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Do attentional focus instructions affect real-time reinvestment during level-ground walking in older adults?

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Abstract

This study represents the first attempt in exploring whether attentional focus instructions could affect real-time reinvestment (conscious movement processing) in older adults during level-ground walking. Forty-five community-dwelling older adults were instructed to walk at a self-selected pace along a 6-meter level-ground walkway under three randomized attentional focus conditions (i.e., Internal, External, and Control) for a total of fifteen trials (five trials for each condition). Electroencephalography (EEG) T3-Fz coherence was utilized as an objective measurement of real-time reinvestment during walking. The Chinese version of the Movement Specific Reinvestment Scale (MSRS-C) was used to measure the trait reinvestment propensity. Results revealed that the EEG T3-Fz coherence did not differ among the three conditions. The EEG T3-Fz coherence at the Control condition was not correlated with the scores of the MSRS-C. Our findings suggest that the measurement of trait reinvestment propensity (MSRS-C) may not be sensitive enough to reflect real-time reinvestment. Moreover, attentional focus instructions do not affect real-time reinvestment during level-ground walking, possibly due to the low level of motor task difficulty in level-ground walking for healthy older adults. Future studies should investigate this influential issue with a more challenging walking task.

Keywords: attention; conscious movement processing; electroencephalography; gait; older adults; reinvestment

Introduction

Reinvestment (conscious movement processing) was defined as a purposeful attempt to execute a motor skill with inward focus utilizing the explicit knowledge and strategies for running the skill (Masters 1992; Masters and Maxwell 2008). Reinvestment was also found to associate with a shift in attentional processing, characterized by increased awareness of the movements internally and reduced awareness of the environmental features externally (Young and Williams 2015; Uiga et al. 2015; Young et al. 2015). Such attentional shift appears to compromise motor efficiency during postural and locomotor tasks (Zaback et al. 2015; Ellmers and Young 2019; Mak et al. 2019, 2020a), that might increase the risk of falling in older adults (Young et al. 2015). Masters et al. (1993) proposed that the propensity for reinvestment is a personality trait with individual differences, and the Movement Specific Reinvestment Scale (MSRS) has been subsequently developed to measure this trait (Masters et al. 2005). The 10-item scale measures two factors of reinvestment, including Movement Self-consciousness (MSC) and Conscious Motor Processing (CMP), in which a higher score represents a higher trait propensity for reinvestment. The Chinese version of the MSRS (MSRS-C) has also been validated among Chinese older adults in Hong Kong through confirmatory factor analysis, that supported the two-factor model previously established in the Western population (Masters et al. 2005). Wong et al. (2008, 2009) were the first to explore the trait reinvestment propensity in the older population. It was discovered that older fallers have a higher propensity to reinvest when compared to the non-fallers. This reinvestment propensity was presented with an increased inclination to allocate attention internally to the limb movements at the expense of processing external environmental information. Although the MSRS has been widely used to assess the predisposition of reinvestment in different populations, recent investigations in the older population appear to implicate that the MSRS could not reflect real-time reinvestment during locomotor and postural tasks (Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019; Mak et al. 2020b).

Researchers in neuroscience have recommended the use of electroencephalography (EEG) as an objective, real-time measurement of reinvestment (Zhu et al. 2011; Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019; Chan et al. 2019). Zhu et al. (2011) suggested the use of EEG coherence, or “communication”, between the left temporal region (T3) and the frontal midline region (Fz) of the cortex, could provide insight on the involvement of verbal-analytical control to motor performance. The T3 is responsible for verbal-analytical processing (Haufler et al. 2000), and the Fz is responsible for movement planning (Kaufler and Lewis 1999). Zhu et al. (2011) were the first to report that individuals with a high trait propensity for reinvestment (i.e., high reinvestors) demonstrated a higher EEG coherence between T3 and Fz regions (i.e., EEG T3-Fz coherence) during a golf-putting task when compared to the individuals with a low trait propensity for reinvestment (i.e., low reinvestors). In conjunction with the theory of reinvestment, it implies that high reinvestors have a greater propensity to utilize conscious (verbal) movement processing (T3) during movement planning (Fz) (Masters 1992; Masters et al. 1993).

Subsequently, Ellmers et al. (2016) investigated whether the utilization of EEG T3-Fz coherence could be applied to postural control, the skill that has been mature in an early stage of life without the necessity of explicit declarative knowledge to regulate movements. They recruited young adults to perform voluntary swaying movements under conditions that direct their attention towards consciously controlling their body movements (internal focus) and towards an external auditory cue that relates to their swaying movements (external focus). Significantly higher T3-Fz coherence was reported under internal focus condition compared to external focus condition or baseline (no instruction) during the postural sway task. Ellmers and colleagues concluded that the attempt to direct a more conscious effort to movement control (through an internal focus instruction) for regulating posture, which usually occurs with a minimal amount of verbal-analytical conscious processes, also leads to an increase in dependence on explicit cognitive processing. Chu and Wong (2019) conducted an EEG study that involved postural tasks in older adults. Higher T3-Fz EEG coherence, interpreted as increased conscious postural control, was reported when regulating postural stability on a compliant surface with increasing (perceived) standing task difficulty. The results echo with the theoretical framework of reinvestment (Masters et al. 1993; Masters and Maxwell 2008) and add further support to the application of EEG T3-Fz coherence as an objective, real-time measurement of reinvestment in postural control among older adults.

Although earlier studies have examined the feasibility of implementing EEG T3-Fz coherence to measure real-time reinvestment in the relatively static postural control tasks, it remains unclear how EEG T3-Fz coherence could uniquely react to the changes in attentional focus during locomotion in older adults. Investigating in a relatively dynamic motor task such as locomotion, that involves multi-joint coordination with a relatively high attentional cost (Lajoie et al. 1993), can be even more influential because locomotion has been suggested to be the most common fall-related activity in older adults (Li et al. 2006). Also, the associations between attentional focus and outcomes in locomotor performance observed in previous studies (Mak et al. 2019, 2020a, b) were based on the theoretical assumption that there were changes in cognitive effort/involvement of conscious control during movements. As such, exploring the involvement of conscious control (reinvestment) during locomotion in real-time is deemed necessary to consolidate our theoretical understanding of the underlying mechanisms interlinking reinvestment and motor performance.

While it is reasonable to suggest that trait propensity may capture the expected value of the behaviour in real-time (Augustine and Larsen 2012), we, nevertheless, hypothesized that trait reinvestment propensity is not significantly correlated with the real-time reinvestment during level-ground walking, based on the findings from the recent investigations (Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019; Mak et al. 2020b). Moreover, the present study investigated whether attentional focus instructions could change real-time reinvestment, measured by the EEG T3-Fz coherence, in older adults during level-ground walking. We also hypothesized that lower EEG T3-Fz coherence can be observed when older adults are given an external focus instruction when compare to to the control condition (or the internal focus instruction), and alternatively, higher EEG T3-Fz coherence can be observed when older adults are given an internal focus instruction when compare to the control condition (or the external focus instruction).

Method

Participants

Forty-five older adults (mean age = 70.4, SD = 3.7; 18 males and 27 females) participated in this study. They were recruited by convenience sampling from the local community in Hong Kong. The current sample size was referenced from a previous similar study which reported an effect size of 0.25 for the same main variable (T3-Fz coherence) (Shahzada et al. under review). A power analysis consequently suggested that a total sample size of 36 participants would be adequate to obtain 90% power for this study. To be more conservative, we increased the sample size by 20%, making it a total of approximately 45 participants. The exclusion criteria were (1) With any history of neurological impairment (e.g., Stroke or Parkinsonism); (2) Unable to walk independently indoors; (3) With a score of less than 25 (over 30) on the Cantonese version of the Mini-Mental State Examination (MMSE-C - Folstein et al. 1975; Chiu et al. 1994), which represents impaired cognitive functioning (Lezak et al. 2004).

Tasks and Procedure

Before any experimental walking trials, demographics and baseline characteristics were obtained from the participants (Table 1). They were asked to complete the Chinese version of the Movement Specific Reinvestment Scale (MSRS-C - Masters et al. 2005; Wong et al. 2008, 2015, 2016) to evaluate the trait propensity for reinvestment. A higher total score represents a higher trait propensity for reinvestment. Participants also completed the 13-item Falls Efficacy Scale (FES-13 items) to assess their fear of falling (Hellström and Lindmark 1999). The scale included thirteen items of non-hazardous daily activity to be scored from 0 – 10, with a higher score indicating higher efficacy to complete the daily activity and, therefore, lower fear of falling. Physical measurements, including the Berg Balance Scale (BBS) (Berg et al. 1989) and the Timed Up & Go Test (TUG) (Podsiadlo and Richardson 1991), were performed to assess functional balance and mobility of the participants. Participants who scored less than 41 out of 56 in the BBS were categorized as having medium to high fall risk (Stevenson et al. 2010), whereas participants who complete the TUG with more than 14 seconds were also categorized as having high fall risk (Shumway-Cook et al. 2000).

Participants were then invited to carry out three practice walking trials along a straight 6-meter level-ground walkway with their self-selected, natural. After practice, they were instructed to perform a block of five control walking trials (Control), a block of five external focus walking trials (External), and a block of five internal focus walking trials (Internal). The order of blocks was randomized. For every walking trial, they were instructed to walk with their self-selected, natural pace until the end of the 6-meter walkway and return to the starting point. For the Control condition, there was no specific instruction. For the Internal condition, the specific instruction was, "Please focus on your lower limb movements during walking”. For the External condition, two computer monitors, one located at the end of the walkway and the other located behind the starting point, were switched on for projecting a random series of numbers ranging from 0 to 9 during the walking trials. This External condition was designed to allow participants to look at the random numbers throughout the entire walking trial until they returned to the starting point. The specific instruction was, "Please look at the monitor in front of you and focus on the numbers shown on it during walking”.

Apparatus

Electroencephalographic (EEG) data were acquired by a wireless EEG device (Brainquiry PET 4.0, Brainquiry, The Netherlands) with a sample rate of 200 Hz. Disposable 24mm electrodes were attached to participants at three scalp locations, including the left temporal region (T3), right temporal region (T4), and frontal midline (Fz) (Zhu et al. 2011; Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019; Chan et al. 2019). A reference electrode was placed at the right mastoid (A2), and a ground electrode was placed at the left mastoid (A1). An electrode was positioned on the bony prominence under the left eye (Fp1) to collect the eye blink. Locations of all sites were determined by the standard international ten-twenty electrode system (Klem et al. 1999).

EEG data were recorded in real-time using a biophysical data acquisition software and pre-processed by a biophysical data processing and analysis software (BioReviewer 1.5, CyberEvolution, US). An impedance test was performed before each measurement by a 48–52 Hz filter with a fixed threshold at 20 microvolts. A low pass filter (42 Hz) and a high pass filter (2 Hz) were applied to minimize potential noise and biological artifacts from the raw signals. Previously customized algorithms were used to calculate the EEG T3-Fz and the EEG T4-Fz coherences in the 1-Hz frequency bins (Zhu et al. 2011). Specifically, we selected a high-frequency band of Alpha2 EEG coherence signals (10–12 Hz) since it has a relatively higher sensitivity in localizing activation in the cortical regions than a low-frequency band of Alpha1 EEG coherence signals (Nunez and Williamson 1996; von Stein and Sarnthein 2000). The Alpha2 frequency bandwidth was also found to be more reflective of task specification processing and less indicative of general arousal than the Alpha1 frequency bandwidth (Smith et al. 1999; Klimesch 1999). In addition to the EEG T3-Fz coherence, the EEG T4-Fz coherence was also measured since it represents the level of visuo-spatial processing involved in motor planning and performance, which ensures that the differences in the EEG T3-Fz coherence is not due to global activation of the brain (Zhu et al. 2011).

Data analysis

Participants were split into two groups, including the High Reinvestors Group (HRG) and Low Reinvestors Group (LRG), by the median split of the MSRS-C total scores (Chu and Wong 2019; Ellmers et al. 2016). Participants ($n = 22$) with scores of the MSRS-C ≤ 32 were classified as LRG, and Participants ($n = 22$) with scores of the MSRS-C ≥ 33 were classified as HRG. One participant was excluded due to the missing data of EEG coherence.

Statistical analysis was performed using the SPSS, version 25.0 (IBM, Armonk, NY, USA). A *p*-value of $< .05$ was considered statistically significant. Several one-way Analysis of

Variances (ANOVAs) were first computed to compare the baseline characteristics between the HRG and LRG. A Pearson product-moment correlation was then performed as a correlation analysis to investigate the potential association between the MSRS-C score and the EEG T3-Fz coherence at the Control condition. The BBS, TUG, and FES-13 were included in the correlation analysis to explore whether they have any novel associations among each other in our participants. Two 2 x 3 (Group x Condition) mixed ANOVAs, together with post-hoc Bonferroni adjustment, were conducted to examine the interaction, between-group differences (i.e., LRG and HRG), and within-group differences (i.e., Control, External, and Internal) of the outcome variables of EEG T3-Fz coherence and EEG T4-Fz coherence.

Results

Baseline Characteristics

No significant differences were found in age, scores of the MMSE-C, BBS, TUG, and FES-13 between the LRG and HRG (all $p > .05$). As shown in the Table 1, only the MSRS-C score differed significantly between the LRG and HRG due to the group allocation ($p < .001$).

Table 1 near here

MSRS-C and T3-Fz Coherence

The MSRS-C score was not significantly correlated with the T3-Fz coherence at the Control condition ($r [41] = -.05$, $p = .76$). In addition, this was also examined by estimating a Bayes factor using Bayesian Information Criteria (Wagenmakers 2007), comparing the fit of the data under the null hypothesis and the alternative hypothesis. An estimated Bayes factor (null/alternative) of 7.85:1 suggested that the data were 7.85 times more likely to be observed under the null hypothesis. As a secondary analysis, when examining how T3-Fz coherence at Control condition associated with other baseline measurements, we discovered that T3-Fz coherence at Control condition did not significantly correlated with TUG, BBS, or FES-13 (all $p > .05$). When examining how MSRS-C associated with other baseline measurements, we discovered that MSRS-C did not significantly correlated with BBS or FES-13 (all $p > .05$), but a significant and positive correlation was evident between the MSRS-C and the TUG (r [44] = .37, $p = .01$).

Attentional Focus (T3-Fz coherence)

Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, χ^2 (2) = 0.475, $p > .05$. There was no significant interaction effect between the group and condition (F [2, 78] = 0.13, $p = .88$, $\eta p^2 = .003$). As illustrated in the **Fig. 1**, there were also no significant main effect of condition (F [2, 78] = 0.70, $p = .50$, $\eta p^2 = .018$) and group (F [1, 39] = 0.35, $p = .56$, $\eta p^2 = .009$). In addition, an estimated Bayes factor (null/alternative) of 38.29:1 for the interaction effect between the group and condition suggested that the data were 38.29 times more likely to be observed under the null hypothesis. An estimated Bayes factor (null/alternative) of 23.25:1 for the main effect of condition suggested that the data were 23.25 times more likely to be observed under the null hypothesis. An estimated Bayes factor (null/alternative) of 4.16:1 for the main effect of group suggested that the data were 4.16 times more likely to be observed under the null hypothesis.

Fig. 1 near here

Attentional Focus (T4-Fz coherence)

Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, χ^2 (2) = 1.713, $p > .05$. There was no significant interaction effect between the group and condition (F [2, 78] = 0.07, $p = .93$, $\eta p^2 = .002$). As illustrated in the **Fig. 2**, there were also no significant main effect of condition (F [2, 78] = 2.01, $p = .14$, $\eta p^2 = .049$) and group (F [1, 39] = 0.56, $p = .46$, $\eta p^2 = .014$). In addition, an estimated Bayes factor (null/alternative) of 39.65:1 for the interaction effect between the group and condition suggested that the data were 39.65 times more likely to be observed under the null hypothesis. An estimated Bayes factor (null/alternative) of 4.69:1 for the main effect of condition suggested that the data were 4.69 times more likely to be observed under the null hypothesis. An estimated Bayes factor (null/alternative) of 3.59:1 for the main effect of group suggested that the data were 3.59 times more likely to be observed under the null hypothesis.

Fig. 2 near here

Discussion

The present study provides evidence for the notion that the trait reinvestment propensity may not necessarily reflect the real-time reinvestment in older adults, at least not in the context of level-ground walking at a natural pace, as demonstrated by the non-significant correlation between the MSRS-C score and the EEG T3-Fz coherence at the Control condition. The lack of association between the trait reinvestment propensity and the real-time reinvestment during locomotion in older adults is theoretically consistent with a recent study, with older adults walking on the level-ground, by Mak et al. (2020b), who did not observe any significant differences in gait pattern between older adults with high and low self-reported trait reinvestment (measured by the MSRS-

C). While Mak and colleagues speculated that level-ground walking might not have induced conscious effort in controlling movement that leads to gait changes in those who self-reported high trait reinvestment, we further support this argument by providing evidence from a cognitive perspective (i.e., no difference in the levels of real-time reinvestment). Taken together with findings from other EEG studies (Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019), we suggest that the MSRS-C (i.e., the measurement of the self-reported trait reinvestment) may not necessarily reflect the actual level of real-time reinvestment (conscious cognitive involvement) during walking.

Wong et al. (2015) conducted a focus group study that discussed the potential weaknesses of the MSRS-C application in older adults. They discovered that some older adults were uncertain about the specific movement they should relate to when responding to the MSRS-C that was designed to relate to general movements. Although recent evidence has shown that older adults responded to the MSRS-C similarly between asking about general movements and walking movement (Wong et al. 2016), it still may not be surprising to observe that some older adults are reinvesting their cognitive effort in one specific movement but not in the other, such as in walking downhill but not in level-ground walking. This may be attributable to the different causes of reinvestment, including personal experience and specific movement mechanisms related to falls, which eventually lead to a potential discrepancy in the MSRS-C score if different individual refer to different movements (Wong et al. 2015).

Apart from the characteristics of the MSRS, the nature of reinvestment should also be considered. The movement-specific reinvestment can typically be induced by increased awareness of movement impairment or heightened fear or anxiety in older adults (Wong et al. 2008, 2009). Under the Control condition, regardless of the trait reinvestment propensity of the participants, the movement task is normal locomotion, which appears to be cognitively and physically unchallenging and should habitually be performed with relatively low levels of reinvestment (Malone and Bastian 2010). Under these circumstances, the task may not have invoked conscious cognitive effort in movement processing, even in those reported with high trait reinvestment. As such, the real-time reinvestment of participants in the LRG and HRG remained low and without significant difference between groups even they had different personality traits of reinvestment (Spielberger 1972).

This study also intended to examine whether the real-time reinvestment could be affected by the verbal instructions of attentional focus in a cohort of community-dwelling older adults. No differences were observed on the levels of real-time reinvestment among the Control, Internal and External conditions (see **Fig. 1**). The present findings contradict with the notion from previous literature that internal focus instructions trigger conscious (verbal) movement processing (Schneider and Fisk 1983; Wulf et al. 2004; Schmidt and Lee 2005), while external focus instructions attenuate such processing by promoting movement automaticity (Wulf et al. 2001; Chiviacowsky et al. 2010). One major factor accounting for this minimal effect of attentional focus instructions is suggested to be the potentially low level of motor task difficulty or perceived motor task difficulty. In the Control condition, the current cohort of healthy older adults was presumably maintaining a low level of real-time reinvestment. They were thus able to allocate sufficient attentional resources to the external environment in the simple gait task, which is similar to the daily walking movement (Malone and Bastian 2010). The current findings suggest that looking at digits at the destination may not have altered much of the participants' usual locomotion routine by lowering an already-low level of reinvestment. It also appears to be unlikely that the effect of an inward focus instruction towards body movements sufficiently prompts the older adults to induce effortful controlled processes during a physically and cognitively undemanding motor task.

It is speculated that the adherence to the verbal instructions could be one factor that contributes to the varying effects of attentional focus instructions on real-time reinvestment (Davids 2007). Given that the sole element of internal focus or external focus could clearly be distinguished in the verbal instructions adopted in the current and previous studies, the issue then lies on whether participants truly adhere to specific instructional attention, or more likely, whether these attentions may have unintentionally been switched or combined due to the goal of the task between conditions. For example, a previous study investigating standing vertical jump height under different attentional focus instructions asked participants to focus on the rung as an external focus when performing the vertical jump to reach and touch the rung (Wulf et al. 2007). On the other hand, they instructed participants to look at their fingertips as an internal focus or just focus on jumping as high as possible as the control condition when performing the task. Peh et al. (2011) argued that in this particular study, across all the conditions, participants ultimately have to pay attention visually to the targeted location of a specific rung. Regarding the internal focus condition, the above circumstance could thus trigger participants to switch attention between the fingertips and the rung. Moreover, concerning the control condition, participants were asked to touch the highest rung, which could trigger external-related attention or fixation onto the rung. As a result, we cannot neglect the likelihood that participants' attentions were interchanging between different sources of visual information (i.e., the rung and fingertips) when controlling the jump and reach movement during particular attentional focus condition. Future studies are suggested to provide concrete manipulation tasks with objective performance assessment (e.g., counting number of steps for internal focus, and adding up the presented numbers for external focus) for each corresponding walking trial to induce participants' awareness of specific attentional focus and ensure that they have actually followed the instructions.

There are limitations to this study. First, our results are limited to straight line level-ground walking, which are not necessarily applicable to more dynamic walking tasks that are commonly observed in a real-life setting. Future research could explore different types of walkway (e.g., a curvy path, obstacle circumvention, etc.) that more likely represent daily living activities carried out by older adults. Second, our cohort represents community-dwelling older adults with a relatively high level of balance ability (as shown by the BBS scores) and our findings might not be generalizable to a wider population. Third, we did not collect any force or kinematic measurements (i.e., centre of pressure, spatial and temporal gait parameters, etc.) which potentially limits our understanding of the association between real-time reinvestment and level-ground walking performance.

Given the weight of recent evidence suggesting associations between an internal attentional focus and disrupted locomotor outcomes in older adults (Mak et al. 2019, 2020a), it was equally important to establish these fundamental associations in terms of changes in cognitive effort/involvement in conscious control; an assumption applied in these studies. While most of the previous research has used EEG to infer associations concerning real-time reinvestment during the postural tasks (Ellmers et al. 2016; Chu and Wong 2019; Chow et al. 2019), this study is the first instance where real-time reinvestment has been investigated during a level-ground walking task in older adults. Although our current results help establish a foundation that the effect of attentional focus instructions might not be sufficiently effective in changing real-time reinvestment during level-ground walking among older adults, further research can build on this research protocol by examining the association with increased motor task difficulty (e.g., walking on a foam, elevated surface), presumably due to its existing association with increased physical and cognitive demands that might lead to heightened real-time reinvestment (Boisgontier et al. 2013; Young et al. 2015). The follow-up research could then provide a capacity to illustrate, for example, the potential beneficial effect of external instructions on reducing real-time reinvestment and improving walking performance.

Conclusions

This study is the first attempt to investigate the association between attentional focus instructions and real-time reinvestment, measured by the EEG T3-Fz coherence, during level-ground walking at a natural pace in older adults. The findings first demonstrated that real-time reinvestment at the level ground does not differ between older adults who reported a low or high trait propensity for reinvestment. Moreover, it was also discovered that the effect of attentional focus instructions to the real-time reinvestment during level-ground walking was not evident among older adults. Further research should be conducted following this established research protocol with increased locomotor task difficulty.

Declarations

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Conflicts of Interest

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

Ethical Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW IRB) (Reference Number: UW17-528).

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent for publication

Informed consent was obtained from all individual participants regarding publishing their data.

Availability of data and material

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

Code availability

Not applicable.

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Table 1 Participants' Baseline Characteristics

Variables	Mean (SD) or N (%) Low Reinvestors (LRG)	High Reinvestors (HRG)	Total	*p*-value
N (numbers)	22	22	44	-
Gender (female)	11 (50%)	15 (68.2%)	26 (59.1%)	-
Age (years)	70.1 (3.8)	70.8 (3.7)	70.4 (3.7)	.50
MMSE-C	29.5 (0.8)	29.4 (0.8)	29.4 (0.8)	.85
BBS	55.0 (1.7)	54.6 (1.8)	54.8 (1.7)	.44
TUG (seconds)	10.1 (1.7)	11.2 (2.5)	10.6 (2.2)	.09
FES-13	114 (13)	116 (12)	115 (12)	.68
MSRS-C	24.1 (5.6)	41.2 (7.4)	32.7 (10.8)	< .001*

Note. MMSE-C = Cantonese version of the Mini-Mental State Examination (Range: 0 – 30); BBS = Berg Balance Scale (Range: 0 – 56); TUG = Timed Up & Go Test; FES-13 = Falls Efficacy Scale (13 items) (Range: 0 – 130); MSRS-C = Chinese version of the Movement Specific Reinvestment Scale (Range: 10 – 60). * denotes significant difference.

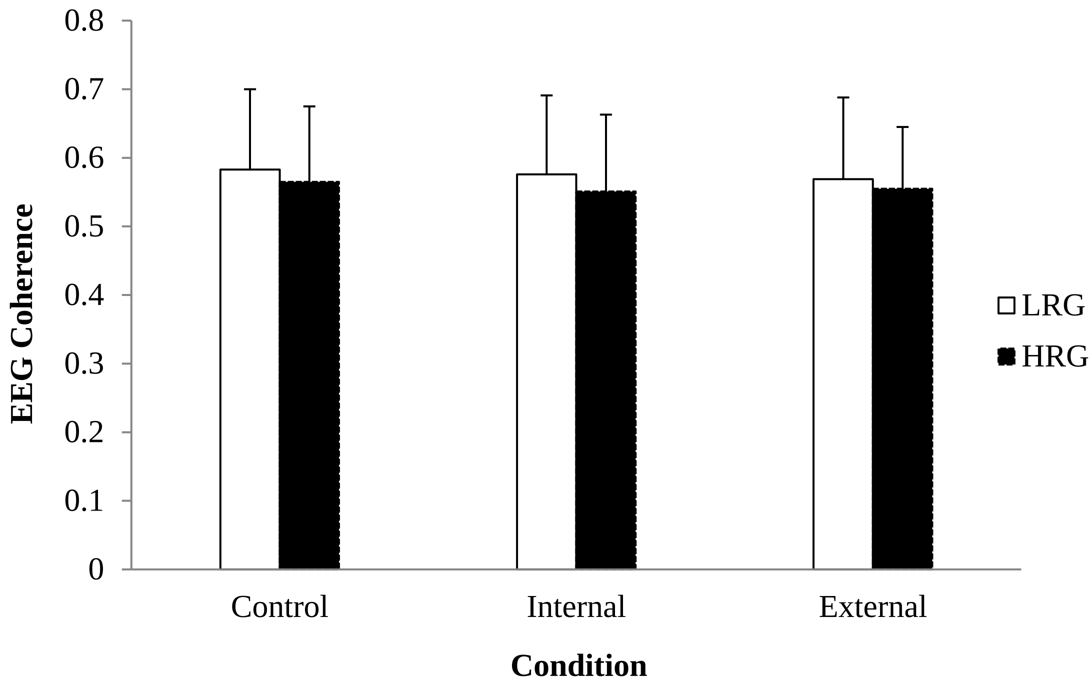
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
EEG Coherence
Control
Internal
External
Condition
LRG
HRG

Fig. 1

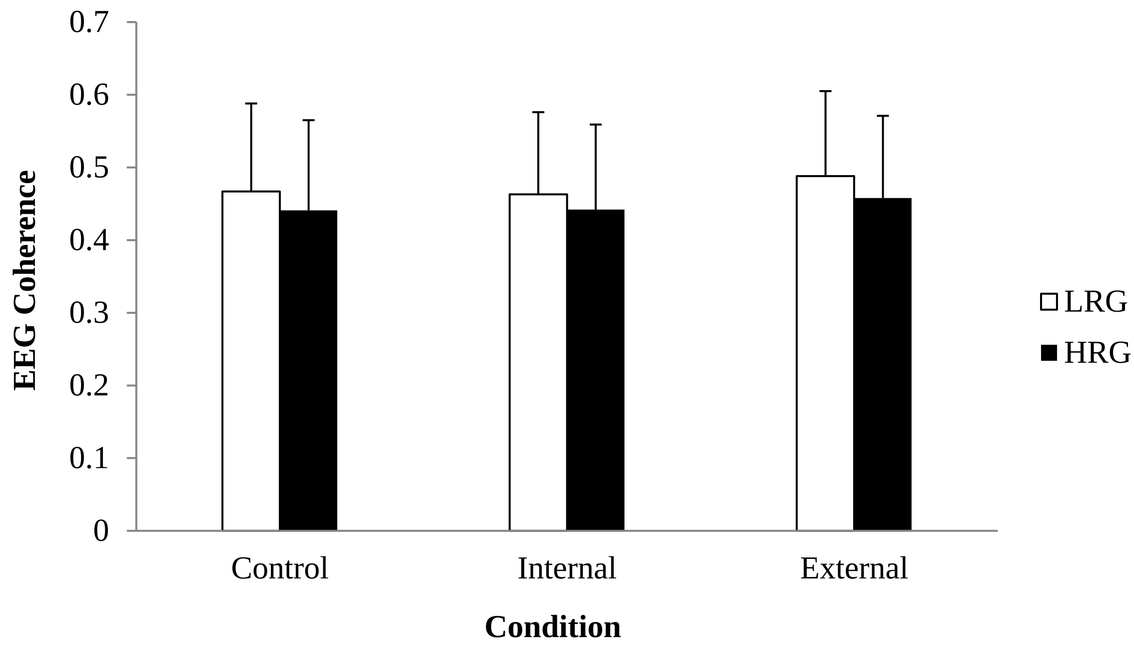
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
EEG Coherence
Control
Internal
External
Condition
LRG
HRG

Fig. 2

Figures captions

Fig. 1 Comparison of EEG T3-Fz coherence among Control, Internal and External conditions in Low Reinvestors (LRG) and High Reinvestors (HRG). Error bars represent standard deviations of the data

Fig. 2 Comparison of EEG T4-Fz coherence among Control, Internal and External conditions in Low Reinvestors (LRG) and High Reinvestors (HRG). Error bars represent standard deviations of the data