Triggering and measuring social inhibitory response in humans immersed in interactions with virtual humans

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Abstract. The aim of the proposed study is to determine if a virtual human can evoke a measurable inhibitory response to anti-social stimuli within the prefrontal cortex. Justification, protocol and demonstrator are described here. The work follows a previous study demonstrating that neural inhibitory responses can be measured within an immersive virtual reality display. We have adopted the approach of combining functional Near Infrared Spectroscopy (fNIRS) and virtual reality head-mounted display. Haemodynamic changes will be measured in healthy participants and subsequently, subjects with mental deficits, as both engage in interactions that seek to evoke a response that would normally be inhibited. Disinhibition is an aspect of social response exaggerated by several deficits of mind, including dementia, autism and Tourette's syndrome. This research could improve tools for understanding, diagnosis and treatment of such condition.

Keywords. Virtual Reality, Virtual Humans, Neuroimaging, Social Interaction.

1. Introduction

As a crucial part of our daily activity in life, we engage in social interaction with people [1]. However, in the course of social interaction, exhibition of anti-social behaviour is common [2]. The degree to which these antisocial behaviours are exhibited during interaction is often influenced by such factors as the influence of alcohol, temperaments and mental well-being of interacting parties [3]. Mental health studies suggest that anti-social behaviour is more likely to be exhibited (disinhibited) by people with cognitive impairments or mental deficits [4].

We are interested in the neural inhibitory response that would normally stop antisocial behavior arising from social cues perceived as evocative. Our experiment attempts to provide such cues and measure the response. Such an experiment relies on naturalistic conversation, preferably including a non-verbal element. However, the likelihood of fatigue for human confederates, the cost of recruiting trained confederates, repeatability and controllability of experiments, and ensuring safety of confederates, suggest adoption of virtual human confederates. Virtual Reality (VR) brings the advantage of carrying out our experiments in a controlled environment and immersive VR makes interactions with virtual humans more natural and compelling. To measure the response, we employ neural imaging, specifically measuring changes to blood oxidization in the prefrontal cortex (PFC).

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To date we have developed the protocol, and experimental environment, gained ethical approval and have begun recruiting.

2. Literature Review

We identify useful cues around our focus from existing studies. To achieve this, we consider studies that have focused on triggering responses to stimuli, measuring these stimuli as well as the technologies and paradigms adopted by these studies.

2.1. Virtual Reality (VR)

Psotka [5] argues that communication with virtual characters is more naturalistic and thus convincing in immersive virtual reality. In line with this argument, this study shall adopt immersive Virtual Reality (VR). Existing VR Technologies include the Head Mounted Displays (HMD) and CAVE Automatic Virtual Environments (CAVE) [6]. We are primarily interested in HMDs because of their wide availability and general low cost.

2.2. Virtual Humans (VH) and Social Interaction

Within this study, we focus primarily on virtual humans (VHs). A good number of studies have attempted replicating social interaction in virtual space using virtual humans and avatars [7]. Whilst several studies have attempted to show that VHs are perceived the same way as real humans, the empirical evidences provided by these studies are often inconsistent. Hence the conflict in opinions around perception of VHs [7].

The current study attempts to distinguish between perception of VHs and the neural response invoked by them. We attempt to provide empirical evidence to these neural responses. VR studies around the social domain have focused mostly on perception of confederates and therapies for public speaking and phobia for crowds. We have found none that targets inhibition to anti-social stimuli during social interaction or monitors neural responses during these interactions. This study therefore attempts to fill this gap.

2.3. Neuroimaging

The choice of neuro-imaging tools has often been guided by research interest and availability of technology or funds. The current study is concerned with inhibition during social interaction and we expect the medial prefrontal cortex (MPFC) to be implicated during interaction and their associated inhibition [8]. Therefore, we adopt a neuro-imaging tool that is effective in measuring PFC activity.

We note that some paradigms such as the Hayling, Stroop and Simon tasks have been used in attempts to measure inhibition in the past [8-11]. Honan et al [13] however, argue that the inhibition evaluated by these measures may differ from inhibition within the social domain.

3. Methodology

We seek to utilize our findings from this review to develop a system that seeks to correlate inhibition as evaluated by a classic paradigm for evaluating inhibition (the Hayling task) with neural responses from immersive interaction with friendly and evocative virtual humans.

3.4 Proposed Experiment

The proposed experiment shall be a virtual simulation of a room with virtual humans. Our participants shall be immersed in this simulation through an HMD. A friendly virtual confederate within the scene shall calmly disagree with the participant's opinion, while another virtual confederate (not initially part of the conversation) interrupts the discussion also in disagreement (but in a confrontational manner), thereby potentially triggering inhibitory response in the participant.

This study is yet to be carried out. However, ethical approval has been obtained and piloting is about to commence. The VR simulation will be tuned in piloting.

4. Potential Impact

The findings from this study will be potentially useful in behavioural therapies especially for people with a history of anti-social behavior or possible mild cognitive impairments or psychological disorders that make anti-social behavior more likely.

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