



The Effectiveness and Perceptions of Three Moderate Intensity Walking Cadence Aids and their Effects on Affective States: A Mixed Methods Study

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ABSTRACT

International Journal of Exercise Science 17(5): 531-550, 2024. Substantial health benefits can be derived from walking at a moderate intensity cadence. To help regulate this cadence, three distinct aids exist 1) self-perception; 2) cadence prescription; 3) auditory cues. This study aimed to compare the effectiveness and explore perceptions of these aids to promote moderate intensity walking and effects on affective states, thereby addressing an important research gap. Individualised moderate relative intensity walking cadence was determined for participants ($n = 23$, $M_{age} = 26.35$, $SD = 10.11$). A convergent mixed-methods design was employed. A within-persons repeated measures design was used to explore the effectiveness of three aids (general guidelines, cadence prescription, and music) on promoting moderate intensity physical activity and positive affective states. Perceptions of these aids were elicited through qualitative interviews and thematic content analysis. Main effects for condition on relative physical activity intensity ($\eta^2 = .72$) and positive affect ($\eta^2 = .25$) were observed. Music evoked significantly higher relative physical activity intensity than other conditions (p values $< .01$), and higher positive affect compared to the general guidelines condition ($p = .038$). A significantly greater proportion of participants achieved moderate relative intensity physical activity during the music compared to general guidelines condition ($p = .03$). Congruently, qualitative findings suggested that participants predominantly perceived music as most effective for promoting a moderate intensity cadence and positive affect. However, individual variability existed in ability to utilise this aid. Implications of the findings for practitioners seeking to promote a moderate intensity cadence and positive affect during walking are discussed.

KEY WORDS: Walking, moderate intensity, cadence, music, affect

INTRODUCTION

The health benefits of regular physical activity among adults are irrefutable. Physical activity is a health-promoting behavior that protects against non-communicable diseases including cardiovascular disease, type 2 diabetes, certain cancers, and depression (19, 32). However, within Northern Ireland, only 42% of males and 33% females meet the minimum

recommendations of 150 minutes of moderate physical activity in bouts exceeding 10 minutes, or 75 minutes of vigorous per week (18, 19). Thus, research on factors enabling physical activity participation at a minimum threshold of moderate intensity is imperative. Intensity can be expressed in absolute or relative terms. Absolute intensity does not consider individual capability, for example, metabolic equivalents. Relative intensity assesses the level of effort in relation to an individual's own capacity, such as a percentage of maximal heart rate (objective measure) or rate of perceived exertion ([RPE]; subjective measure) (41). Walking is an appropriate physical activity modality, corresponding to moderate intensity (19). Walking necessitates no special skills, facilities, nor equipment, limited clothing, is of low risk and cost, can be assimilated readily into one's daily routine (i.e., occupational, recreational, or travel-related physical activity), individually, or in a social milieu. Walking is a preferred physical activity mode across a range of populations (29), and a potential gateway through which inactive and low active individuals can accumulate physical activity-related benefits (38), particularly if engaged at moderate intensity (14).

To assist with the attainment and self-regulation of moderate intensity physical activity three strategies exist; 1) participant self-perception; 2) cadence prescription; 3) auditory cues such as music (57). To assist self-perception, the National Health Service (NHS) provide generic descriptive guidelines of moderate intensity physical activity (40). However, evidence suggests affording generic descriptions is insufficient to assist moderate intensity physical activity accumulation (48), with individual variability existing in ability to gauge intensity whilst walking (37). A recent systematic review (38) reported that providing instructions to walk at 'medium pace' evokes light intensity physical activity when considering relative intensity, and unexpectedly, walking speeds adopted in response to 'fast-pace instructions' exceeded that of 'maximal pace instructions'. Therefore, investigation into methods to assist the self-regulation of walking cadence is necessitated.

The utility of cadence prescription (62), such as the 100 steps min⁻¹ target for assisting attainment and regulation of moderate intensity physical activity has been demonstrated (35, 58). However, this requires ongoing monitoring and cognitive demands that may be unacceptable to individuals, potentially reducing long-term fidelity. Cadence matched rhythmic cueing has been successfully employed to improve gait among individuals with Parkinson's Disease (7), and to regulate walking at a prescribed intensity (51). However, most of the aforementioned studies have employed a metronome to stimulate a cadence response, and similar to cadence prescription, the long-term acceptability in free-living conditions is questionable (25) and to-date unknown.

Music may provide an acceptable and effective alternative to descriptive information, prescribed cadence, and metronome cueing to assist individuals in gauging moderate intensity physical activity (51, 54). Recently Faulkner et al. (2021), demonstrated that music prompted free-living overweight adults to achieve a walking pace of moderate intensity (25). Music may also provide additive benefits of augmenting the positive affective states typically associated with physical activity, particularly if self-selected (30) by acting as a distraction (45) and

reducing perceived exertion (46). Affect is a subjective state conceptualized as two independent constructs, positive affect and negative affect (66), and is important for promoting and protecting mental health (59). Positive affect reflects states such as joy, alertness, and enthusiasm, while negative affect measures the amount of unpleasantness or dissatisfaction the person is experiencing (66). People tend to participate in activities that make them feel good, and their affective reactions are a good indicator of their future engagement (8, 21). Consequently, identifying the most effective methods to enhance affective responses could be crucial for sustained participation (10).

To date, no research comparing the effectiveness of different approaches to assist individuals to walk at moderate intensity, nor qualitative exploration of perceptions of these methods exists. Utilizing qualitative methods to compliment a quantitative approach would facilitate a comprehensive and deeper understanding of the effectiveness of approaches for attaining and regulating moderate intensity walking, their acceptability, and impact on important outcomes such as affect (65). Mixed methods approaches facilitate the elaboration, enhancement, and clarification of results from one method to another, and assessments of convergence and corroboration via data triangulation (2).

Therefore, the current research aimed to provide a unique contribution to the literature by employing a mixed methods approach to ascertain the effectiveness and perceptions of three distinct moderate intensity walking cadence aids (general guidelines, cadence prescription, and music), and their effects on affective states. This satisfies a need to determine the optimal and most sustainable methods of assisting moderate intensity physical activity bouts (58). Moreover, the study aimed to descriptively compare the levels of synchronization across conditions i.e., cadence attained during conditions compared to prescribed moderate intensity cadence. Compared to the general guidelines and cadence prescription aids, it was hypothesized that the provision of music would lead to significantly greater moderate intensity walking, positive affect, and lower negative affect.

METHODS

Participants

Participants were recruited via a convenience sampling approach using an e-mail list of Ulster University. Eligibility criteria required participants to be aged 18-64 years; community dwelling and independent; free from health conditions impeding physical activity (e.g. chest pain with exertion, or muscle pain that would prevent walking for bouts of 10 minutes); not taking medication nor pregnant; and absent from any familial history of heart conditions prior to the age of 55 years. Eligibility was assessed by a Physical Activity Readiness Questionnaire (PAR-Q). A power analysis was conducted to determine the sample size required for this study, based on an unpublished pilot study, with congruent aims and outcomes. The effect size (0.35), power (95), and alpha level (0.05) used in the power analysis indicated that a sample of 23 was required. Moreover, a sample size of 23 likely ensured that saturation was achieved (27). This research

was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science (39).

Protocol

Transparency and Openness: The present study aligns with the APA Style Journal Article Reporting Standards for Mixed Methods Research (34). The study reports how sample size was determined, any data exclusions and manipulations, and all measures used in the study. Ethical approval was granted by the Post-Graduate and Staff Research Filter Committee, at Ulster University, and informed consent was provided. This study's design and its analysis were not pre-registered. All anonymized data have been made publicly available at Figshare and can be accessed at [10.6084/m9.figshare.22110440](https://doi.org/10.6084/m9.figshare.22110440), and the semi-structured interview schedule can be found in Table 1.

Design: This study employed a convergent mixed methods design. Firstly, a within persons repeated measures design was employed to explore the effectiveness of three distinct moderate intensity walking cadence aids (general guidelines, cadence prescription, and music) on moderate intensity physical activity attainment (relative and absolute), and affective states. Subsequently a qualitative descriptive approach, a method where information can be elicited directly from those experiencing the phenomenon under investigation was employed (12). Post-trial interviews were undertaken to understand perceptions of the three distinct walking cadence aids.

Measures: A questionnaire collected socio-demographic information including age, sex, educational attainment, relationship status, and preferred music genres and tracks. Body weight was determined via an electronic scale to the nearest 0.1kg (Seca 813, Seca Ltd, Birmingham, UK) and height was measured by a stadiometer (Seca Leicester Height Measure, Invicta Plastics, Leicester, UK) to the nearest 0.1cm. Body mass index (BMI) was calculated using the following formula: kg/m^2 .

Participants' relative physical activity intensity was assessed subjectively using the Borg Rating of Perceived Exertion (RPE) Scale. This is a 15-point measurement scale ranging from 6 (no exertion) to 20 (maximum exertion). The Borg RPE Scale correlates highly with a person's heart rate during physical activity (11) and has been used extensively in research to assess relative intensity (15, 43) with a rating of 11 to 13 considered as moderate intensity (41, 54).

Absolute physical activity intensity was assessed using a RT3 triaxial accelerometer (Stay Healthy, Monrovia, CA, USA). This waist worn accelerometer collected motion on three axes producing a Metabolic Equivalent of Task (MET) at one-minute epochs of wear time. A MET score of < 3 was considered as light, 3 to 5.9 as moderate, and > 5.9 as vigorous absolute intensity (3). Time spent in each intensity was totaled during the three 10-minute walking trials. The Stay Healthy RT3 triaxial accelerometer has been shown to be valid when compared to oxygen consumption during treadmill exercises and unregulated activities, with a correlation coefficient of 0.85 ($p < .001$) (52). Additionally, it has demonstrated good reliability with an intraclass

correlation coefficient of 0.85 ($p < .001$) (26). Walking cadence was measured using a Digi-Walker SW-200 pedometer. The Digi-Walker SW-200 pedometer exhibits acceptable reliability and validity (55). Total steps taken were divided by duration of the exercise bout to produce a mean walking cadence (steps/ minute). Finally, positive and negative affect was measured using the Positive and Negative Affect Scale [PANAS] (66). The PANAS uses two 10 item mood scales comprising of words that describe different feeling and emotions (e.g., enthusiastic; alert; active; strong; proud; irritable; scared; nervous; guilty). Respondents rated to what extent they currently felt these states on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). Positive and negative items on the PANAS Scale were summed to produce separate positive and negative affect scores, with higher scores on each indicating higher levels of positive and negative affect (range = 10-50). The psychometric properties of PANAS have been established (66) and internal consistency was acceptable in the current study (α range = .76 - .96).

Procedure: All data collection procedures were undertaken at Ulster University on one occasion, with only the researcher and participant present. The researcher had no prior relationship with participants and was trained in mixed methods research. Participants completed a questionnaire containing sociodemographic and PAR-Q items to assess eligibility and music preference.

Subsequently, participants completed a pre-test treadmill procedure to determine their moderate relative intensity walking cadence. Participants' heart rates were monitored using a Polar RS400 heart rate monitor (Polar Electro, Kempele, Finland) while walking on a treadmill in five-minute bouts at four separate speeds (3kmph, 4kmph, 5kmph, and 6kmph) with a three-minute rest period separating bouts. Concurrently, walking cadence was recorded in steps min^{-1} using a SW-200 pedometer (Yamax, Tokyo, Japan). To ensure a steady state heart rate was reached, only data from the final two minutes of each five-minute walking bout was recorded. For each participant walking cadence was plotted against % of maximum heart rate ($220 - \text{age}$). A linear regression line of best fit was utilized to determine walking cadence that corresponded to 60% of the participants maximum heart rate i.e., moderate intensity (Centre for Disease Control & Prevention, 2015). A commercial DJ software was used to ascertain music with a consistent tempo that corresponded to participants' music preference and their moderate intensity walking cadence, which was loaded onto an MP3 player.

Participants performed a warm-up guided by a trained instructor. Next, participants undertook three 10-minute walking bouts on an indoor elliptical track, each a distinct condition, and separated by a washout period of three minutes. During each condition participants attempted to gauge moderate intensity physical activity. During condition 1 participants were provided with a description of moderate intensity physical activity as stated within the current guidelines (40), which was read out loud by a researcher (D.B.) and provided to the participant in written form. These instructions stated 'moderate activity will raise your heart rate, and make you breathe faster and feel warmer. One way to tell if you're working at a moderate intensity level is if you can still talk, but not sing'. The instructions also included a range of examples of moderate intensity activities such as brisk walking. In condition 2 participants were provided

with their predetermined moderate relative intensity walking cadence, and a wristwatch (if required) to assist with self-regulation of cadence. In condition 3 participants were provided with an MP3 player containing music with a tempo corresponding to their pre-determined moderate relative intensity walking cadence and asked to synchronize walking cadence to the beat of the music. All participants were required to repeat back the instructions and were provided an opportunity to ask questions to ensure understanding. All participants completed condition 1 first, with conditions 2 and 3 counterbalanced to prevent order effects. The counterbalancing procedure was undertaken in SPSS version 24, with participants randomly allocated a sequential order for the latter conditions. Condition 1 was omitted from the counterbalancing procedure to remove contamination from any knowledge and practice of the prescribed moderate intensity cadence in conditions 2 and 3 (51). During each bout participants wore a RT3 accelerometer and SW-200 pedometer, with minutes spent in moderate absolute intensity and step count recorded. Following each condition, participants completed assessments of affective states and relative physical activity intensity.

Following a 10-minute break period, participants undertook a semi-structured interview to explore their perceptions of the three conditions. Interviews are a common qualitative data collection technique, which encompasses the interviewer asking questions, probing the interviewee, and evoking opinions on a defined topic to furnish rich and detailed information for analysis (28). One-to-one interviews was chosen over other qualitative methods (focus groups or observations), given the sensitive issues discussed (i.e., negative affective states) (28), and to encourage participants to disclose information more openly, increasing credibility of findings (4). All interviews were recorded with the participants' consent, undertaken seated in a private room with only the participant and a researcher present (D.B), and lasted between 10 and 30 minutes.

The four stages proposed by Howitt (2019) for conducting interviews was utilized (28). Firstly, the researcher ensured that the interview was recorded and the recording quality intact (e.g., eliminating extraneous noise). Next, during the orientation stage the participant was provided a rationale for, and approximate duration of the interview, and an explanation of ethical considerations. Next, the researcher asked eight open-ended questions from a semi-structured interview schedule (Table 1) probing participants' perceptions of the three conditions. The questions probed clarity, ease of implementation, and effectiveness of the three aids for assisting walking at moderate intensity, and effects on affective states. During the interview, follow-up probes were utilized to explore emerging issues, and to ensure data was firmly grounded in participants' perspectives. Finally, the researcher brought the interview to a conclusion. Following the interviews, recordings were transcribed verbatim.

Statistical Analyses

All data were analyzed using SPSS (version 24). Descriptive statistics including means, standard deviations, and frequencies were computed to determine participant characteristics. Preliminary data checks were carried out prior to analysis, to ensure assumptions including normality, sphericity, and outliers were met. Next, a Repeated Measures Analysis of Variance

was used to explore differences across the three conditions for time spent in light, moderate, and vigorous absolute intensity physical activity, relative intensity physical activity, walking cadence, and positive and negative affective states. Where significant main effects emerged, Bonferroni post-hoc comparisons between conditions were undertaken. A Cochran's *Q* Test (17) was undertaken to determine if the percentage of participants attaining moderate relative and absolute intensity physical activity differed across the three conditions, with Dunn's Test (with Bonferroni correction) employed for pairwise comparison of conditions. Finally, Bland–Altman plots were created to explore synchronization with the prescribed moderate relative intensity walking cadence during each condition. This involved plotting the discrepancies between prescribed moderate relative intensity cadence and cadence realized during each condition. Alpha levels were set at $p < 0.05$.

Table 1. Interview schedule.

Interview schedule	
1)	Can you tell me if you thought the moderate intensity description condition was clear or unclear?
2)	Can you tell me if you thought the moderate intensity description provided was helpful or unhelpful for maintaining moderate intensity for a period of 10 minutes?
3)	Can you tell me if you thought the moderate intensity step rate condition was clear or unclear?
4)	Can you tell me if you thought the moderate intensity step rate provided was helpful or unhelpful for maintaining moderate intensity for a period of 10 minutes?
5)	Can you tell me if you thought the music condition was clear or unclear?
6)	Do you think that using the music provided was helpful or unhelpful for maintaining moderate intensity over 10 minutes?
7)	Which condition helped you to maintain a moderate intensity pace the most and why?
8)	Which of the three conditions influenced your mood the most and why?

Transcripts were analyzed manually using an inductive thematic content analysis approach (13). Two researchers (E. S. & D.B) independently scanned transcripts for words, phrases, or paragraphs to attribute corresponding codes. These codes were combined into themes, and subsequently refined. Themes were reviewed, where necessary combined or subdivided, and subsequently categorized into higher and lower order themes. Any discrepancies between coders were resolved via a discussion. E. S. holds a PhD in health psychology, and D.B. an undergraduate student in psychology. Both researchers were experienced in qualitative analysis.

RESULTS

Socio-Demographics: Twenty-three participants met the eligibility criteria and took part in the study. Participants were aged between 19 and 57 years (mean age = 26.35 years, SD = 10.11). Participants were predominantly female (61%) and educated to university level (87%). Forty-eight percent were married or in a full-time relationship. Fifty-seven percent of participants had a BMI within a healthy range (BMI = 18.5 to 24.9), 35% were overweight (BMI = 25 to 29.9), and 9% were obese (BMI > 30).

Table 2. Trial differences in walking cadence, affect, absolute and relative intensity, proportion of participants attaining moderate relative intensity, and 10-minute bouts at absolute moderate intensity.

Variable	General guidelines	Cadence prescription	Music	f/ q	df	p
Walking cadence, M (SD)	118.50 (9.80)	118.90 (9.80)	120.10 (10.30)	0.695	21	.510
Absolute light intensity, M (SD)	1.35 (2.77)	1.22 (2.61)	0.83 (2.21)	2.39	2	.10
Absolute moderate intensity, M (SD)	7.04 (3.61)	7.22 (3.55)	7.39 (3.92)	0.42	2	.66
Absolute vigorous intensity, M (SD)	1.61 (3.14)	1.57 (3.13)	1.71 (3.68)	0.42	2	.71
Absolute moderate intensity physical activity bout attainment, %	43.50	43.50	47.80	0.29	2	.87
Relative intensity, M (SD)	8.61 (1.3)	9.78 (2.02)	11.57 (2.74)	27.19	21	<.001
Moderate relative intensity attainment, %	4.30	21.70	39.10	6.4	2	.04
Positive affect, M (SD)	29.83 (8)	31.26 (8.7)	32.74 (10)	3.51	21	.048
Negative affect, M (SD)	10.74 (1.79)	11.04 (3.36)	10.91 (2.42)	0.295	21	.747

Note. N = 23. Significant effects are given in bold.

Differences Across the Conditions for Time Spent in Light, Moderate, and Vigorous Absolute Intensity, Relative Intensity, Steps, and Affective States: The results were examined based on an alpha of .05. As demonstrated in Table 2, the main effects for positive affect and relative physical activity intensity were significant. Post-hoc tests indicated significantly higher positive affect in the music condition than the general guidelines condition ($p = .038$). Relative intensity physical activity differed across conditions, increasing between general guidelines and cadence prescription conditions ($p = .003$), general guidelines and music conditions ($p < .001$) and for cadence prescription and music conditions ($p < .001$). The effect size for these differences ranges from small (eta - squared = .25, for positive affect) to moderate (eta-squared = .72, for relative intensity physical activity). As demonstrated in Table 2, the proportion of participants achieving moderate relative intensity differed across conditions. Post-hoc tests indicated that significantly greater proportion of participants achieved moderate relative intensity during the music compared general guidelines condition ($p = .03$). The main effects for negative affect, time spent in light, moderate, and vigorous or proportion of participants achieving 10-minute bouts in absolute intensity, or walking cadence was non-significant. As shown in Figure 1c, during the music condition 2 of 23 participants (8.70%) achieved perfect synchronization with the prescribed moderate relative intensity walking cadence, whereas 6 of 23 (26.10%) walked within ± 3 steps min^{-1} . As shown in Figures 1a & 1b in the general guidelines and cadence prescription conditions, no participant achieved perfect synchronization with prescribed relative moderate intensity walking cadence, with 3 of 23 (13.04%) walking within ± 3 steps min^{-1} .

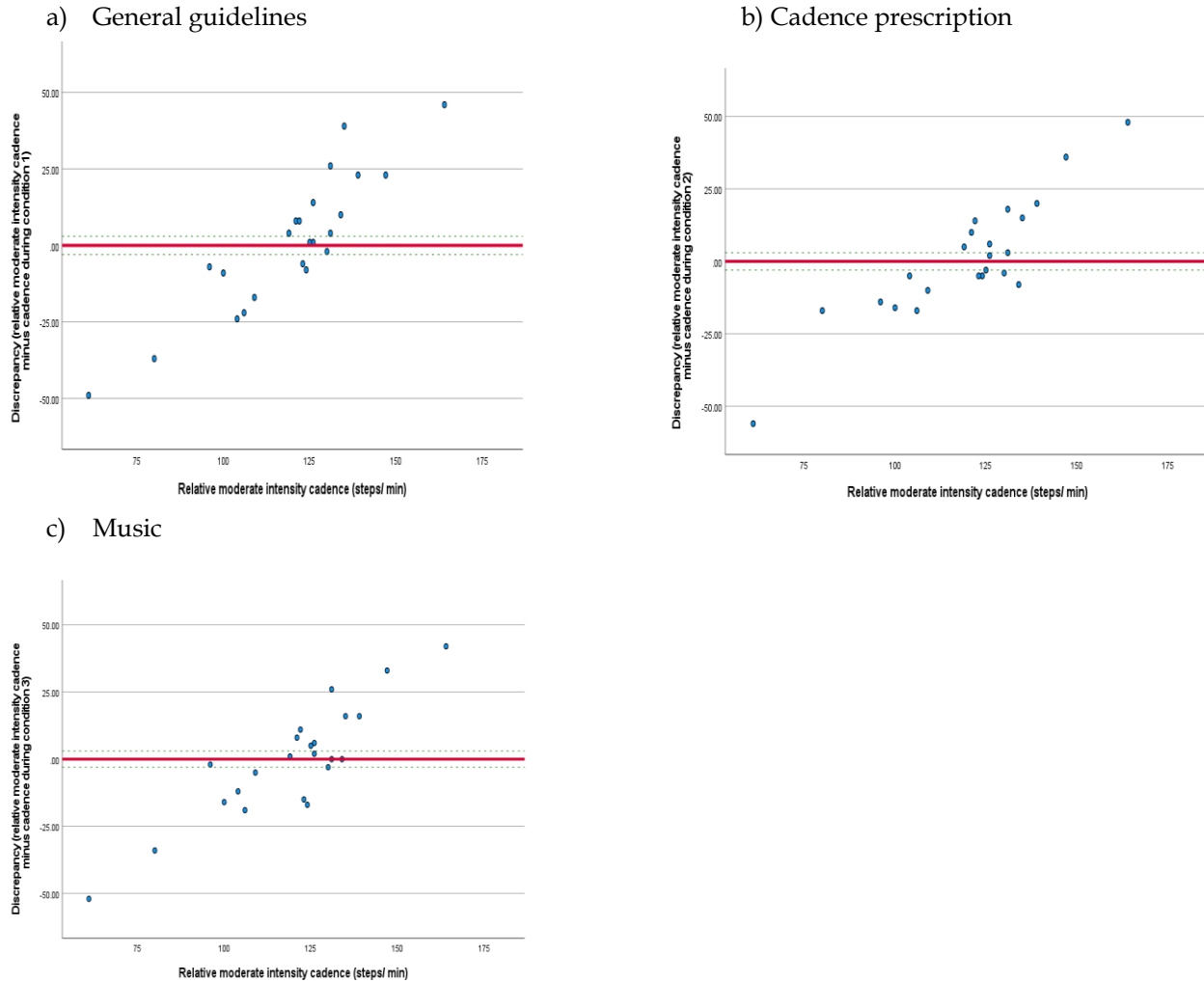


Figure 1. Moderate relative intensity cadence discrepancy scores between conditions.
Note. N =23. The horizontal solid line represents perfect synchronization to moderate relative intensity cadence. The horizontal dashed line represents ± 3 steps min^{-1} of moderate relative intensity cadence.

Perceptions of the Three Conditions: Twenty-one participants completed an interview exploring perceptions of the three conditions, with two participants withdrawing for reasons unknown. Findings are presented in relation to four overarching themes: attainment and regulation of moderate intensity physical activity, clarity and comprehension, ease of implementation, and affective states.

Attainment and Regulation of Moderate Intensity Physical Activity: Both the music and cadence prescription conditions were predominantly positively perceived by participants for attaining and regulating moderate intensity. When probed for their primary favored method, 14 of 21 participants (67%) cited the music condition. Participants perceived that the music condition enhanced their ability to attain and self-regulate a consistent moderate intensity by providing a constant point of reference to entrain their footsteps.

...the beats in it help keep your feet going, you know that steady rhythm so I do, so I think when you're walking or exercising, I think music helps keep you on that steady line, whereas when you're walking normally you can stop or get distracted and that will either pick up your pace, but when you're concentrating on the music you're just constantly listening to the beat and it keeps you going steadily...it keeps you on progress. (Participant [P]9)

...it's easier because there's that repetition, of just...this is something I can keep following to and it's always something you can shift back onto if you start to drift off in your own head. It's just constantly there reminding you how to count the beats and stuff and the beats per minute are matched to what you are trying to achieve. (P19)

The cadence prescription condition was perceived by 6 of 21 (29%) participants as the most effective means of attaining and regulating moderate intensity walking.

I think knowing my steps per minute for condition 3 (cadence prescription) helped the most, because it was an active, it was an active cognitive exercise that I was engaged in, counting my steps per second and trying to think more about the walking ...I think it's a better way of being fully aware of how fast you're walking and trying to keep to your respective beats per minute or steps per minute. (P13)

I didn't realize how many steps I was supposed to be doing per minute and that made me count and get the pace up. (P14)

Individual variability in perceptions of the general guidelines for attaining and regulating a moderate intensity cadence existed, with only 1 of 21 (5%) advocating this as the most effective method. Those who perceived this aid positively cited the specific examples of moderate intensity activities offered within the physical activity guidelines as helpful.

The information was helpful, it made me aware of what I needed to do to achieve moderate intensity exercise daily, so I can increase my walking speeds daily to make sure that am I doing moderate intensity even when I am getting from place to place. (P11)

Um, I thought the first one with the NHS description helped me keep the pace better... purely because it was just giving you physical things you could look out for and you didn't have to pay too much attention to. (P16)

However, others felt that this aid evoked a light intensity cadence response.

In that one I was just walking and winging what I thought was a moderate pace, but it was the least I felt out of breath and stuff because I wasn't actually pushing myself. (P9)

I didn't know how many steps I should be doing and I was just kind of dandering... and I wasn't thinking about it I was just going for a walk. (P17)

Clarity and Comprehension: Participants perceptions differed with regards to the clarity and comprehension of the three moderate intensity cadence aids. Participants were able to comprehend what was required within the music condition.

Personally, I find the music fairly clear in what it is you're trying to do in maintaining a persistent beat, beats per minute that you can walk to. (P13)

Yeah, I understood what I was expected to do. (P3)

Participants predominantly cited the cadence prescription as clear and intelligible.

I understood the question and what was asked of me, it was clear, it was concise. It was straight to the point, there was no room for interpretation on...whereas with the first one it was leaving it open a bit more to interpretation. (P3)

...steps per minute? Yeah, I had to count, and it was clear what I had to do, a good understanding of what was expected. (P8)

The majority of participants indicated that the general guidelines aid facilitated an understanding of what was required to achieve a moderate intensity cadence, however more individual variability existed compared to the other conditions.

I found it quite clear to understand, I would do quite a lot of walking so found it clear to understand, it gave a couple of different ways to sort of ascertain what moderate activity was, umm, the breathing, the being able to talk and the getting warm. (P3)

Not very clear...I think moderate is different for each person and it's really just open to interpretation. So you need more detail I think on what moderate actually is. (P21)

Ease of Implementation: Most participants indicated that the general guidelines were easy to implement, with 10 of 21 (48%) participants preferring this aid to others, citing reduced cognitive demands as a key factor.

The first one just because I wasn't really thinking about it, there wasn't really any effort to keep up. (P10)

So I kind of used that from the description of how I would pace my walking, so I think I that was really good about it. (P9)

Seven of 21 (33%) of participants indicated that music was the easiest aid to implement compared to others.

It had a good beat to follow so it was easy. It was consistent em, it was good yeah... you were able to have that beat and then set your pace to that beat, so yeah. (P11)

There was no problem at all. I was, uh, getting the right beat and it was very easily done and maintained once you got the beat and that was against your step it was very simple. Much easier because you were more focused on the music rather than absolutely nothing and just walking aimlessly. Like when you had a beat to go to. (P20)

However, variability existed with regard to ease of implementation. Certain participants indicated that although instructions were easily understood, it was difficult to enact.

It was sort of like going through songs I know and trying to match the beats/min to and trying to match that but again its sort of impossible to do it. It was clear what you had to do. (P5)

Others felt the changing composition of the music did not facilitate consistent entrainment, even at a consistent tempo.

One track sounded a lot quicker than the others, whether it was just a particular style I don't know, I'm sure the beats were the same, but it did feel like one of the songs was a lot faster than the others so, that probably encouraged you to walk a bit faster. However, I found it very difficult to get into a steady pace with the music, like a steady stride because the music changed sort of, the composition of music changed so it was difficult to get into a steady stride with the beat because it's quite confusing. (P16)

Discrepant views on the ease of implementation of the cadence prescription aid was evident. Only 4 of 21 (19%) of participants favored this aid for ease of implementation.

Um, the step rate, yeah that was fine, it was easy...with me given an easy number at 119 to try and track just two steps per second, like it was relatively easy to time it using my watch. (P13)

I was able to um, balance my step count to what I was supposed to do in the minutes... I was able to this no problem. (P11)

Several participants noted the ongoing cognitive demand associated with this aid as difficult (e.g., being cognizant of the prescribed step rate, monitoring of steps, and time), and questioned the long- term feasibility of this method.

I just didn't really grasp, I wasn't doing it very well.... must be my rubbish counting. Em I don't know, I got the first few minutes I think well, then I maybe lost interest a bit and started dazing off... probably not the best thing to be doing everyday if you're wanting to keep that. (P2)

The pace one, like counting your pace would probably be more difficult if you were walking with someone, like if you were walking with a friend or something. (P3)

Affective States: Twenty-one of 21 (100%) participants indicated that the music condition promoted greater positive affective states including enhanced alertness, calmness, and relaxation compared to the other conditions, which evoked negative affectivity in some.

I felt more alert and more active...I felt more happier doing it, I don't like exercise...so the music was actually brightening up my mood while I was doing it made me feel more happier doing it compared to the other two. (P9)

It kept me alert and it kept me, um, interested as well so it did throughout this study, the other two stages um, I just wanted the time to go up as soon as possible, but with the final stage especially with one of the songs I was very interested in and focused on, it kept me interested and motivated. (P12)

Well, I didn't enjoy the second one where I had to do the counting...but I just kind of felt that you know, trying to keep pace with all of a sudden I was kind of thinking make sure to try to get these steps in. I think it was maybe, ok you had to focus on that, and make sure I was doing it correctly I suppose. (P20)

DISCUSSION

The present study provides a unique contribution to the literature by comparing the utility of three distinct approaches for aiding a moderate intensity cadence and their effects on affective states. Moreover, the novelty extends to the inclusion of a qualitative approach exploring individuals' perceptions of these aids, important information for triangulation, and determining acceptability and long-term fidelity. The findings suggest that compared to the cadence prescription and general guidelines aids, music resulted in significantly greater relative physical activity intensity, proportion of participants attaining moderate relative intensity physical activity, and positive affective states. This was corroborated by qualitative findings which suggested that predominantly participants perceived music as the most effective means of attaining the aforementioned outcomes. However, consistent with the cadence prescription and general guideline aids, individual variability existed in participants perceived and actual ability to utilise music to attain and regulate a moderate intensity cadence.

The music aid elicited a mean RPE of 11.57 which corresponds to moderate relative intensity (41). A walking cadence of 120.10 was observed which also aligns with a moderate relative intensity cut-off point determined via a receiver operating characteristic method of analysis by O'Brien et al. (2018); albeit cut-off points in that study ranged from 120–125 steps min⁻¹ depending on the modelling technique (42). These findings are consistent with Perry et al. (2019) that found entrainment to a single track with tempo of 100 bpm resulted in ≥3 metabolic equivalents in 90% of participants, and greater metabolic intensity compared to a self-paced trial (44). Similarly, Faulkner et al. (2021) demonstrated music to prompt the attainment of a target walking cadence, and the regulation of exercise intensity, which was sustained in the absence of music (25).

In the current study the music aid was perceived as easy to comprehend, with the beat providing a reference point for consistent entrainment at a moderate intensity cadence (63). Entrainment can occur to varying tempo spontaneously (64), or preferentially by instruction (63) and may reduce the metabolic cost of exercise by promoting neuromuscular or metabolic efficiency (31). However, the ability to entrain varied, with only 8.70% of participants achieving perfect synchronization, and 26.10% within 3 steps -1 (Figure 1c), which was triangulated by qualitative findings, and likely responsible for the inconsistent attainment of moderate relative intensity within this condition. These findings are inconsistent with Rowe et al. (2013) who found 92% of participants were able to walk within 3 steps -1 of a metronome (51). However, in contrast to a metronome, a music track or playlist may not always provide a consistent beat to act as cue to entrain footsteps and may be of varying 'vigor' which is known to influence walking cadence despite consistent tempo (33), a suggestion supported by the qualitative findings. Moreover, ability to entrain to music may be moderated by the prescribed tempo, which is optimal between 106 and 130bpm (60). As shown in Figure 1, participants with a prescribed cadence outside this range exhibited greatest deviations, supporting the existence of an 'entrainment basin' (64). Lastly, variability in entrainment ability may be due to sex (64), provision of instruction, practice, and experience (63).

The cadence prescription aid evoked greater moderate relative intensity compared to the general guidelines condition. However, the mean RPE of 9.78 and cadence of 118 steps min⁻¹, corresponds to light relative intensity physical activity (41, 42). Indeed only 21.70% of participants attained moderate relative intensity using this aid. The findings are discrepant with previous research, demonstrating individualized or generalized walking cadence prescription led to a significant increase in moderate intensity bouts (35, 57). This difference may result from the longer duration of the aforementioned studies, affording greater time to practice cadence regulation. Most participants perceived this aid to be intelligible, however consistent with the music condition, individual variability existed in perceived and actual ability to implement. As shown in Figure 1b, only 13% of participants walked within 3 steps min⁻¹ of their prescribed cadence, corroborated by qualitative findings, with 19% of participants specifying this as the easiest aid to implement. For certain participants this aid was cognitively demanding, incapable of holding their attention, and of questionable long-term efficacy, particularly in a social setting.

The general guidelines aid led to a significantly lower proportion of participants (4.3%) realizing moderate relative intensity, with a mean RPE of 8.61 and cadence of 118 step min⁻¹, corresponding to light relative intensity (41, 42). This was triangulated by qualitative findings with one participant (4.3%) perceiving this as the most effective aid for attaining and regulating a moderate intensity cadence, with several indicating that it only encouraged light intensity physical activity. Despite certain participants advocating the efficacy of the descriptive examples of moderate intensity provided by this aid, others perceived it as vague, and susceptible to individual interpretation. Previous research has shown similar poor regulation of moderate intensity physical activity after hearing a description (16, 48) or when instructed to walk at a 'medium pace' (38). No differences were exhibited in absolute intensity (METs), a finding of less relevance given participants were prescribed an individualized moderate

intensity cadence. Importantly, relative intensity indicators consider individual differences in fitness, a factor known to moderate the cadence required to achieve moderate intensity (1). Indeed, similar to previous research (5), the moderate relative intensity cadence varied from 75 to 150 steps min^{-1} , highlighting the significance of setting individualized cadence goals, rather than generic, heuristic goals such as 100 steps/ min (1), even if more onerous to determine.

Finally, the music condition was both perceived and observed to evoke higher positive affect than other aids. Interestingly, this was observed despite a higher intensity being achieved than other conditions. This contrasts with most evidence which suggests increased intensity is associated with lower positive affect (23, 47). However, listening to music can maintain or improve positive affect despite exercising at a higher intensity (9). Music increased positive affect in a sample of patients walking on a treadmill (24) and individuals exercising at a high intensity (30). Music may enhance affective states through the activation of the prefrontal cortex, distracting from fatigue (30, 56), and relieving stress (53).

Strengths and Limitations: The current study possesses limitations. The predominantly female sample, a sex known to have greater ability to entrain to music (64) limits generalizability. Similarly, the sample consisted of predominantly of individuals within a 'healthy' BMI range, thus caution should be exercised when generalizing the findings to the general population who may have different experiences, and physical activity capabilities. Moreover, conflicting definitions of moderate relative intensity exist, including 64-76%, 55-69%, and 60% of HRmax (61), thus introducing potential error. The individualized moderate intensity cadence determined in a controlled treadmill trial, may not generalize to the indoor track, however this procedure is consistent with other studies (51), and walking during these two conditions may be kinetically equivalent (49). RPE, a subjective measure of moderate relative intensity used during the walking trial may be susceptible to measurement error, however it is a valid and reliable instrument that strongly correlates to physiological measures of exercise intensity (6). Moreover, quantitative results may owe to a 'Hawthorne Effect' and not reflect free-living behaviors. The measurement of affective responses was undertaken following each condition, not in-task, nor any individual differences in these responses ascertained. Any enhancement or preservation of affective states post-exercise may stem from a 'rebound effect' due to the cessation of the activity, rather than the effects of the exercise bout itself (8). Moreover, the examination of mean responses across individuals may mask important differences in affective responses between individuals (22). Finally, the qualitative approach did not incorporate member reflections, prolonged engagement, or calculation of inter-coder agreement, which are important facets of rigor (4). Given the sampling approach employed, readers should use the thick description of the methods to judge transferability of the findings to other settings, and its dependability (4). Despite these limitations, the study possesses strengths given it is the first to quantitatively compare the effectiveness, and qualitatively explore perceptions of three distinct moderate intensity walking aids. The mixed methods approach facilitates triangulation, and the elucidation of findings in richer detail than quantitative methods alone (2).

Implications for Research and Practice: The results inform researchers and practitioners seeking to promote moderate intensity physical activity. Providing general physical activity guidelines may be insufficient to prompt moderate intensity walking. Cadence prescription promotes greater moderate intensity physical activity; however, music may be the most effectual, with the additive benefit of heightening positive affect. Practitioners and researchers should be cognizant of the individual variability in ability, and factors that moderate entrainment to music to heighten intervention fidelity and avoid 'type 3 error' (20); for instance, by selecting tracks with consistent 'vigor' and beat throughout (33). Moreover, sufficient instruction and practice (63) may promote physical and psychological capability for entrainment (36), important determinants of behavioral enactment. Among those with sufficient ability to entrain, music could be utilized to manipulate training intensity by progressing and regressing tempo.

Finally, cadence prescription was perceived as cognitively demanding, difficult to implement, and evoked negative affectivity for certain participants. Those wishing to utilize cadence prescription should be cognizant of this by utilizing contemporary pedometers that provide real-time audible feedback when upper and lower limits of moderate intensity cadence are exceeded (5).

Future Research: This research should be replicated over a longer time period to enable sufficient opportunity for practice of the three aids or compare the effects of different doses of training on entrainment and moderate intensity physical activity. A mixed method comparison of individuals with greater and less ability for entrainment may identify those likely to benefit from music as moderate intensity cadence aid, and any how to enhance entrainment ability.

Conclusion: Music was the most effective aid for assisting the attainment and regulation of a moderate intensity walking cadence, and promoting positive affect, compared to cadence prescription or provision of general guidelines. This was corroborated by qualitative findings; however individual variability exists in perceived and actual ability to entrain to music.

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