her teeth twice every day?				
19	...brush Keira's teeth twice every day when you feel stressed out and tired?				
20	...remember to brush Keira's teeth twice every day?				
21	...help Keira get used to having her teeth brushed by an adult twice every day?				
22	...brush Keira's teeth twice a day without having any professional advice?				

	How easy or difficult do you think it would be to.....?	Very Difficult	Quite Difficult	Quite Easy	Very Easy
23	...brush Keira's teeth twice every day if friends and family don't provide any advice about this?				
24	...brush Keira's teeth twice every day without having someone at home to help (e.g. partner, husband etc)?				
25	...brush Keira's teeth twice a day without support from friends and family?				

Part 2: You and Your Child

The questions in this section are about you and your child.

1. What is today's date? ___ day / ___ month / ___ year

2. What is your address?

We are asking for your address/ e-mail address and phone number so that we can contact you in about 2 weeks time. We will send you one final set of questions which we would be very grateful if you could answer.

We will not pass on your address or any other private details to anybody else.

Postal Address

E-mail Address _____

Phone Number _____

3. Please indicate how you would prefer us to send you these last few questions we would like you to answer in approximately 2 weeks time.

I would prefer you to: Post out the questions to my home address

E-mail me a link to the questions

3. What is your date of birth? ___ day / ___ month / ___ year

4. What is your child's date of birth ___ day / ___ month / ___ year

5. What is your child's gender: male female

6. How old was your child when they got their first tooth?

_____ months old

7. Approximately, how many milk teeth has your child got now?

_____ milk teeth

8. Who usually looks after your child during a typical day?

(more than one box can be ticked)

- | | | | |
|------------------|--------------------------|---------------------|--------------------------|
| Mother at home | <input type="checkbox"/> | Father at home | <input type="checkbox"/> |
| Sister/brother | <input type="checkbox"/> | Child's grandparent | <input type="checkbox"/> |
| Other relative | <input type="checkbox"/> | Friend/neighbour | <input type="checkbox"/> |
| Paid childminder | <input type="checkbox"/> | Nursery school | <input type="checkbox"/> |
| Day nursery | <input type="checkbox"/> | Playgroup | <input type="checkbox"/> |
| Other | <input type="checkbox"/> | (specify) | |

9. Who does your child live with most of the week?

(more than one box can be ticked)

- | | |
|-----------------------------------------|------------------------------------------|
| Mother | <input type="checkbox"/> |
| Father | <input type="checkbox"/> |
| Mother and father (in same house) | <input type="checkbox"/> |
| Mother and father (in different houses) | <input type="checkbox"/> |
| Mother and stepfather | <input type="checkbox"/> |
| Father and stepmother | <input type="checkbox"/> |
| Grandparents | <input type="checkbox"/> |
| Other | <input type="checkbox"/> (specify) |

10. How many children are living in your house now?

11. Who else lives in your house?

- | | | | |
|----------------------------------|--------------------------|------------------------|--------------------------|
| Partner (e.g. husband, wife etc) | <input type="checkbox"/> | Child's grandparent(s) | <input type="checkbox"/> |
| Child's aunt(s) | <input type="checkbox"/> | Child's uncle(s) | <input type="checkbox"/> |
| Family friend(s) | <input type="checkbox"/> | Lodger(s) | <input type="checkbox"/> |
| Other | <input type="checkbox"/> | (specify) | |

12. **What is your marital status?**
 Married / civil partnership Single
 Divorced / separated? Widowed
 Living with partner (not married)
13. **What is your current occupation?**
(more than one box can be ticked)
 In full-time employment please state job.....
 In part-time employment please state job.....
 In full-time education In part-time education
 Full-time carer Currently unemployed
 Other (specify)
14. **What is your child's father's occupation?**
(more than one box can be ticked)
 In full-time employment please state job.....
 In part-time employment please state job.....
 In full-time education In part-time education
 Full-time carer Currently unemployed
 Other (specify)
13. **At what level did child's mother finish her full-time education?**
 Primary school Secondary school
 Further education (college) Higher education (university)
 No formal education
 Other (specify)
15. **At what level did child's father finish his full-time education?**
 Primary school Secondary school
 Further education (college) Higher education (university)
 No formal education
 Other please specify
16. **What is the postcode of your home address?**

17. What is your ethnic group? Please choose one section from (a) to (e), then place a tick in the appropriate box to indicate your cultural background

a. White

British

Irish

Other please specify.....

b. Mixed

White and Black Caribbean

White and Black African

White and Asian

Other please specify.....

c. Asian or Asian British

Indian

Pakistani

Bangladeshi

Other please specify.....

d. Black or Black British

Caribbean

African

Other please specify.....

e. Chinese or other Ethnic Group

Chinese

Other please specify.....

**Thank you for completing the
Toddler Tooth-Brushing Questionnaire!**

Thank you for completing this questionnaire,
we very much appreciate your help with this study.

We will contact you in about 2 weeks time
to ask you a final few questions.



Appendix K- Screenshots of online version of PSE scale from scale development study (Chapter Four)

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The Toddler Tooth-Brushing Questionnaire

Welcome to **The Toddler Tooth-Brushing Questionnaire**
You are invited to take part in a research study that we are conducting at the University of Salford.

We are trying to find ways to support parents as they establish tooth-brushing routines with their toddler-aged children. To help us to do this we are asking mum's living in Salford who have toddlers aged around 18-30 months old, to complete this questionnaire.

Part 1 of the Questionnaire
Part 1 of the questionnaire will ask you how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations. The questions in Part 1 are based around an imaginary toddler called 'Keira'. We would like you to try and imagine that you are taking care of Keira, and then say how easy or difficult you think it would be to brush Keira's teeth in the different situations outlined in the questions.

Part 2 of the questionnaire
Part 2 of the questionnaire includes questions about yourself and your family, such as your age, your child's age and your contact details (e.g. e-mail address). The reason that we would like to have your contact details is that we would like to contact you in about 2 weeks time to ask you just a few more questions. You will be able to answer these further questions via a link we will send you in an e-mail.

Thank you very much for your help with this research

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Online Surveys - Admin

Part 1: Brushing 'Keira's' Teeth.

In this section we will ask you how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations.

Instead of thinking about your own toddler when you answer these questions, we would like you to think about an imaginary toddler that we have called 'Keira'.

1. Please indicate on the scale of 'Very Easy' to 'Very Difficult' how easy or difficult you think it would be to brush Keira's teeth in the 25 situations in the grid below. Please provide only one answer to each question.

	How easy or difficult do you think it would be to...?			
	Very Easy	Quite Easy	Quite Difficult	Very Difficult
a. ...turn brushing Keira's teeth twice every day into a regular routine?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ...turn twice-daily tooth-brushing into a fun game for Keira?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ...brush Keira's teeth twice every day even if she sometimes had tantrums during tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ...brush Keira's teeth twice every day even if she physically struggled during tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ...brush Keira's teeth twice every day and then let her try to brush her own teeth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ...persevere with brushing Keira's teeth twice every day when she didn't like it?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ...reward Keira when she was well behaved during twice-daily tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. ...let Keira watch you brushing your own teeth to help her get used to twice-daily tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. ...start brushing Keira's teeth twice every day as soon as her first tooth appears?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. ...brush Keira's teeth twice every day if she didn't like having her teeth brushed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. ...brush Keira's teeth twice every day if she regularly tried to grab the tooth-brush from you?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l. ...wake Keira up to brush her teeth if she was sleeping?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m. ...brush Keira's teeth twice every day if she sometimes won't open her mouth during tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n. ...brush Keira's teeth twice every day if she didn't like the taste of the toothpaste?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o. ...brush Keira's teeth twice every day if she sometimes wanted to brush her teeth herself?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
p. ...be in charge of brushing Keira's teeth twice every day?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
q. ...make sure Keira's teeth stay healthy by brushing her teeth twice every day?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
r. ...brush Keira's teeth twice every day when you feel stressed out and tired?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
s. ...remember to brush Keira's teeth twice every day?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
t. ...help Keira to get used to twice-daily tooth-brushing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
u. ...brush Keira's teeth twice a day without having any professional advice?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
v. ...brush Keira's teeth twice every day if friends and family don't provide any advice about this?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
w. ...brush Keira's teeth twice every day without having someone at home to help (e.g. partner, husband)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
x. ...brush Keira's teeth twice a day without support from friends and family?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
y. ...brush Keira's teeth twice every day if you hadn't been encouraged to brush your own teeth as a child?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Done

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Edit

Part 2: You and Your Child

The questions in this section are about you and your child.

Part 2: Your and Your Child

The questions in this section are about you and your child.

2. What is your e-mail address?

We are asking for your e-mail address so that we can e-mail you in about 2 weeks time. In this e-mail we will send you a link to just a few more questions which we would be very grateful if you could answer.

We will not pass on your e-mail address or any other private details to anybody else.

3. What is your date of birth?

4. What is your child's date of birth (dd/mm/yyyy)?

5. How old was your child when they got their first tooth?
Please check **only one box**.

less than 3 months old
 4-6 months old
 8-10 months old
 11-12 months old
 more than 12 months old

6. How many milk teeth has your child got now?
Please check **only one box**.

0-5

Done

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more than 12 months old

6. How many milk teeth has your child got now?
Please check **only one box**.

0-5
 6-10
 11-15
 16-20

7. Who does your child live with most of the week?
You can check **more than one box** if you need to.
(select all that apply)

Mother Father
 Mother and Father (in same house)
 Mother and Father (in different houses)
 Mother and Stepfather
 Father and Stepmother
 Grandparents
 Legal Guardian
 Other (please specify):

8. Who else lives in your house?
You can check **more than one box** if you need to.
(select all that apply)

Partner (e.g. husband, wife etc)
 Child's grandparent(s)
 Child's aunt(s)
 Child's uncle(s)
 Family friend(s) Lodger(s)
 Other (please specify):

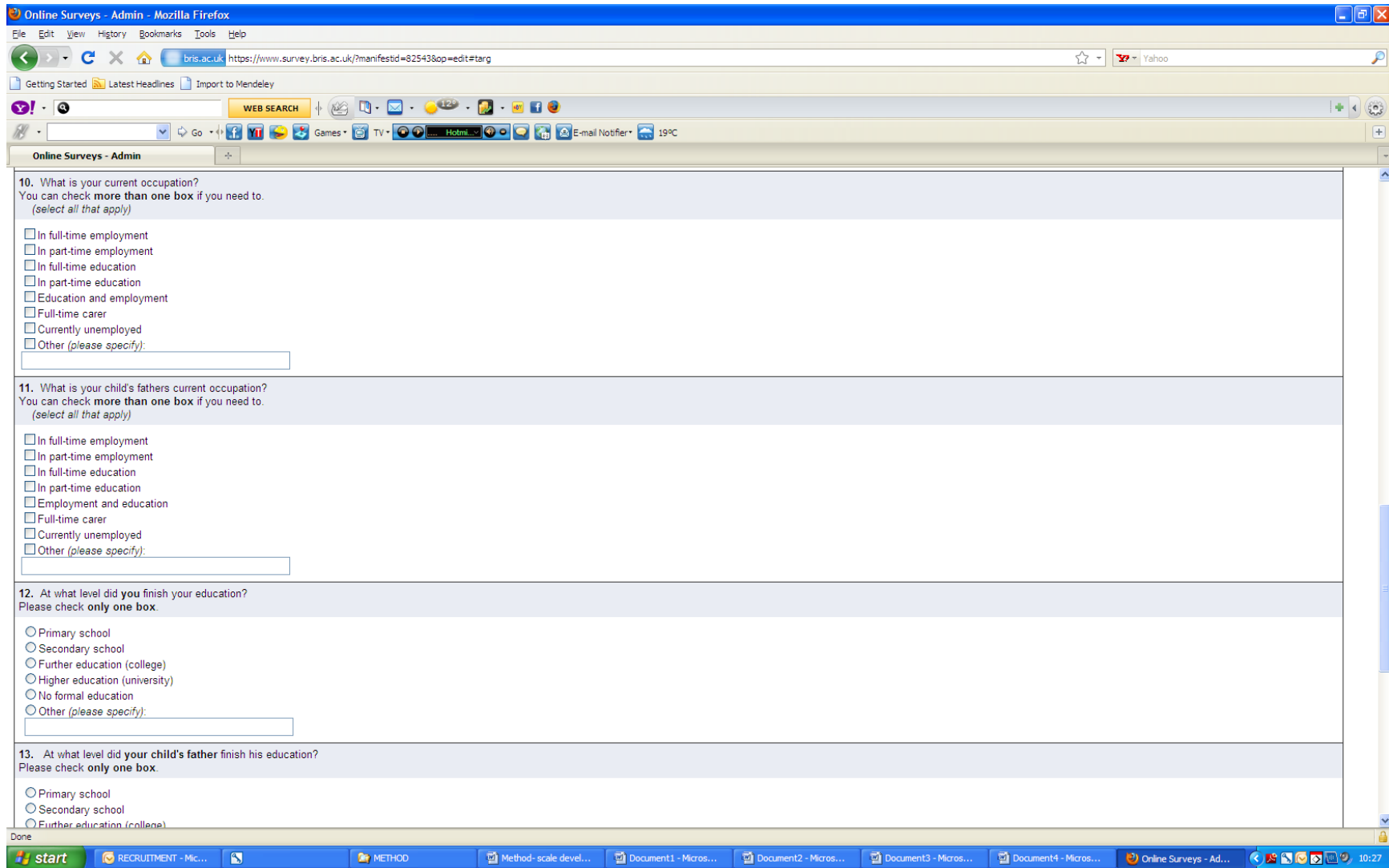
9. What is your marital status?
You can check **more than one box** if you need to.
(select all that apply)

Married / civil partnership
 Single
 Divorced / separated?
 Widowed
 Living with partner (not married)

10. What is your current occupation?

Done

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Other (please specify):

13. At what level did your child's father finish his education?
Please check only one box.

Primary school
 Secondary school
 Further education (college)
 Higher education (university)
 No formal education
 Other (please specify):

14. What is the first part of your postcode?
For example, M6.

15. What is your ethnic group?

White British
 White Irish
 White and Black Caribbean
 White and Black African
 White and Asian
 Indian
 Pakistani
 Bangladeshi
 Caribbean
 African
 Chinese
 Other (please specify):

Continue > Check Answers & Continue >

Edit

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Done

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Thank you for completing the Toddler Tooth-Brushing Questionnaire

Thank you for completing this questionnaire, we very much appreciate your help with this study.

We will e-mail you in approximately **2 weeks** to send you a link to just a few more questions.

[Edit](#)

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Done

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University of Salford
A Greater Manchester University



INFORMATION SHEET- The Salford Family Health Routines Study.

Name of Researcher: Sarah Alison

Supervisors: Dr Sarah Norgate, Prof Lindsey Dugdill, Prof Cynthia Pine

You are invited to take part in a research study, but before you decide whether you would like to take part, we would like you to read this information sheet. This information sheet explains why we are doing this research and what it will involve. Please read this information sheet carefully and discuss it with your family and friends if you wish. You do not have to make up your mind straight away.

If you have any questions about the research and would like to talk to someone about these, please feel free to contact me (Sarah Alison) by phone or e-mail:

☎ 0161 295 5093/07890 408 532

✉ s.n.elison@salford.ac.uk

Why are we doing this research?

Our research group is very interested in finding out how families in Salford can be best supported to ensure they are as healthy as possible. Often, for families with young children it can be difficult to establish healthy routines such as regular mealtimes, exercise and tooth-brushing habits. For this reason, we are collecting detailed information from families such as yours about the difficulties they might have when trying to establish and maintain healthy routines with young children.

Who can take part?

We are asking first-time mums to take part. We would like these first-time mums to have a baby who have got their first tooth and are either (approx.) 12, 18 or 24 months old.

What would be involved if I decide to take part?

Some of the information we are collecting in this study will come from video-diaries. If you decide to take part, we will be supplying you with a camcorder which we would like you to keep for a week. What we will then ask you to do is to video your tooth-brushing routines with your child for the time that you have the camcorder. We are asking family's to do this as we are very interested in seeing how children's tooth-brushing routines might change over time as they get older.

We would also like to visit you at home a couple of times whilst you have the camcorder. During this short home-visit the main researcher (Sarah Elison) will visit you at home to collect your video-recording.

After the study you will receive a souvenir to say thank you for taking part. This will be an edited DVD of all the video-footage you have collected whilst you and your child have been taking part in the study.

What will happen to the information collected in the study?

This video-diary information will then be analysed and the findings written up into a report. When we write up the findings we will change the names of yourself and your child, and we will also change the names of anyone you might talk about in your video footage.

The information you provide to us will be stored securely at the University of Salford and will remain completely confidential. Nothing in the stored information or written report will allow anyone to identify who you are.

Do I have to take part in this study?

Participation in this study is completely voluntary and you can withdrawal at any time if you wish to do so. The researcher will be contacting you by phone in a few days to ask you if you would like to take part in this study. If you do not wish to take part, simply tell the researcher this and we will not contact you again.

What do we hope to gain from this research

Very little is known about the kinds of difficulties families face when caring for young children and how these difficulties might prevent them from having healthy routines. We hope to then use this information to find ways of helping parents who might need extra support when trying to establish routines with their children. However, you may also have helpful suggestions of things that have helped your family to stick to healthy routines, so we would very much like to find out more about these and pass this information on to families throughout Salford.

Our wish for the future is that the correct support is provided to all families in Salford to help them be as healthy and happy as possible. We would like to find ways of identifying families who would benefit from extra support and guidance when they are trying to establish healthy routines with their children. The information we gain from this study will enable us to design ways of identifying and helping such families.

Who are the researchers and who is funding the research?

The research team is based at the University of Salford in the Faculty of Health and Social Care. The research is being funded by the National Institute for Health Research.

This study has been approved by the University of Salford Research Governance and Ethics Committee.

Please feel free to contact me if you would like to take part in the study or have any questions Sarah Elison.

☎ 0161 295 5093/ 07890 408 532 ✉ s.n.elison@salford.ac.uk

Toddler Tooth-Brushing Routines Video Diary Study

Camcorder Instructions

1. Make sure the camcorder battery is charged (plug the power pack into the socket covered by the flap labeled 'DC IN' and plug the power pack and camcorder into your mains electricity supply)



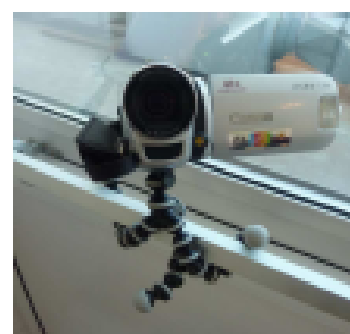
2. Once the camcorder is charged, remove the power pack and flip the screen arm open. To switch the camcorder on press the small black rectangular button at the end of the camcorder marked 'ON/OFF'.



3. If the camcorder is properly switched on, the green light should come on.



4. Set up the camcorder in your bathroom using the tripod or gorilla pod that the researcher has provided you with. Ensure your bathroom sink can be seen clearly.



5. Before you start recording, make sure that the words 'MOVIE MODE' appear on the screen. If the screen says 'DUAL SHOT' or 'PHOTO MODE', turn the dial at the end of the camcorder (that has the oval shaped red switch in the centre of it) until the word 'MOVIE MODE' appears on the screen. You will also see a timer in the right hand corner of the screen.



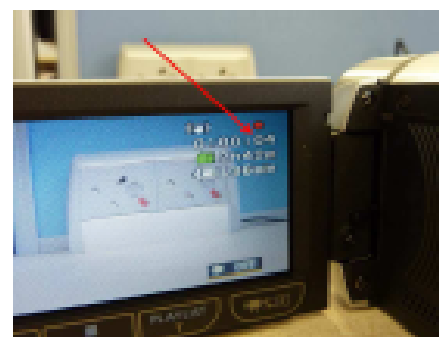
6. To start filming, press the oval shaped red switch at the end of the camcorder. You should see the timer in the top right hand corner of the screen start to count up in seconds.



7. To adjust the focus, zoom in or out by flicking the switch on top of the camcorder marked 'W – T' to the left or right. Please make sure that the picture is set up so that both yourself and your child are clearly in shot.



8. To stop filming, press the oval shaped red switch again. You should see the clock in the top right hand corner stop counting up in seconds and a red dot appear above the clock.



9. When you have stopped filming, switch off the camcorder using the 'ON/OFF' button at the end of the camcorder. The green 'on' light should then go off. You can then flip the screen arm back to the closed position.



Please keep your camcorder stored safely in its box when you are not using it.

Thank you!

The Toddler Picture Book Project

Would you and your toddler like to try out some new children's books we are developing at the University of Salford?

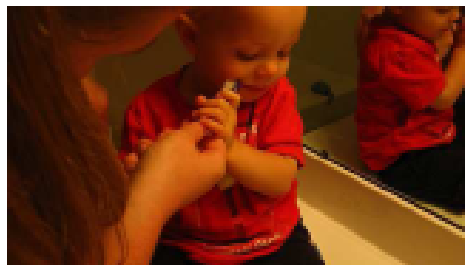
Here at the University of Salford we are interested in helping families with young children to be as healthy and happy as possible!

As part of our 'Salford Bright Smiles' project we are developing two new children's books aimed at helping toddlers get used to two really important health routines; tooth-brushing and hand-washing.

We are looking for 45 families around Greater Manchester with a child around 24-months old to try out these new books. We would then ask you to provide some information to us to help us find out if these new children's books help toddlers to get used to tooth-brushing and hand-washing.

If you would like more information about these new children's books, please contact Sarah Ellison (Child Health Researcher) on: 0161 295 5093 or 07890 408 532 (work mobile)

Or, e-mail us at: s.n.ellison@salford.ac.uk



Participation in this project is completely voluntary, and any information you provide us with (about you or your child) will be completely confidential.

Thank you for taking the time to read this letter. We very much appreciate your support!

Sarah Ellison (Child Health Researcher)

Supervisory Team

Dr Sarah Norgate, Prof Lindsey Dugdill, Prof Cynthia Pine

The Toddler Picture Book Project

Information Sheet

Name of Researcher: Sarah Ellison

Supervisors: Dr Sarah Norgate, Prof Lindsey Dugdill, Prof Cynthia Pine



You are invited to take part in this research project, but before you decide whether you would like to take part, we would like you to read this information sheet. This information sheet explains why we are doing this research and what it will involve. Please read this information sheet carefully and discuss it with your family and friends if you wish. You do not have to make up your mind straight away.



If you have any questions about the research and would like to talk to someone about these, please feel free to contact me (Sarah Ellison) by phone or e-mail:

Phone: 0161 295 5093 or 07890 408 432 (work mobile)

E-mail: s.n.ellison@salford.ac.uk

Why are we doing this work?

Our research group is very interested in finding out how families in Salford can be best supported to ensure they are as healthy as possible. Often, for families with young children it can be difficult to establish healthy routines such as regular tooth-brushing and hand-washing habits. For this reason, we are trying to come up with ways to support families like yours to establish these healthy routines. In order to do this, we need collect information from families with young children.

Who can take part?

We are asking families who have a child who is around 24-months old to take part.

What would be involved if I decide to take part?

All families who decide to take part will be put into one of three different groups and will be asked to do the following;

Groups 1, 2 & 3:

- Be visited at home by a researcher from the University of Salford and then visited one more time a month later.
- Complete some short questionnaires.
- Record a total of 3 bed-time health care routines in which they brush their child's teeth and wash their child's hands.
- All families will be provided with a video camera to record these hygiene routines which they will keep for 1 month.

In addition, Groups 2 & 3 will be provided with a picture book that they will be asked to read with their child once a day for a fortnight.

Which group would I be in?

You will not be able to choose which group you are in. Allocation of families to each group is random. After agreeing (consenting) to take part in the study everyone has an equal chance of being in either of the two groups.

Everyone will be asked to complete some questionnaires throughout the study.

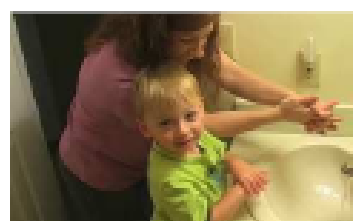
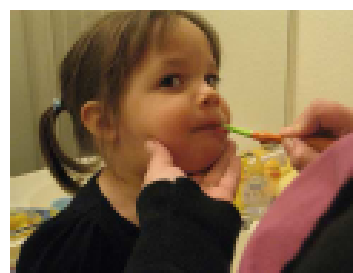
Everyone will be asked to record 3 bed-time health care routines.

Everyone who takes part will also be given the two picture books as a gift to keep at the end of the project to help them with their child get used to health routines.

What will happen to the information collected?

The video-diary and questionnaire information will be analysed and the findings written up into a report. When we write up the findings we will change the names of yourself and your child, and we will also change the names of anyone you might talk about in your video footage.

The information you provide to us will be stored securely at the University of Salford and will remain completely confidential. Nothing in the stored information or written report will allow anyone to identify who you are.



Toddler Picture Book Project Questionnaire

Part 1

In this questionnaire we will ask you a number of questions. Some of these will be about how easy or difficult you think it would be to brush a toddler's teeth in a number of different situations.

Instead of thinking about your own toddler when you answer these questions, we would like you to think about an imaginary toddler that we have called 'Kelra'.

Please indicate on the scale of 'Very Easy' to 'Very Difficult' how easy or difficult you think it would be to brush Kelra's teeth in the 25 situations in the grid below. Please provide only one answer to each question.

How easy or difficult do you think it would be to.....?		Very Difficult	Quite Difficult	Quite Easy	Very Easy
1	...turn brushing Kelra's teeth twice every day into a regular routine?				
2	...turn twice-daily tooth-brushing into a fun game for Kelra?				
3	...brush Kelra's teeth twice every day even if she sometimes had tantrums during tooth-brushing?				
4	...brush Kelra's teeth twice every day even if she physically struggled during tooth-brushing?				
5	...brush Kelra's teeth twice every day and then let her try to brush her own teeth?				
6	...persevere with brushing Kelra's teeth twice every day even if she doesn't like tooth-brushing?				

How easy or difficult do you think it would be to.....?		Very Difficult	Quite Difficult	Quite Easy	Very Easy
7	...brush Kelra's teeth twice every day if you hadn't been encouraged to brush your own teeth as a child?				
8	...start brushing Kelra's teeth twice every day as soon as her first tooth appears?				
9	...brush Kelra's teeth twice every day if she didn't like having her teeth brushed?				
10	...brush Kelra's teeth twice every day if she regularly tried to grab the tooth-brush from you?				
11	...brush Kelra's teeth twice every day if she sometimes won't open her mouth during tooth-brushing?				
12	...brush Kelra's teeth twice every day if she didn't like the taste of the toothpaste?				
13	...brush Kelra's teeth twice every day if she sometimes wanted to brush her teeth herself?				
14	...be in charge of brushing Kelra's teeth twice every day?				
15	...make sure Kelra's teeth stay healthy by brushing her teeth twice every day?				
16	...brush Kelra's teeth twice every day when you feel stressed out and tired?				

How easy or difficult do you think it would be to.....?		Very Difficult	Quite Difficult	Quite Easy	Very Easy
17	...remember to brush Kelra's teeth twice every day?				
18	...help Kelra get used to having her teeth brushed by an adult twice every day?				
19	...brush Kelra's teeth twice a day without having any professional advice?				
20	...brush Kelra's teeth twice every day if friends and family don't provide any advice about this?				
21	...brush Kelra's teeth twice every day without having someone at home to help (e.g. partner, husband etc)?				
22	...brush Kelra's teeth twice a day without support from friends and family?				

Toddler Picture Book Project Questionnaire

Part 2

We also have just a few last questions to ask you about how you feel you are able to get along in life more generally. How true do you think each of the 10 statements below are if you think about how you get along in life?

	How true is it for you that...?	Not at all true	Hardly true	Moderately true	Exactly true
1	I can always manage to solve difficult problems if I try hard enough.				
2	If someone opposes me, I can find the means and ways to get what I want.				
3	It is easy for me to stick to my aims and accomplish my goals.				
4	I am confident that I could deal efficiently with unexpected events.				
5	Thanks to my resourcefulness, I know how to handle unforeseen situations.				
6	I can solve most problems if I invest the necessary effort.				
7	I can remain calm when facing difficulties because I can rely on my coping abilities.				
8	When I am confronted with a problem, I can usually find several solutions.				
9	If I am in trouble, I can usually think of a solution.				
10	I can usually handle whatever comes my way.				

Thank you for completing this questionnaire!

Appendix P- Sample pages from the Oxford CDI from the picture book intervention study (Chapter Six)



Oxford Communicative Development Inventory

A UK adaptation of the MacArthur-Bates CDI *

The Oxford CDI is a list of words that are typical in children's vocabularies. The inventory is a comprehensive "catalogue" of words that are used by many different children across a wide age range, so do

not worry if your child knows only a few of them at the moment.

If you have any additional comments or information that you think we should consider, please add these at the end.

Filling out the Oxford CDI

For words that your child understands but does not yet say place a mark in the first column, labelled "U".

	U	U/S
crocodile	●	○

For words that your child understands and also says place a mark in the second column, labelled "U/S".

	U	U/S
crocodile	○	●

If your child uses a different pronunciation of a word, mark the word anyway. (e.g., 'bickie' for biscuit, or 'telly' for television)

Occasionally we list two alternative forms - please underline the one your child understands and/or produces.

	U	U/S
<u>pool</u> /pond	○	●

Please fill in the whole circle exactly as shown, do not just tick or partly fill the circle.

correct marking - ● incorrect markings - ⊙ or ⊛

* For information and original copies of the MacArthur CDI, please contact the Developmental Psychology Lab, San Diego State University, San Diego, CA 92182, USA.

Oxford Communicative Development Inventory

Subject code

Your name:

Child's name: Male/female:

Birth date of child:/...../..... Today's date:/...../.....

.....

Animal sounds	U	U/S		U	U/S
baa baa	<input type="radio"/>	<input type="radio"/>	ouch	<input type="radio"/>	<input type="radio"/>
choo choo	<input type="radio"/>	<input type="radio"/>	quack	<input type="radio"/>	<input type="radio"/>
cockadoodledoo	<input type="radio"/>	<input type="radio"/>	uh oh	<input type="radio"/>	<input type="radio"/>
grr	<input type="radio"/>	<input type="radio"/>	vroom	<input type="radio"/>	<input type="radio"/>
meow	<input type="radio"/>	<input type="radio"/>	woof	<input type="radio"/>	<input type="radio"/>
moo	<input type="radio"/>	<input type="radio"/>	yum	<input type="radio"/>	<input type="radio"/>
Animals					
	U	U/S		U	U/S
animal	<input type="radio"/>	<input type="radio"/>	horse	<input type="radio"/>	<input type="radio"/>
bear	<input type="radio"/>	<input type="radio"/>	kitten	<input type="radio"/>	<input type="radio"/>
bee	<input type="radio"/>	<input type="radio"/>	lamb	<input type="radio"/>	<input type="radio"/>
bird	<input type="radio"/>	<input type="radio"/>	lion	<input type="radio"/>	<input type="radio"/>
bunny / rabbit	<input type="radio"/>	<input type="radio"/>	monkey	<input type="radio"/>	<input type="radio"/>
butterfly	<input type="radio"/>	<input type="radio"/>	mouse	<input type="radio"/>	<input type="radio"/>
cat	<input type="radio"/>	<input type="radio"/>	owl	<input type="radio"/>	<input type="radio"/>
chicken	<input type="radio"/>	<input type="radio"/>	penguin	<input type="radio"/>	<input type="radio"/>
cow	<input type="radio"/>	<input type="radio"/>	pig	<input type="radio"/>	<input type="radio"/>
deer	<input type="radio"/>	<input type="radio"/>	pony	<input type="radio"/>	<input type="radio"/>
dog	<input type="radio"/>	<input type="radio"/>	puppy	<input type="radio"/>	<input type="radio"/>
donkey	<input type="radio"/>	<input type="radio"/>	sheep	<input type="radio"/>	<input type="radio"/>
duck	<input type="radio"/>	<input type="radio"/>	spider	<input type="radio"/>	<input type="radio"/>
elephant	<input type="radio"/>	<input type="radio"/>	squirrel	<input type="radio"/>	<input type="radio"/>
fish	<input type="radio"/>	<input type="radio"/>	tiger	<input type="radio"/>	<input type="radio"/>
frog	<input type="radio"/>	<input type="radio"/>	turkey	<input type="radio"/>	<input type="radio"/>
giraffe	<input type="radio"/>	<input type="radio"/>	turtle	<input type="radio"/>	<input type="radio"/>
goose	<input type="radio"/>	<input type="radio"/>			
Vehicles					
	U	U/S		U	U/S
aeroplane / plane	<input type="radio"/>	<input type="radio"/>	bus	<input type="radio"/>	<input type="radio"/>
bicycle / bike	<input type="radio"/>	<input type="radio"/>	car	<input type="radio"/>	<input type="radio"/>
boat	<input type="radio"/>	<input type="radio"/>	fire engine	<input type="radio"/>	<input type="radio"/>
lorry / truck	<input type="radio"/>	<input type="radio"/>	pushchair/buggy	<input type="radio"/>	<input type="radio"/>
motor-bike	<input type="radio"/>	<input type="radio"/>	train	<input type="radio"/>	<input type="radio"/>

Appendix Q- Sample pages from the toothbrushing picture book intervention (Chapter Six)



Dear Parent,

This book has been developed to help you and your toddler have more fun during tooth-brushing!

As a parent you will know how important it is to take care of your child's dental health by brushing their teeth for them with a fluoride toothpaste twice every day. However, we also know that sometimes toddlers are not too keen on hygiene routines like tooth-brushing! So we hope that this book will help you to turn tooth-brushing with your toddler into a daily activity you can both learn to enjoy.

To get the most benefit out of this book we recommend you read it with your toddler every day for 2 weeks (or as many times as you can manage). Perhaps spend around 10 minutes reading this book with your child each day. There is a tick chart at the back of this book on page 19 where you can tick how many times you manage to read this book with your child during the 2 weeks that you are reading it.

There are also ideas on each page for questions that you could ask your child about each page in the book. You might also think of your own questions to ask your child. Try asking your child about each page and encourage them to make comments on the photos and get involved with the process of reading the book.

After you have spent 2 weeks reading this book with your child, we will send you a freepost envelope so you can return the book to us. But do not worry, as shortly after we have asked you to return the book to us we will send you a copy of the book to keep as a present, along with a copy of another book we have been developing here at the University of Salford.

We hope you enjoy reading this book with your child as much as we have enjoyed writing it!

Best wishes from the Salford Bright Smiles Team!



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Why not try showing your child how to point to their 'gums' and then their 'teeth'. This will help them see the difference between 'gums' and 'teeth'.

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Appendix R- Sample pages from the handwashing picture book intervention (Chapter Six)



Dear Parent,

This book has been developed to help you and your toddler have more fun during hand-washing!

As a parent you will know how important it is to take care of your child's health by washing their hands regularly to clean away germs that can cause illnesses such as coughs and colds. However, we also know that sometimes toddlers are not too keen on hygiene routines like hand-washing! So we hope that this book will help you to turn hand-washing with your toddler into a daily activity you can both learn to enjoy.

To get the most benefit out of this book we recommend you read it with your toddler every day for 2 weeks (or as many times as you can manage). Perhaps spend around 10 minutes reading this book with your child each day. There is a tick chart at the back of this book on page 19 where you can tick how many times you manage to read this book with your child during the 2 weeks that you are reading it.

There are also ideas on each page for questions that you could ask your child about each page in the book. You might also think of your own questions to ask your child. Try asking your child about each page and encourage them to make comments on the photos and get involved with the process of reading the book.

After you have spent 2 weeks reading this book with your child, we will send you a freepost envelope so you can return the book to us. But do not worry, as shortly after we have asked you to return the book to us we will send you a copy of the book to keep as a present, along with a copy of another book we have been developing here at the University of Salford.

We hope you enjoy reading this book with your child as much as we have enjoyed writing it!

Best wishes from the Salford Bright Smiles Team!



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Why not try asking your child what colour the stars on the page are?

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