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Conscious control of gait increases with task difficulty and can be mitigated by external focus instruction

Toby C.T. Mak[1]*, Ph.D., William R. Young[2], Ph.D., Thomson W.L. Wong[1,3], Ph.D., RPT

[1] School of Public Health, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong SAR, China.

[2] College of Life and Environmental Sciences, University of Exeter, United Kingdom.

[3] Department of Rehabilitation Sciences, Faculty of Health and Social Sciences, The Hong Kong Polytechnic University, Hong Kong SAR, China.

*Corresponding author:

Dr. Toby C.T. Mak
School of Public Health,
Li Ka Shing Faculty of Medicine,
The University of Hong Kong
E-mail: makchito@connect.hku.hk
ORCID: 0000-0002-0490-4950

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We aimed to address whether increased task difficulty is sufficient to induce heightened conscious control and influence gait performance in older adults through the manipulations of either task difficulty or attentional focus. Fifty older adults, split into high- (HR) and low-reinvestor (LR) groups, performed a walking task on a 7.4m straight walkway in two conditions: firm level-ground surface (GW) and foam surface (FW). They subsequently performed the same walking task under two attentional focus conditions: Internal focus (IF) and External focus (EF). Electroencephalography (EEG) T3-Fz and T4-Fz coherences were used to indicate real-time conscious motor control and visual-spatial control, respectively. We observed significantly higher T3-Fz and T4-Fz coherences under FW compared to GW. HR reduced their gait speed at a greater extent than LR under FW. Significantly lower T3-Fz coherence and faster gait were demonstrated under EF compared to IF. LR walked slower under IF compared to Baseline while gait speed of HR did not differ. Visual-spatial and conscious movement processing increase as a function of task difficulty during gait. Our findings also advocate the use of external focus instructions in clinical settings, with the potential to reduce conscious control and promote movement automaticity, even in relatively complex gait tasks.

Keywords: attentional focus; conscious control; gait; task difficulty

Introduction

Although the control of walking actions are mostly regulated by relatively automatic movement processes (Boisgontier et al., 2013), this automaticity may be affected and disrupted when older adults become concerned about the movements and/or experience movement difficulties. Under such circumstances, older adults typically attempt to consciously control and monitor their walking movements; a phenomenon commonly termed ‘reinvestment’ (Masters & Maxwell, 2008).

Reinvestment is associated with a shift in attentional processing characterised by a reduction in external awareness of environmental features and an increased awareness of one’s movements (Uiga, Capio, Wong, Wilson, & Masters, 2015; Young & Williams, 2015; Young, Olonilua, Masters, Dimitriadis, & Williams, 2015). Such changes appear to compromise motor efficiency during posture and gait tasks (Ellmers & Young, 2019; Mak, Young, Chan, & Wong, 2020; Mak, Young, Lam, Tse, & Wong, 2019) that might increase the likelihood of falls in older adults (Young et al., 2015). For example, Mak et al. (2019, 2020) have demonstrated reduced movement efficiency and greater postural sway during level-ground walking tasks when older adults were prompted to consciously process movements. While reinvestment appears to jeopardize motor efficiency during relatively simple posture and gait tasks, it is thought that such inefficiencies will inevitably be realised as instabilities during more complex and challenging tasks (Young & Williams, 2015). Masters, Polman, & Hammond (1993) proposed that the propensity for consciously processing movements (movement-specific reinvestment) is a personality trait that varies between individuals. Wong, Masters, Maxwell, & Abernethy (2008, 2009) were the first to examine reinvestment propensity in older adults and discovered that older adults with a history of falling have a higher tendency to consciously process movements compared to age-matched older adults without any reported history of falling. Individuals with a greater trait reinvestment propensity ('high reinvestors') were also associated with an increased tendency to allocate attention internally at the expense of processing external environmental information.

Previous research has claimed to demonstrate a relationship between increased task difficulty and attentional demands, typically by assessing the outcome of a secondary motor or cognitive task (Boisgontier et al., 2013). Despite this weight of evidence, there has been little discussion about this relationship in the context of conscious cognitive processing (i.e., reinvestment may be largely responsible for such associations). After all, evidence exists linking heightened conscious motor processing in older adults with incidences of stopping walking when talking (Young et al., 2015). Utilizing electroencephalography (EEG) T3-Fz coherence to represent real-time conscious control, Chu & Wong (2019) recently documented an increase in real-time conscious motor control as a function of increased (perceived) task difficulty in older adults during various 'static' posture tasks carried out on a compliant (foam) surface. The use of EEG T3-Fz coherence—a measure of 'communication' between the left temporal region (T3) responsible for verbal-analytical processing (Haufler, Spalding, Santa Maria, & Hatfield, 2000), and the frontal midline region (Fz) of the cortex responsible for movement planning (Kaufler & Lewis, 1999)—was recommended as an objective method to detect the engagement of conscious control in motor performance (Zhu, Poolton, Wilson, Maxwell, & Masters, 2011). Zhu et al. (2011) first reported that high reinvestors increased T3-Fz coherence during golf-putting compared to 'low reinvestors'; implying that high reinvestors have a greater tendency to utilize conscious (verbal) movement processing (T3) during movement planning (Fz).

Chu & Wong (2019) examined static posture which requires relatively little effort in physical and cognitive demands (Lajoie, Teasdale, Bard, & Fleury, 1993). Investigating dynamic posture such as locomotion; a movement that involves multi-joint coordination and more dynamic, on-line regulation with a relatively higher attentional cost (Lajoie et al., 1993), is essential since locomotion is suggested to be the most common fall-related activity in older adults (Li et al., 2006). Thus, the **first aim** of the current study is to evaluate whether increased task difficulty will contribute to increased conscious movement control during locomotion in older adults. We applied a compliant (foam) surface to heighten task difficulty during a walking protocol. Compliant surfaces create dynamic perturbations to locomotion which increase demands for proprioceptive feedback; thus increasing task complexity compared to walking on a level-ground firm surface (MacLellan & Patla, 2006). We attempted to compare EEG T3-Fz coherence between walking on a foam surface and a firm level-ground surface. As a general indicator of performance, we also compared gait speed between conditions. We predicted that conscious control would increase and gait speed would decrease as a function of task difficulty. Since high reinvestors were often found to allocate more inward attention towards their limb movements during walking (Uiga et al., 2015), we specifically predicted that they are more likely to adopt conscious strategies and reduce their gait speed more than low reinvestors when walking on the foam surface.

Conscious control, in most situations, serves to compromise motor behaviour (Masters & Maxwell, 2008; Wulf, 2013). Given the apparent adoption of conscious movement processing observed in older adults concerned about their balance (Chu & Wong, 2019; Ellmers, Cocks, & Young, 2019), our **second aim** was to explore manipulations of attention that could modulate changes in conscious motor control. A considerable amount of literature has described the effects of manipulating attentional focus on motor performance (Wulf, 2013). An internal focus—a parallel concept to the theory of reinvestment—refers to an inward attention to consciously controlling and monitoring movements which compromises the automaticity of movement control mechanisms. In contrast, an external focus refers to a diverted attention towards movement effects on the environment, which is thought to enable self-organized motor control processes to run in the relative absence of cognitive interference, potentially reducing conscious involvement (and associated demands) during movement execution, resulting in a more efficient and effective motor performance (Wulf, 2013). Previous work by Ellmers et al. (2016) investigated whether the EEG T3-Fz coherence method is sensitive to detect changes in attentional focus when regulating postural control. Their results indicate that an internal focus led to an increase in dependence on such explicit cognitive processing. However, they did not discover any differences in T3-Fz coherence between an external focus condition and baseline, possibly due to the relatively low levels of conscious control during the relatively simple postural sway task.

Taking into account the potential explanation for the lack of significant findings above, we suggest that verbal instructions related to attentional focus could regulate the involvement of conscious control in a more complex task. We argue that an external focus condition could reduce EEG T3-Fz coherence compared to an internal focus or baseline condition during our current challenging gait task. We also sought to determine if the above manipulations of task difficulty and attentional focus would influence gait performance. Given the anticipated increase in conscious control and compromised gait performance during a baseline task with high task demands (the first aim of the study), we predicted that, when adopting an external focus of attention, both high and low reinvestors would exhibit reduced conscious control and improvement in gait performance compared to baseline or an internal focus condition. When given an internal focus instruction, we expected low reinvestors, thought to allocate greater attention to the external environment (Uiga et al., 2015), to shift their attention more to an inward awareness of body movements, resulting in an increase in conscious control and compromised gait performance. Conversely, high reinvestors are expected be more accustomed to such processes (Uiga et al., 2015), and would therefore demonstrate a reduced susceptibility to internal focus instructions and maintain gait performance compared to Baseline.

Method

Participants

Fifty community-dwelling older adults (mean age=71.4±4.7) were recruited by convenience sampling from the community in Hong Kong. Study Four reported an effect size of 0.16, which suggests a total sample size of approximately 50 participants can provide adequate power for this study. They were a) aged 65 or above; b) able to walk independently indoors; c) scored at least 25/30 on the Mini-Mental State Examination–Cantonese version (MMSE-C) (Chiu, Lee, Chung, & Kwong, 1994) which represents normal cognitive functioning; and d) without any history of neurological impairment (e.g., Stroke or Parkinsonism). The research protocol was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW IRB) (UW 19-096).

Tasks and Procedure

Before performing walking trials, participants' demographics were collected (i.e., age, gender, education level and medical history). The Berg Balance Scale (BBS) was then performed for assessing functional balance ability (Berg, Wood-Dauphine, Williams, & Gayton, 1989). Participants also performed the Timed Up & Go Test (TUG) to evaluate functional mobility (Podsiadlo & Richardson, 1991). Apart from physical measures, participants completed the Falls Efficacy Scale (FES-13 items) as a psychological assessment to evaluate fear of falling (Hellström & Lindmark, 1999). Participants also completed the Chinese version of the Movement Specific Reinvestment Scale (MSRS-C) (Masters, Eves, & Maxwell, 2005; Wong et al., 2008) to assess the propensity for consciously processing movements.

Walking procedure

Participants completed walking trials on both firm and foam surfaces. They were initially instructed to perform a block of five Ground Walking trials (GW) on a straight, firm 7.4-metre level-ground walkway and another block of five Foam Walking trials (FW) on a straight 7.4-metre foam walkway. The foam walkway was made of medium density foam (MacLellan & Patla, 2006) with dimensions of 8m (long) x 0.8m (wide) x 0.3m (depth). The order of blocks was randomized. For every trial, participants were instructed to walk to the end of the corresponding walkway at a self-selected comfortable pace. Upon completion of the GW and FW walking trials, participants were asked to complete a Visual Analog Scale (VAS) ranging from 0–100 for reporting perceived task difficulty in each condition (Gift, 1989). The FW trials also served as a Baseline condition to compare with attentional focus walking trials.

After completing the GW and FW trials, participants proceeded to a series of attentional focus walking trials that were categorised according to attentional focus instructions provided. Participants were instructed to perform a block of five External Focus walking trials (EF) and a block of five Internal Focus walking trials (IF) on the foam walkway. The order of blocks was again randomized. For EF, a 27’’ LED computer monitor was positioned at the end of the walkway. A random series of digits ranging from 1–9 were presented on the monitor during the trials (Mak et al., 2020, 2019). The instruction to participants was “Please walk to the end of this 7.4-metre walkway at your natural pace. While you are walking, please look at the monitor in front of you and focus on the digits presented”. A yes-or-no question was then asked about the digits immediately after the trial for manipulation check. An example was “The second digit appeared in the monitor was 4”. For IF, the monitor was switched off. The instruction to participants was “Please walk to the end of this 7.4-metre walkway at your natural pace. While you are walking, please focus on your lower limb movements”. A yes-or-no question was then asked about their lower limb movements immediately after the trial for manipulation check. An example was “You walked for more than 12 steps”.

Apparatus

A wireless electroencephalographic (EEG) device (Brainquiry PET 4.0, Brainquiry, The Netherlands) with a sample rate of 200Hz was used to collect EEG activity data during the walking trials. Real-time cortical activity was recorded by a biophysical data acquisition software (BioExplorer 1.5, CyberEvolution, US). Participants were equipped with disposable 24mm electrodes placed at three scalp locations, which are the left temporal region (T3), right temporal region (T4) and frontal midline (Fz) (Chow, Ellmers, Young, Mak, & Wong, 2019; Chu & Wong, 2019; Ellmers et al., 2016; Zhu et al., 2011). The disposable electrodes were also attached to the right mastoid as the reference electrode and left mastoid as the ground electrode. Locations of all sites were measured according to the standard international ten-twenty electrode system (Klem, Lüders, Jasper, & Elger, 1999). EEG data was pre-processed by a biophysical data processing and analysis software (BioReviewer 1.5, CyberEvolution, US). Before every measurement, an impedance test was performed by a 48–52 Hz filter with threshold fixed at 20μV. A low pass filter (42Hz) and a high pass filter (2Hz) were used to eliminate potential biological artifacts and noise from the raw signals. T3-Fz and T4-Fz coherences were calculated in 1-Hz frequency bins with previous customized scripts and algorithms (Zhu et al., 2011). Specifically, we selected a high-frequency band of Alpha2 EEG coherence signals (10–12Hz) since it has a relatively higher sensitivity in localizing activation in cortical regions than a low-frequency band of Alpha1 EEG coherence signals (von Stein & Sarnthein, 2000). In addition to T3-Fz coherence, T4-Fz coherence was measured since it is thought to represent the level of visuo-spatial processing involved in motor planning and performance, which might provide a more comprehensive understanding on the cortical co-activation during the locomotor tasks described above (Zhu et al., 2011). Gait speed was computed by dividing the walking distance by ambulation time.

Data analysis

Participants were first divided into two groups of High Reinvestors (HR) or Low Reinvestors (LR) by median split of the MSRS-C total score (Chu & Wong, 2019). Twenty-two participants were classified as LR (MSRS-C<33) and twenty-four participants were classified as HR (MSRS-C>33). Four participants were excluded from group allocation (MSRS-C=33). The raw data of EEG T3-Fz and T4-Fz coherences for one participant were missing and therefore not included in our analyses. Statistical analysis was performed using SPSS, version 25.0. Multiple independent samples t-tests were first performed to compare participants' characteristics between groups (HR and LR). For the first aim, four 2x2 mixed ANOVA were then performed to investigate the effects of walking task complexity (GW, FW) between groups (HR and LR) on VAS perceived difficulty, EEG T3-Fz coherence, T4-Fz coherence and gait speed. For the second aim, three 2x3 mixed-ANOVA with Bonferroni adjusted post-hoc tests were performed to investigate the effects of attentional focus conditions (EF, IF, Baseline) between groups (HR and LR) on T3-Fz coherence, T4-Fz coherence and gait speed during the foam walking task.

Results

Participants' Characteristics

Age, MMSE, BBS, TUG and FES-13 scores did not differ significantly between HR and LR (all $p > .05$) (see Table 1). MSRS-C score differed significantly between HR and LR ($p < .001$). In addition, the average accuracy for external and internal focus manipulation checks were 97.3% and 82%, respectively.

Table 1 near here

Foam–Ground walking trials

For VAS scores, there were no significant group x task complexity interaction ($F[1, 44]=.962$, $p=.332$, $\eta p^2 =.021$) and main effects of group ($F[1, 44]=.263$, $p=.611$, $\eta p^2 =.006$). A significant main effect of task complexity was found, showing that VAS at FW was significantly higher than that at GW ($F[1, 44]=37.739$, $p < .001$, $\eta p^2 =.462$).

For EEG T3-Fz coherence (see Figure 1) and T4-Fz coherence, there were no significant group x task complexity interaction (T3-Fz: $F[1, 43]=.238$, $p =.628$, $\eta p^2 =.005$; T4-Fz: $F[1, 43]=.259$, $p =.614$, $\eta p^2 =.006$) and main effects of group (T3-Fz: $F[1, 43]=.114$, $p =.738$, $\eta p^2 =.003$; T4-Fz: $F[1, 43]=.063$, $p =.803$, $\eta p^2 =.001$) for both variables. Significant main effects of task complexity were found, revealing increases in both T3-Fz and T4-Fz coherences during FW compared to GW (T3-Fz: $F[1, 43]=6.066$, p =.018, ηp^2 =.124; T4-Fz: $F[1, 43]=8.028$, p =.007, ηp^2 =.157).

For gait speed, there was a significant group x task complexity interaction ($F[1, 44]=11.036$, p =.002, ηp^2 =.201) (see Figure 2). There was no significant main effect of group ($F[1, 44]=2.457$, p =.124, ηp^2 =.053). However, a significant main effect of task complexity was found ($F[1,44]=87.759$, p <.001, ηp^2 =.666). Post-hoc comparisons revealed that HR walked significantly slower than LR in FW ($t[44]=2.334$, p=.024) but not in GW ($t[44]=.803$, p=.426). While both HR and LR significantly reduced gait speed during FW compared to GW (HR: $t[23]=8.434$, p<.001); LR: $t[21]=4.682$, p<.001), the reduction for HR was larger than LR.

Figure 1 near here

Figure 2 near here

Attentional Focus walking trials

For EEG T3-Fz coherence, Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 1.603$, p =.449. There were no significant group x condition interaction ($F[2, 86]=.571$, p =.567, ηp^2 =.013) and main effects of group ($F[1, 43]=.022$, p =.882, ηp^2 =.001). A significant main effect of condition was found ($F[2, 86]=4.828$, p =.01, ηp^2 =.101). Post hoc comparisons showed that T3-Fz coherence was significantly lower under EF compared to IF (p=.023) (see Figure 3).

For EEG T4-Fz coherence, Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 1.764$, p =.414. There were no significant main effects of condition ($F[2, 86]=2.356$, p =.101, ηp^2 =.052), group ($F[1, 43]=.064$, p =.801, ηp^2 =.001) or group x condition interaction ($F[2, 86]=.161$, p =.851, ηp^2 =.004).

For gait speed, Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 3.789$, p =.150. There was a significant group x condition interaction ($F[2, 88]=3.261$, p =.043, ηp^2 =.069) (see Figure 4). There was no significant main effect of group ($F[1, 44]=2.612$, p =.113, ηp^2 =.056). However, a significant main effect of condition was found ($F[2, 88]=26.669$, p <.001, ηp^2 =.377). Post-hoc comparisons revealed that LR and HR only differed in Baseline ($t[44]=2.334$, p=.024) but not in IF ($t[44]=1.523$, p=.135) and EF ($t[44]=.896$, p=.375). Bonferroni-adjusted post-hoc comparisons revealed that gait speed for both HR and LR was significantly faster under EF compared to IF (HR: p<.001; LR: p=.002). However, gait speed of LR was significantly slower under IF compared to Baseline (p=.050). In contrast, gait speed of HR did not differ between IF and Baseline (p=1.000).

Figure 3 near here

Figure 4 near here

Discussion

Our investigation into the effect of task difficulty on conscious motor processing (the **first aim** of the study) revealed a significant discrepancy in T3-Fz coherence between conditions when older adults walked on a compliant (foam) surface compared to a firm level-ground surface. This observation is thought to represent increased communication/coherence between T3 and Fz regions (verbal-analytical/motor planning) in a condition where gait movement was challenged, at least perceptually (as reflected by the increased VAS scores during FW). The theoretical framework of reinvestment generally considers conscious control to be a consequence of psychological pressure or movement disorder/impairment (Masters & Maxwell, 2008; Masters et al., 1993). The current findings, however, provide additional evidence to illustrate that locomotor task difficulty—possibly due to complex environmental factors—may also elicit greater cognitive processing or more attention preferentially allocated to monitoring and controlling limb movements to ensure safety. Yet, overreliance on a conscious controlling strategy (in the context of locomotion) could be worrying since conscious verbal control has the potential to overload cognitive processing capacity and compromise performance in gait and other concurrent tasks (Clark, Rose, Ring, & Porges, 2014; Uiga et al., 2020). Our findings of altered gait speed lend support to the above interpretations, specifically in older individuals with high trait reinvestment propensity. We speculate that compared to LR, HR were more susceptible to adopt conscious strategies that likely compromised movement 'fluency' at a greater extent under increased task demands. Interestingly, such gait strategies may be associated with cautious gait patterns frequently observed in older adults with a fear of falling (Ronthal, 2019). Nevertheless, both observations are potentially generated from a common mechanism of adopting an internal focus towards movement mechanics.

It is interesting to note that EEG T4-Fz coherence (the alleged communication between visual-spatial and motor planning processes) increased with T3-Fz coherence during FW trials. The previous study by Chu & Wong (2019) did not discover differences in T4-Fz coherence among different (perceived) task difficulties. We hypothesize that such discrepancy is due to the difference in task characteristic; enhanced effort in visuospatial motor planning is necessary when walking under challenging conditions (i.e., along a foam walkway) to ensure safe navigation (Deeny, Hillman, Janelle, & Hatfield, 2003), compared to a stationary postural task in

Chu & Wong where navigation is not required. This current finding also supports a previous suggestion that visual-spatial processing contributes to the cognitive resources required for regulating gait control, particularly under complex environmental conditions (Menant, Sturnieks, Brodie, Smith, & Lord, 2014).

After reporting increased conscious verbal control as a function of task difficulty, we sought to evaluate an approach that could ameliorate conscious involvement. With reference to this **second aim**, we demonstrate marked differences in T3-Fz coherence between conditions where participants directed their attention either internally or externally during the challenging gait task. Specifically, an external focus manipulation led to lower T3-Fz coherence compared to internal focus. Taken together with our findings of faster gait under EF, the external focus manipulation appeared to successfully divert attentional focus away from participants' body movements with less reliance on conscious (verbal) control processes and promote movement 'fluency' by the dependence on relatively uninterrupted automatic control mechanisms, as posited by the constrained-action hypothesis (Wulf, 2013).

Our findings also revealed that HR and LR reacted differently under IF compared to Baseline. Slower gait was observed in LR when verbally prompted to control gait movement consciously. Such changes in gait were not apparent in HR. Extending Uiga et al. (2015)'s findings, we argue that HR are more accustomed/better-equipped to allocate attention towards conscious movement processing. As mentioned previously, it is likely that HR had an increased tendency to adopt conscious strategies when walking on the foam surface (without any instructions). Therefore, the effect of providing an internal focus instruction might have created very little change in attentional focus. Conversely, our data suggest that LR might possess a reduced capacity to mitigate the effects of IF, resulting in compromised movement automaticity to a greater extent than HR and subsequently less fluent movements in this condition; a slower gait (Masters & Maxwell, 2008).

Taken together, these findings might have high practical utility as they advocate for the use of external focus instructions in gait rehabilitation or therapeutic interventions aiming to reduce conscious motor processing in older adults—an implementation that could potentially benefit gait performance by promoting movement automaticity and subsequently reduce the likelihood of future falls even when facing challenging environmental conditions in daily life. Of course, these suggestions require further scrutiny before such techniques are adopted in practice.

Our findings indicate that MSRS-C scores, a self-reported measurement for trait propensity to consciously control and monitor body movements, do not necessarily relate to T3-Fz coherence in the current gait task; as shown by the lack of significant results between the two reinvestment groups. This is consistent with previous research (Chow et al., 2019; Chu & Wong, 2019; Ellmers et al., 2016). The theory of reinvestment postulates that a higher trait propensity to consciously control movement will presumably engage conscious movement processes which disrupts natural automatic motor processes and jeopardizes movement performance (Masters & Maxwell, 2008). However, we provide further evidence about a clear lack of association between trait reinvestment and conscious motor processes during a gait task. We suggest that trait reinvestment propensity does not play a critical role in the way walkers engage conscious movement processes relevant to their gait even when they are prompted to allocate their attention internally or externally. However, the degree of trait reinvestment could provide an indication regarding a walker's capacity to accommodate conscious movement control strategies under increased task demands and/or efficiently utilise explicit movement cues (e.g., when provided by a physical therapist).

There are some limitations to the current study. First, participants' characteristics have to be taken into account when attempting to generalize our findings to wider older populations. Our cohort demonstrated relatively high levels of functional balance and mobility, and thus might not be representative of those with reduced functional ability. Second, a latest systematic review has suggested a possible interpretation of the T3-Fz coherence measure as reflecting widespread cortical changes instead of inter-regional communication (Parr, Gallicchio, & Wood, 2021). While the current literature is not yet equipped with strong evidence to conclude such perspective, researchers should still be cautious when interpreting the results. Third, we did not obtain any behavioural measurements beyond gait speed during the walking task. Further investigations are warranted concerning potential associations between real-time conscious control (T3-Fz coherence) and a greater variety of behavioural consequences (e.g., gait characteristics relating to efficiency and stability). In addition, future researchers should also investigate how different types of walkway (e.g., a curvy path, obstacle circumvention, etc. that are more commonly observed in a real-life setting) could affect real-time conscious control and/or behavioural outcomes.

The current study represents the first instance where task difficulty is suggested to increase cognitive demands in the context of conscious movement processing and visual-spatial processing during gait. We suggest that HR have a higher propensity to utilize conscious strategies under increased task difficulty in a gait-specific task, but also appear to be more robust when given verbal instructions that refer to body movements. In addition, while previous studies have advocated for the use of manipulations/instructions that induce external allocation of attention, the current study extends this narrative by demonstrating that such manipulations can still be effective during relatively complex gait tasks in older adults. Future work is necessary to establish the association between lessened conscious control and gait performance.

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Declaration of Interest

There are no conflicts of interest for any authors to report.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1. Participants' Characteristics.

Variables	Mean (SD) or N (%)			
	Low Reinvestors (LR)	High Reinvestors (HR)	t-statistics	*p*-value
N (numbers)	22	24	-	-
Gender (female)	13 (59.1%)	21 (87.5%)	-	-
Age (years)	71.1 (4.1)	71.5 (5.3)	-.258	.797
MMSE-C	29.5 (0.7)	29.3 (1.2)	.719	.476
BBS	54.4 (2.9)	54.4 (2.1)	-.072	.943
TUG (seconds)	10.4 (2.5)	10.8 (2.2)	-.485	.630
FES-13	120 (12)	118 (17)	.384	.703
MSRS-C	24.5 (6.4)	43.0 (5.7)	-10.356	<.001*

Note: MMSE-C=Mini-Mental State Examination–Cantonese version; BBS=Berg Balance Scale (range: 0–56); TUG=Timed Up & Go Test; FES-13=Falls Efficacy Scale (13 items) (range: 0–130); MSRS-C=Movement-Specific Reinvestment Scale–Chinese version (range: 10–60).

*denotes *p*-value <.05.

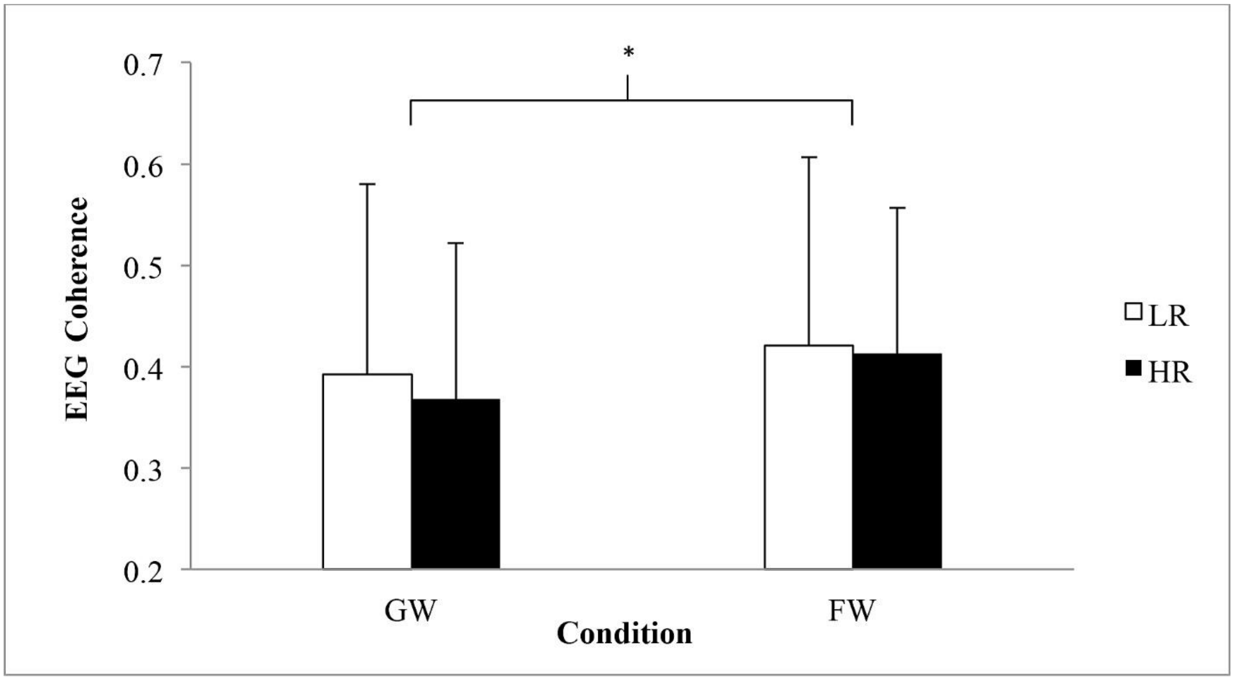
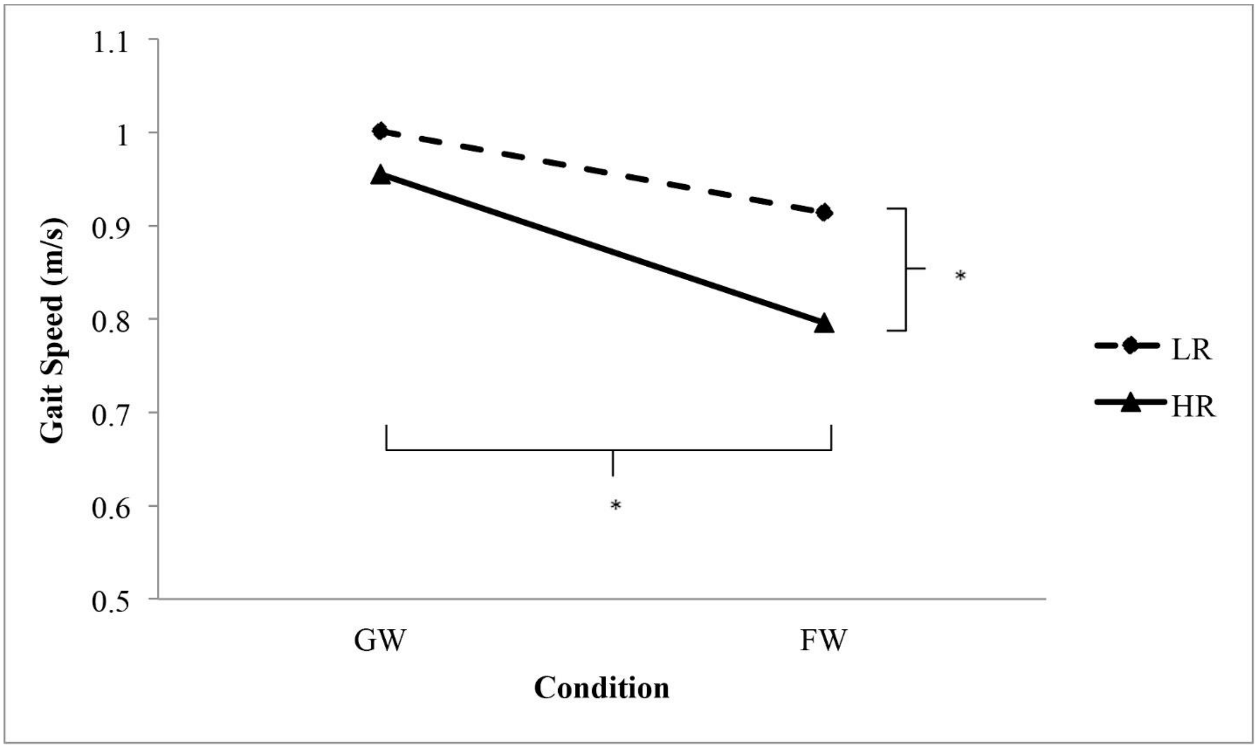


Figure 1.



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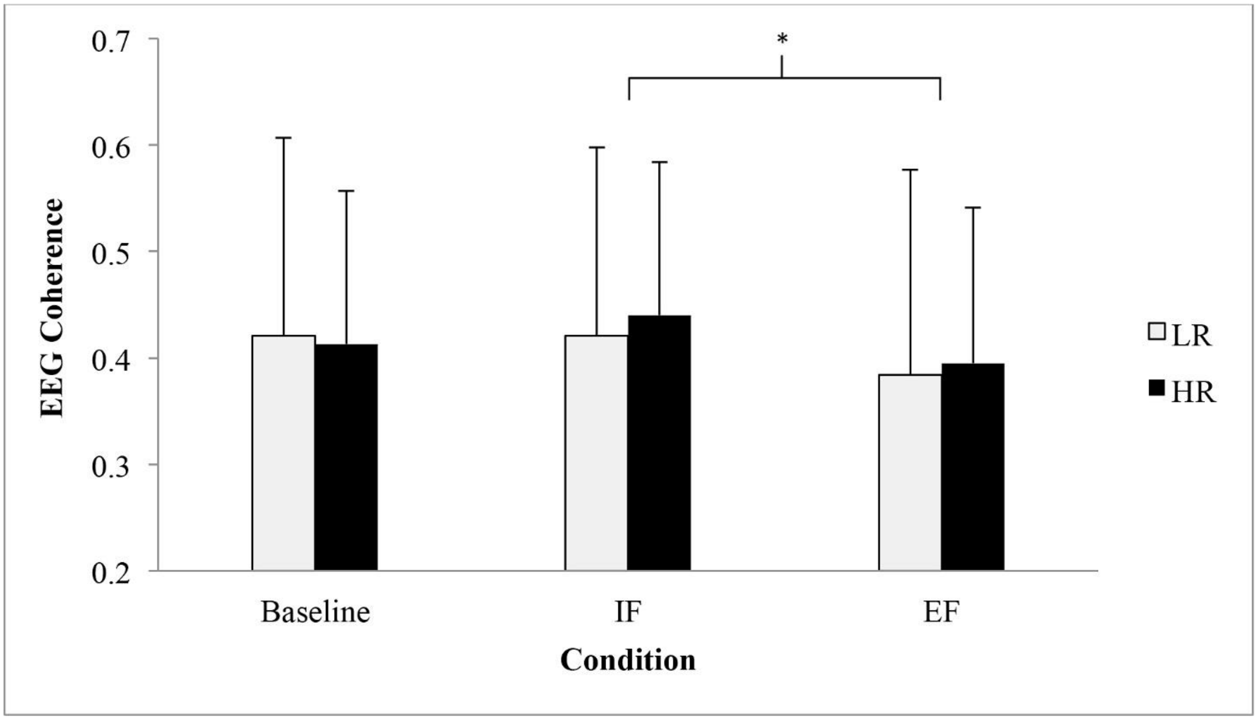

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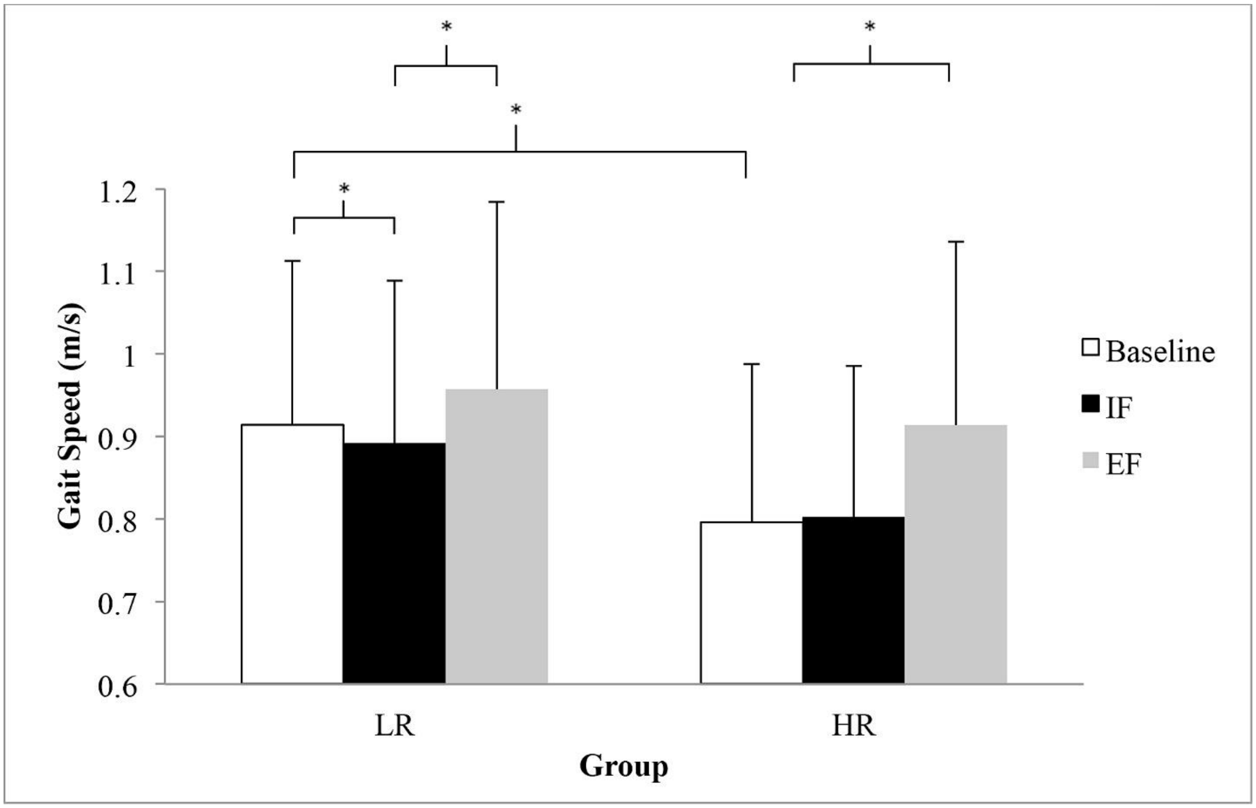

Figure 4.

Figure Captions

Figure 1. Comparison of EEG T3-Fz coherence between Ground Walking (GW) and Foam Walking (FW) in Low Reinvestors (LR) and High Reinvestors (HR). Error bars represent standard deviations of the data. *denotes p-value <.05.

Figure 2. Comparison of gait speed between Ground Walking (GW) and Foam Walking (FW) in Low Reinvestors (LR) and High Reinvestors (HR). *denotes *p*-value <.05.

Figure 3. Comparison of EEG T3-Fz coherence among Baseline, Internal Focus (IF) and External Focus (EF) conditions in Low Reinvestors (LR) and High Reinvestors (HR). Error bars represent standard deviations of the data. *denotes *p*-value <.05.

Figure 4. Comparison of gait speed between Baseline, Internal Focus (IF) and External Focus (EF) conditions in Low Reinvestors (LR) and High Reinvestors (HR). Error bars represent standard deviations of the data. *denotes *p*-value <.05.