Errorless psychomotor training modulates visuomotor behaviors among older adults

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Abstract

This study investigated whether errorless psychomotor training with psychological manipulation could modify visuomotor behaviors in a daily-life reaching motor task for older adults and whether its benefits could be transferrable. Thirty-six older adults (Mean age = 71.06, *SD* = 5.29) were trained by the reaching motor task (lifting a handled mug to a target) utilizing errorless, errorful or normal psychomotor training. Results indicated that errorless psychomotor training decreased the reaching distance away from the target and the jerkiness of acceleration during the reaching task and transfer test. Errorless psychomotor training also reduced gaze fixation duration, horizontal and vertical eye activity. Our findings implicated that errorless psychomotor training could improve movement accuracy and alleviate movement variability during reaching by older adults.

Keywords*:* Psychomotor training; Errorless; Reaching; Visuomotor behaviors; Older adults.

Introduction

Reaching is one of the fundamental forms of goal-directed movements, which can be well-utilized as an experimental paradigm in exploring mechanisms of different motor processes and behavior (Scheidt, Conditt, Secco, & Mussa-Ivaldi, 2005). The reaching movement theoretically includes three consecutive parts: visual measurement, motor planning, and reaching executive (Berthier, Clifton, Gullapalli, McCall, & Robin, 1996; Sober & Sabes, 2005). In the goal-directed reaching movements, proprioception and vision provide two potential sources of sensory information about the initial hand position. These two underlying sensory sources interact in specifying initial hand position when they are simultaneously available. During the reaching task, individuals fuse visual and proprioceptive information to form two estimates of arm's position: one to arrange the reaching direction, and other to convert the direction into motor commands (Sober & Sabes, 2003). These positional estimates depend on the same sensory signals but rely on different proportional combinations of visual and proprioceptive information inputs, which indicate that the brain could weight sensory sources differently (Knill & Pouget, 2004; Sober & Sabes, 2005).

Previous studies provided evidence that it is possible to measure the diversity of weightings which demonstrate the flexibility of sensory integration (Scheidt et al., 2005; Sober & Sabes, 2005). Constraints on visual information via specific training may contribute to conducting a movement by inducing more compensatory ability from proprioception (Casanova, 2012; Casanova, Oliveira, Williams, & Garganta, 2009). For example, researchers have manipulated constraints to access visual information at the orientation of the limbs during the passing action to facilitate learners to use the proprioceptive information for their limbs' orientation (Williams, Janelle, & Davids, 2004). This specific training facilitated the increase of dependence on proprioception, which is a possible strategy to reduce reliance on vision by training (Williams et al., 2004). Therefore, it is possible to decrease the reliance on vision during movement execution by training and switch to obtain sensory information that related to the muscle-related activities. Consequently, it could facilitate the proprioceptive perception flexibly by building up the relationships between body movements and task-goal location (Benjuya, Melzer, & Kaplanski, 2004; Sobuh et al., 2011).

Multiple sensory information could facilitate movement execution (Jueptner et al., 1997) and multisensory reweighting can down-weight unreliable sensory information and simultaneously up-weight more reliable sensory information (Bair et al., 2012) corresponding to the ratio of multiple sensory information inputs (Wahn & König, 2017). This modulation of perceptual and relative crossmodal processes was suggested to be an effective strategy to facilitate movement execution in different sensory conditions (Bair et al., 2012; Setti, Burke, Kenny, & Newell, 2011). However, the modification of multisensory reweighting and relative crossmodal attentional processes was reported to increase the cognitive working memory load (Botta et al., 2011; Cowan, 2011; Quak, London, & Talsma, 2015; Simon, Tusch, Holcomb, & Daffner, 2016). In addition, working memory capacity has proven to have a pronounced aging-related decline due to the age differences in the brain activation (Nagel et al., 2009). Therefore, the increasing demand on working memory to execute motor tasks is speculated to come from both the increasing demand for working memory related to the modification of perceptual and attentional processes (Rybak, Gusakova, Golovan, Podladchikova, & Shevtsova, 1998; Beilock, Bertenthal, McCoy, & Carr, 2004; Soto-Faraco, Ronald, & Spence, 2004; Stone & Carson, 2015) and ageing-related limitation on working memory capacity (Babcock & Salthouse, 1990; Salthouse & Babcock, 1991).

Previous investigation has already illustrated that errorless psychomotor training could minimize working memory demand during movement execution (Maxwell, Masters, & Eves, 2003). The mechanism of the errorless psychomotor training by decreasing errors made is believed to inhibit the hypothesis-testing process (Maxwell, Masters, Kerr, & Weedon, 2001; Lam, 2008). Hypothesis-testing refers to an inferential process that utilizes the known information or outcome to assess whether the information or outcome is consistent with the initial hypothesis (Evett, Devine, Hirt, & Price, 1994; Cronley, Posavac, Meyer, Kardes, & Kellaris, 2005). This hypothesis testing process may shape the relative actions or behaviors (Berry & Broadbent, 1984). The decrease in hypothesis testing is related to lower cognitive demands with minimal errors during the errorless practice (Koehn, Dickinson, & Goodman, 2008; Lam, Maxwell, & Masters, 2010).

It is logical to believe that errorless psychomotor training may benefit the movement execution by contributing to multisensory reweighting and crossmodal attention between vision and proprioception during movement execution using the relatively more available working memory. Additionally, this benefit of errorless psychomotor training in the movement may be salient among older adults due to the aging-related limitation on their working memory capacity. To solve the potential problem of increasing working memory demand, it was proposed to employ the errorless psychomotor training in the daily-life reaching motor task among older adults, which is believed to be able to benefit the overall motor performance with less occupation of working memory (Masters, MacMahon, & Pall, 2004). We predicted that errorless psychomotor training might be able to cope with the effect in the daily-life reaching motor task in which the working memory loading might increase due to the modulation of multisensory reweighting and crossmodal attention between vision and proprioception.

Therefore, we hypothesized that 1) errorless psychomotor training could improve the motor performance in the daily-life reaching motor task among older adults; 2) errorless psychomotor training could adjust the gaze behaviors in the daily-life reaching motor task among older adults.

Materials and Methods

Participants

Thirty-six right-handed older adults (Mean age = 71.06 years, SD = 5.29) participated in the study by convenience sampling from different community centers of older adults in Hong Kong. They were randomly allocated to either one of the three training groups, Errorful Psychomotor Training Group (N=12), Errorless Psychomotor Training Group (N=12) or Normal Training Group (N=12), Characteristics of the participants in three psychomotor training groups were shown in Table 1. All participants had normal or corrected to normal vision and met the inclusion criteria, can understand and sign consent and had no history of the retina, cerebral vascular disease, Parkinson's disease or any other neurological impairment before the experiment. They were then required to complete the Chinese version Mini-Mental State Examination (MMSE-C) and the scores of more than 24/30 were required to be included. Written informed consent was obtained before any experimental procedure. The study protocol was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW IRB - reference number: UW 17-113).

*****Table 1 near here*****

Procedure

Participants were guided to complete tests and training blocks with the daily life reaching motor task by lifting the mugs with different handles and reached to a specific target on the table (see Figure 1). The whole experimental trials consisted of the pretest (10 trials), training (50 trials), posttest (10 trials), retention test 1(after a 30-minute resting, 10 trials), transfer test (10 trials) and retention test 2 (after a 60-minute resting, 10 trials) (see Figure 1D). All the participants had a 10-trial test (pretest, posttest, retention test 1 and 2) with the biggest size handle mug (handle size 1) (see Figure 1A). The training phase consisted of 5 blocks of 10 trials (50 trials in total) interspersed by the 30-second rest intervals. Participants were randomly allocated to either one of the three training groups (i.e., Errorful Psychomotor Training Group, Errorless Psychomotor Training Group or Normal Training Group). There were five mugs with different handle's sizes. The handle of the mug is in a semicircle shape. The size of handles was measured by the diameter from handle size 1 (100mm), handle size 2 (80mm), handle size 3 (60mm), handle size 4 (40mm), and handle size 5 (20mm).

Participants could easily hold the mug with handle size 1 by using the whole hand and move the mug smoothly while most participants could only hold the mug with handle size 5 by using the index finger and thumb and move it with instability. Participants in the Errorful Psychomotor Training Group were required to lift the mug and reached with the handles changing from the smallest size to the biggest one (handle size 5 to 1) at the 5 blocks of training (see Figure 1C). In the Errorless Psychomotor Training Group, participants were requested to lift the mug and reached with the handle size that changed from the biggest to the smallest one (handle size 1 to 5) at the 5 blocks training (see Figure 1C). In the Normal Training group, participants tried to lift the mug and reached with the handle sizes that changed randomly. Following the post-test, a 30-min resting was provided to participants. Afterward, participants were invited to complete the retention test 1. The retention test 1 was then followed by a transfer test. In the transfer test, participants lifted the mug with the biggest size handle (handle size 1) and reached to the target wearing the special glasses (made by a switchable glass and could be controlled to be opaque or transparent) to block part of their visual information (the condition of simulated visual deficit) (see Figure 1B). Finally, participants carried out a 10-trial of retention test 2 after a 60- min resting. The utilization of retention tests 1 and 2 was aimed to assess the extent of training after the retention period.

Materials and Apparatus Setup

The linear accelerometer (JY-901 module with Triple Axis Accelerometer, Elecmaster, China) was used to record the kinematic data in the tests and the training phases. The sensing axes oriented along the anatomical anteroposterior axis, the mediolateral axis, and the vertical axis. During the whole experimental trials with the linear accelerometer, the movement time of reaching was recorded to assess the movement speed, the distance away from the reaching target was measured to assess the movement accuracy and the change of acceleration during reaching was calculated to quantify movement variability. The mobile eye tracker (Dikablis, Ergoneers Inc., Manching, Germany) was used to record gaze behaviors (fixation duration, horizontal and vertical eye activity) in the pretest, post-test, and retention test phases. The specific glass, made by a switchable glass, which could be controlled to be opaque or transparent, was applied in the transfer test to block the visual information between the initiation of the trial and the end landing place of the mug. All participants wore the special glasses in the transfer test which was made by a switchable glass and thus the special glasses could be controlled to be opaque or transparent at the transfer test. The target location was presented before starting the reaching movement. The glasses were opacified once the reaching was initiated so that the participants had no idea of the target location simulating visual deficit. Once the participants located the mug to the target, the special glasses became transparent so that the participants could obtain the visual feedback of the end position to adjust their next trials. Please refer to Figure 1 for the apparatus setup and experimental procedure.

*****Figure 1 near here*****

Results

A series of 3x2 training methods (Errorful Psychomotor Training, Errorless Psychomotor Training, Normal Training) x test modes (pretest, posttest) and Analysis of Variance (ANOVA) with repeated measures were conducted to examine the differences among the three motor training methods (motor training groups) in two different test modes for all the main outcome measures of motor performance and gaze behaviors. More specifically, we aimed to evaluate the training effectiveness of different motor training methods between pretest and posttest. Furthermore, a series of one-way Analysis of Covariance (ANCOVA) were used to evaluate whether the training effectiveness could be transferred to the transfer test among three motor training methods (Errorful Psychomotor Training, Errorless Psychomotor Training, Normal Training), utilizing the pre-test results as the covariate.

The jerkiness of acceleration (in m^2/s^5) was defined as the rate of change of acceleration during the reaching. The greater the jerkiness of acceleration was, the higher rate of changes of acceleration during movement. The jerkiness of acceleration was computed as follows (Flash & Hogan, 1985):

$$\text{The jerkiness of acceleration} = \frac{1}{3}\int_0^t \left(\frac{\text{dAccX}}{\text{dt}}\right)^2 + \left(\frac{\text{dAccY}}{\text{dt}}\right)^2 + \left(\frac{\text{dAccZ}}{\text{dt}}\right)^2$$

Motor Performance

Movement Time. The movement time (in second) was defined as the time from initiation of the reaching movement to the end of reaching. Longer movement time indicated the slower act or process of movement. Neither the training methods (Errorful, Errorless and Normal Training) (F (2, 33) = .339, p = .715, η_p^2 = .020) nor the test modes (pretest, posttest) (F (1, 33) = 18.895, p < .001, η_p^2 = .364) affected the training effect significantly. We also found no significant correlation between training methods and test modes (F (2, 33) = .552, p = .581, η_p^2 = .032) (see Figure 2 left panel). Similarly, the three training methods didn't result in obviously different movement time in the transfer test (F (2, 32) = 2.451, p = .102, η_p^2 = .0133) (see Figure 2 right panel).

*****Figure 2 near here*****

Distance Away from the Target. The distance away from the target (in centimeter) was defined as the distance between the final reaching position of the mug and the target. The shorter distance away from the target, the more accurate the participants completed the reaching movement. Training methods (F (2, 33) = 3.091, p = .059, η_p^2 = .158) and test modes (pretest, posttest) didn't result in significantly different distances (F (1, 33) = 2.021, p = .164, η_p^2 = .058). However, there was a significant interaction between training methods and test modes (F (2, 33) = 3.998, p = .028, η_p^2 = .195). The errorless trainees displayed decreased the reaching distance away from target when compared between the pretest and posttest (p = .007). Also, errorless trainees performed reaching with shorter distance away from the target than the errorful (p = .017) and normal (p = .002) trainees in the post-test (see Figure 3 left panel). In the transfer test, there was a significant difference in the distance away from the target (F (2, 33) = 4.962, p = .013, η_p^2 = .237). The errorless trainees performed reaching with a shorter distance away from the target than errorful (p = .014) and normal (p = .006) trainees (see Figure 3 right panel).

*****Figure 3 near here*****

Jerkiness of Acceleration. The jerkiness of acceleration was calculated to measure the smoothness of movement variability. The observations were not significantly affected by neither training methods (F (2, 33) = 2.474, p = .100, η_p^2 = .130) nor test modes (pretest, posttest) (F (1, 33) = .256, p = .616, η_p^2 = .008). However, there was a significant interaction between training methods and test modes (F (2, 33) = 4.353, p = .023, η_p^2 = .204). The errorless trainees (p = .035) showed decreased the jerkiness of acceleration in the posttest than they did in the pretest. Also, errorless trainees had less jerkiness of acceleration than errorful trainees (p = .001) in the posttest (see Figure 4 left panel). In the transfer test, the three training methods resulted in significant difference in the jerkiness of acceleration (F (2, 33) = 100.989, p < .001, η_p^2 = .863). But the errorless trainees still had less jerkiness of acceleration than errorful (p <. 001) and normal (p <. 001) trainees in the transfer test (see Figure 4 right panel).

*****Figure 4 near here*****

Gaze Behaviors

Fixation Duration. The fixation duration (in second) was defined as the amount of time of each fixation. The longer fixation duration on the target was, the more attention distributed on the target. The training methods resulted in significant difference in fixation duration (F (2, 33) = 9.901, p = .001, η_p^2 = .423) while test modes (pretest, posttest) didn’t (F (1, 33) = .411, p = .527, η_p^2 = .016). There was a significant interaction between training methods and test modes (F (2, 33) = 10.057, p = .001, η_p^2 = .436). Errorless trainees (p < .001) displayed decreased fixation duration in the posttest. Also, errorless trainees took shorter fixation duration than errorful (p <. 001) and normal (p <. 001) trainees in the posttest (see Figure 5).

*****Figure 5 near here*****

Eye Activity during Reaching. The horizontal and vertical eye activity (in pixel) was defined as the standard deviation of the pupil in the x-axis (horizontal) or y-axis (vertical) in pixels, which is a measurement of the eye's search activity. The less eye activity presented during the reaching task indicated the decreasing eye searching activity during the movement execution. We observed a significant interaction between training methods and test modes (F (2, 33) = 6.392, p = .006, η_p^2 = .330). Horizontal eye activity was decreased in errorless trainees (p = .030) but increased in normal trainees (p = .030) in the posttest. Also, errorless trainees conducted less horizontal eye activity than errorful (p = .008) and normal (p=.001) trainees in the posttest (see Figure 6).

*****Figure 6 near here*****

For the vertical eye activity, the main effect of training methods affected the training effectiveness significantly (F (2, 33) = 4.273, p = .025, η_p^2 = .247) but the test modes didn’t (F (1, 33) = 2.375, p = .135, η_p^2 = .0084). There was a significant interaction between training methods and test modes (F (2, 33) = 4.817, p = .017, η_p^2 = .270). We observed that errorless trainees (p = .002) had decreased vertical eye activity in the posttest comparing to the pretest. Also, errorless trainees took less vertical eye activity than errorful (p = .003) and normal (p = .013) trainees in the posttest (see Figure 7).

*****Figure 7 near here*****

Discussion

This study aimed to examine whether errorless psychomotor training could modify visuomotor behaviors in the daily-life reaching motor task by older adults and whether the beneficial effect of errorless psychomotor training on motor performance could be transferred under the condition of simulated visual deficit by blocking parts of the real-time visual feedback. The results generally support our hypotheses that 1) errorless psychomotor training could improve the motor performance in the daily-life reaching motor task among older adults; 2) errorless psychomotor training could adjust the gaze behaviors in the daily-life reaching motor task among older adults.

Our results indicated that errorful, errorless and normal training could improve movement speed as illustrated by the decreasing tread movement time after training, but no significant difference among three training methods could be discovered. Errorless psychomotor training seemed to be able to decrease the reaching distance away from the target and the jerkiness of acceleration during the daily-life reaching motor task, differently from the errorful and normal training. This result confirmed that errorless psychomotor training could minimize working memory involvement to reduce errors of motor performance during training (Maxwell et al., 2001; Maxwell et al., 2003; Lam, 2008). On the contrary, errorful psychomotor training might require higher attentional demand in the working memory due to more errors processed in hypothesis-testing during training (Maxwell et al., 2001). Therefore, errorless psychomotor training could improve movement accuracy and alleviate movement variability by a possible mechanism of less occupation of the attentional demand on movement execution.

Concerning the training effects by different motor training methods on gaze behaviors, errorless psychomotor training was found to reduce fixation duration, horizontal and vertical eye activities significantly when compared to the errorful psychomotor training and normal training. Changes in fixation duration were relevant to the process of gaze behaviors and speed of visuomotor adaptation (Rentsch & Rand, 2014). The decreasing of fixation duration was associated with the less demand of visual information and the less allocation of attention (Henderson, 2007; Castelhano, Mack, & Henderson, 2009; Wass, Smith, & Johnson, 2013). In addition, eye activity could be used to measure the visual and cognitive demands, especially for functions related to visual searching activity (Van Orden, Limbert, Makeig, & Jung, 2001). The decrease of one's eye activity implies a release load of visual searching activity (Van Orden et al., 2001; Töllner, Zehetleitner, Krummenacher, & Müller, 2011). Therefore, the decreasing fixation duration and less eye activity in horizontal and vertical directions in errorless psychomotor training may help decrease the demand for visual information in this daily-life reaching motor task.

Previous studies suggested that the decrease of fixation duration may imply the decreasing reliance on vision but the increasing reliance on proprioception during eye-hand coordination in objection manipulation (Johansson, Westling, Bäckström, & Flanagan, 2001). It may also represent the reweighting of multiple sensory information to facilitate movement execution in different daily-life activities such as limbs' orientation (Bennett, Button, Kingsbury, & Davids, 1999; Williams et al., 2004) or hand-operated tool location (Sobuh et al., 2011). Therefore, it is reasonable to predict that the effect of errorless psychomotor training on decreasing fixation duration and eye activity (both in the horizontal and vertical directions) may facilitate the modification of perceptual and attentional processes by decreasing the demand on visual information but with increasing demand on proprioceptive information.

Additionally, when participants were dealing with the simulated visual deficit by the special glasses in the transfer test, errorless trainees performed reaching with significantly smaller distance away from the target and less jerkiness of acceleration than errorful and normal trainees. The manipulation of reaching movement requires both vision and proprioception (Sarlegna & Sainburg, 2009). The increasing adaptive utilization of proprioception might compensate for the loss of vision in the control of reaching motor task (Johansson et al., 2001; Hayhoe, Shrivastava, Mruczek, & Pelz, 2003; Goble, Noble, & Brown, 2010; Setti et al., 2011). Our results implied that the effect of errorless psychomotor training could be transferred to maintain higher movement accuracy and less movement variability with insufficient visual information comparing to the errorful and normal training. This suggested that proprioceptive resources which could compensate for insufficient visual information might contribute to movement execution.

The modification of gaze behaviors by decreasing fixation duration and eye activity implied the down-weighting of visual information for movement execution (Van Orden et al., 2001; Henderson, 2007; Castelhano et al., 2009). The decreasing reliance on vision might consequently induce the increasing reliance on proprioception for motor control (Johansson et al., 2001). In this study, errorless psychomotor training could decrease fixation duration and eye activity during the daily-life reaching motor task effectively, which implied that the errorless psychomotor training could modify the perceptual and attentional processes by down-weighting on vision and up-weighting on proprioception. This modification of perceptual and attentional processing required the increasing demand on working memory (Rybak et al., 1998; Beilock et al., 2004; Soto-Faraco et al., 2004; Stone & Carson, 2015). Furthermore, the aging-related decline of working memory capacity has been well-proved due to the age differences in the brain activation (Nagel et al., 2009). It could be speculated that the increasing demand of working memory to conduct this daily-life reaching motor task among older adults could be influenced by the needs of modification of perceptual and attentional processing together with the aging-related limitation on working memory capacity (Babcock & Salthouse, 1990; Salthouse & Babcock, 1991). Previous studies proved that errorless motor training could inhibit the hypothesis-testing process by minimizing the accumulation of errors and therefore the working memory capacity could be released (Maxwell et al., 2001; Buszard, Farrow, Reid, & Masters, 2014; Buszard, Reid, Masters, & Farrow, 2016), which could perhaps cope with the increasing demand of working memory to conduct this daily-life reaching motor task among older adults.

In the current study, errorless psychomotor training modified gaze behaviors to improve motor performance among older adults, differently from errorful or normal training. These results supported our prediction that errorless psychomotor training could release working memory capacity for motor control, which could be used to meet the increasing demand of working memory for both aging-related limitation and modification of perceptual and attentional process among older adults. In the study, we infer that errorless psychomotor training improves the motor performance of daily-life reaching motor task by reserving working memory capacity for motor control. The spared working memory may be used to meet the increasing demand of working memory during the perceptual or attentional processes. However, we arrived at this inference by the logical deduction only but did not test the working memory occupation and proprioception directly. In the future work, appropriate tests to assess the working memory occupation and proprioception during errorless psychomotor training could be used to confirm our inference.

Conclusion

We concluded that errorless psychomotor training, rather than that errorful and normal training, could benefit the movement execution of the daily-life reaching motor task among older adults possibly by inducing a multisensory reweighting and crossmodal attention by down-weighting on vision and compensatory up-weighting on proprioception.

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Declaration of Conflicting Interests

All authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. There is no commercial interest exists in the authors relevant to the participants of the manuscript.

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Table

Table 1 Characteristics of the participants in three psychomotor training groups

	Errorful Training Group (N=12, 2 men & 10 women)	Errorless Training Group (N=12, 2 men & 10 women)	Normal Training Group (N=12, 2 men & 10 women)
Age (years)	72.17±6.41	71.83±5.54	69.17±3.35
MMSE (scores)	28.53±1.62	29.42±0.79	29.42±0.99

Figures

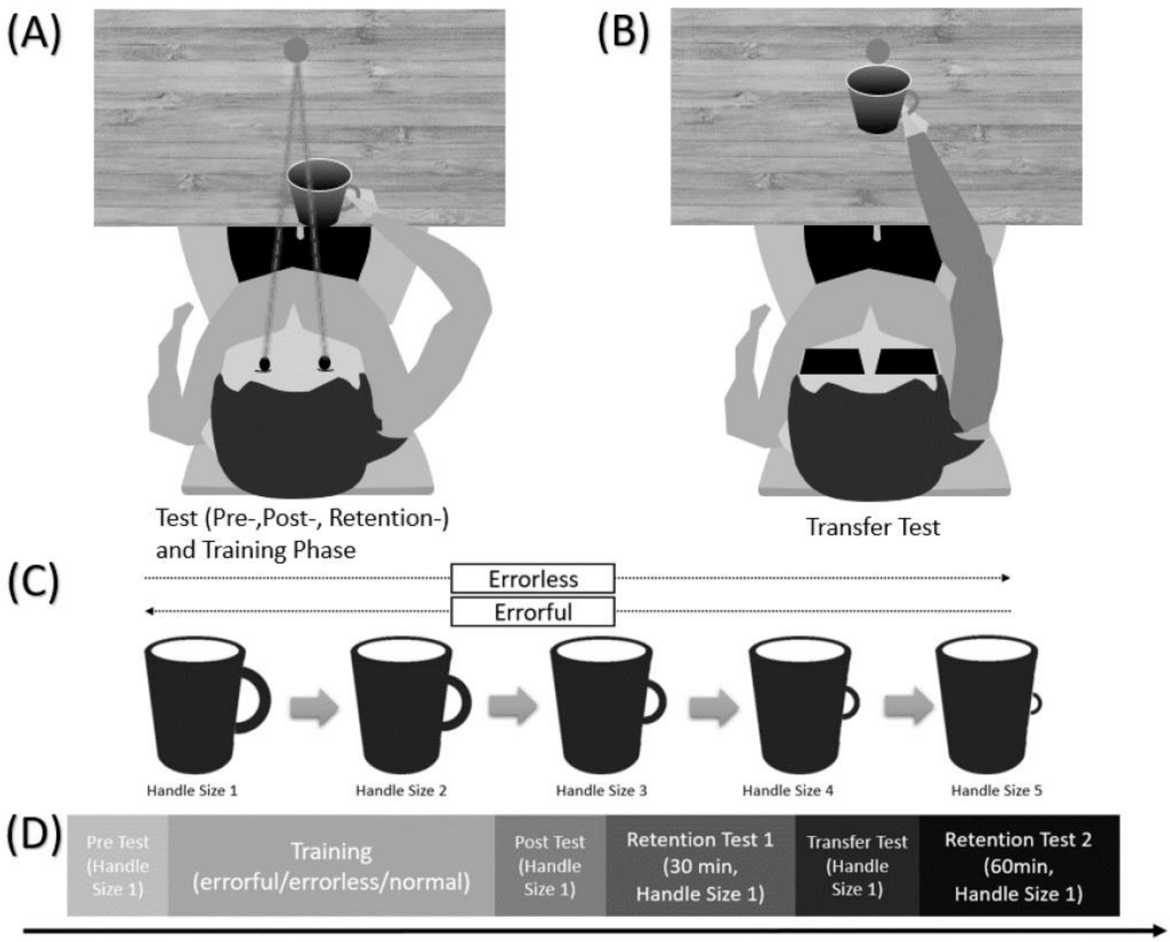

Figure 1 Apparatus setup and experimental procedure. (A) motor task in pre-test, post-test, retention-test, and the training phase; (B) the motor task in the transfer test; (C) materials setup and the training arrangement (D) experimental procedure

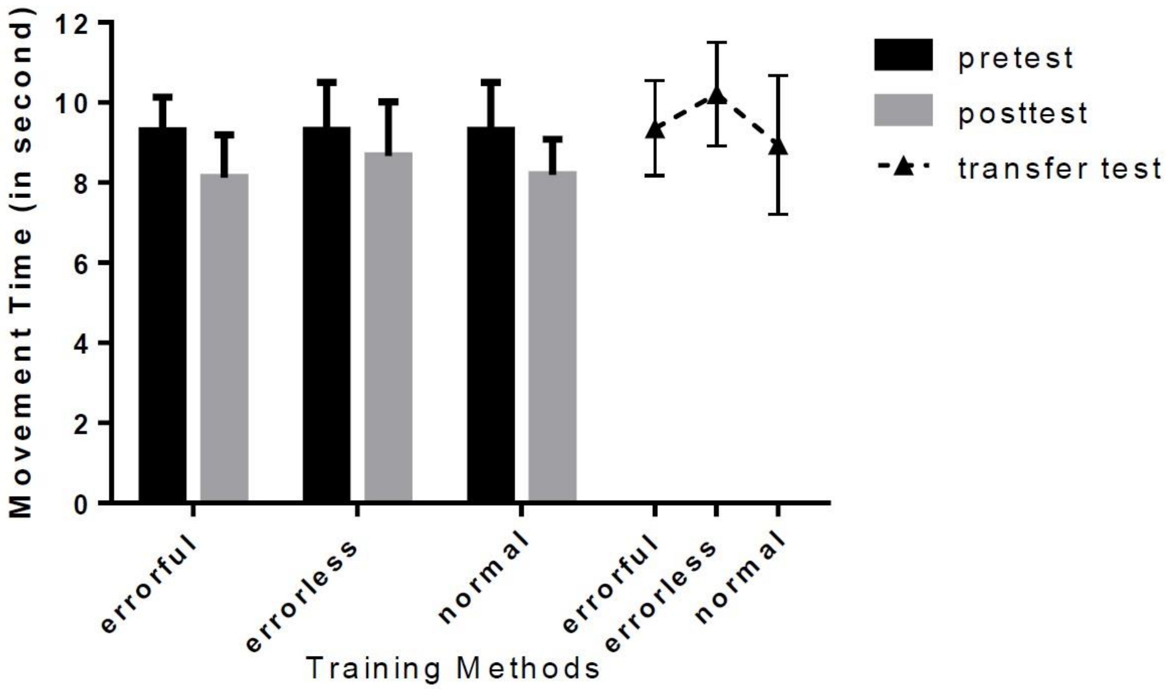

Figure 2 Movement time in pre-, post- and transfer test among three training groups (mean with standard deviation)

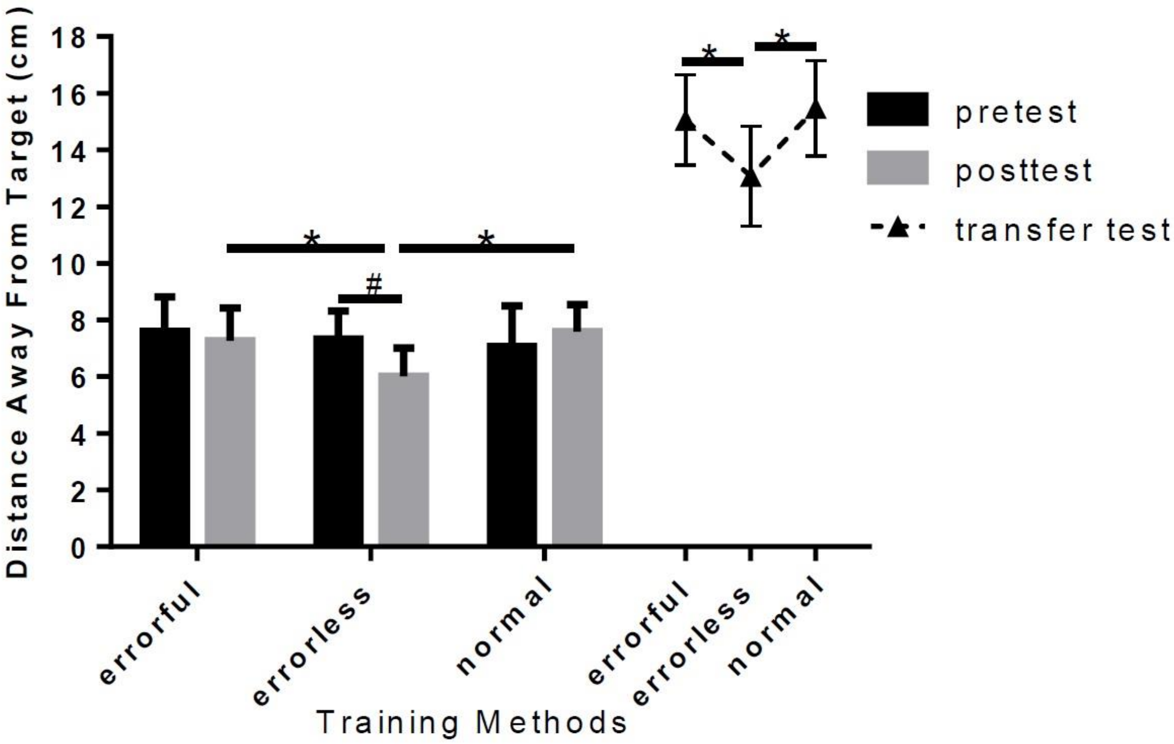

Figure 3 Distance away from the target in pre-, post- and transfer test among three training groups (mean with standard deviation); # represents the difference between pre- and post-test is significant (p<.05), * represents the difference between training methods is significant (p<.05).

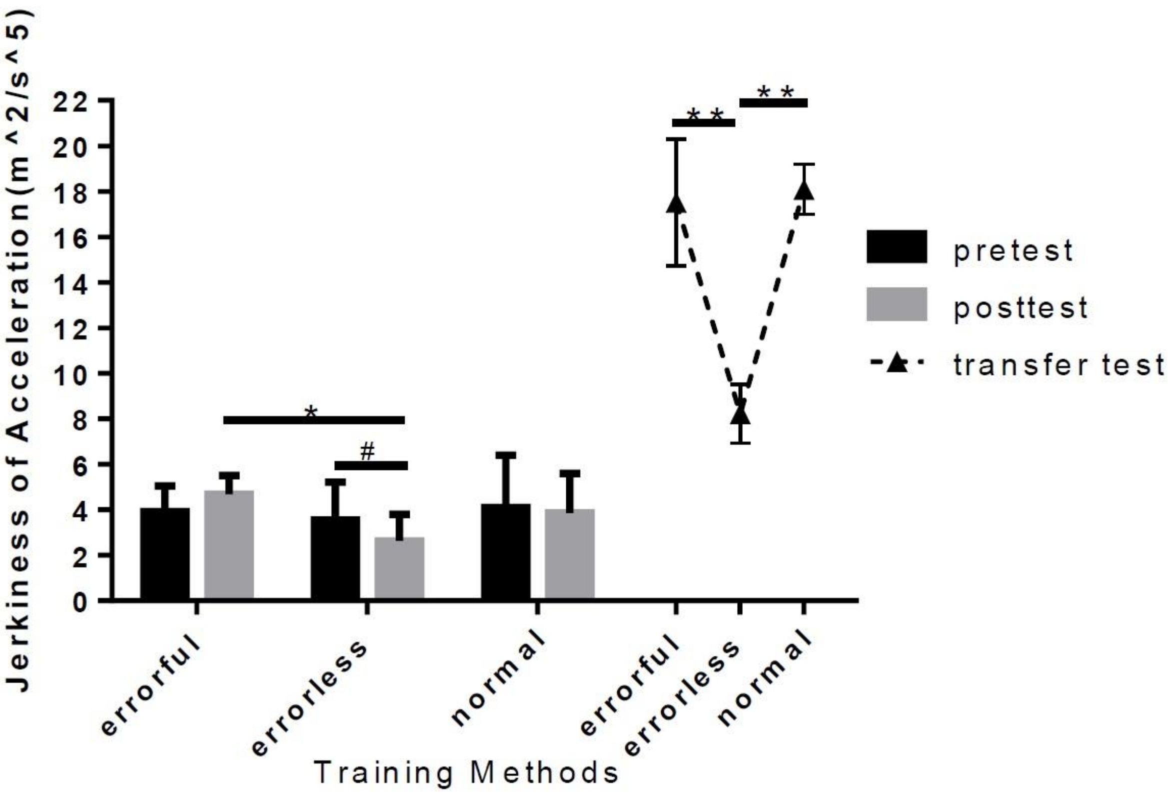

Figure 4 Jerkiness of acceleration in pre- , post- and transfer test among three training groups(mean with standard deviation) ; # represents difference between pre- and post-test is significant (p<.001), ** represents difference between training methods is significant (p<.001), * represents difference between training methods is significant (p<.05).

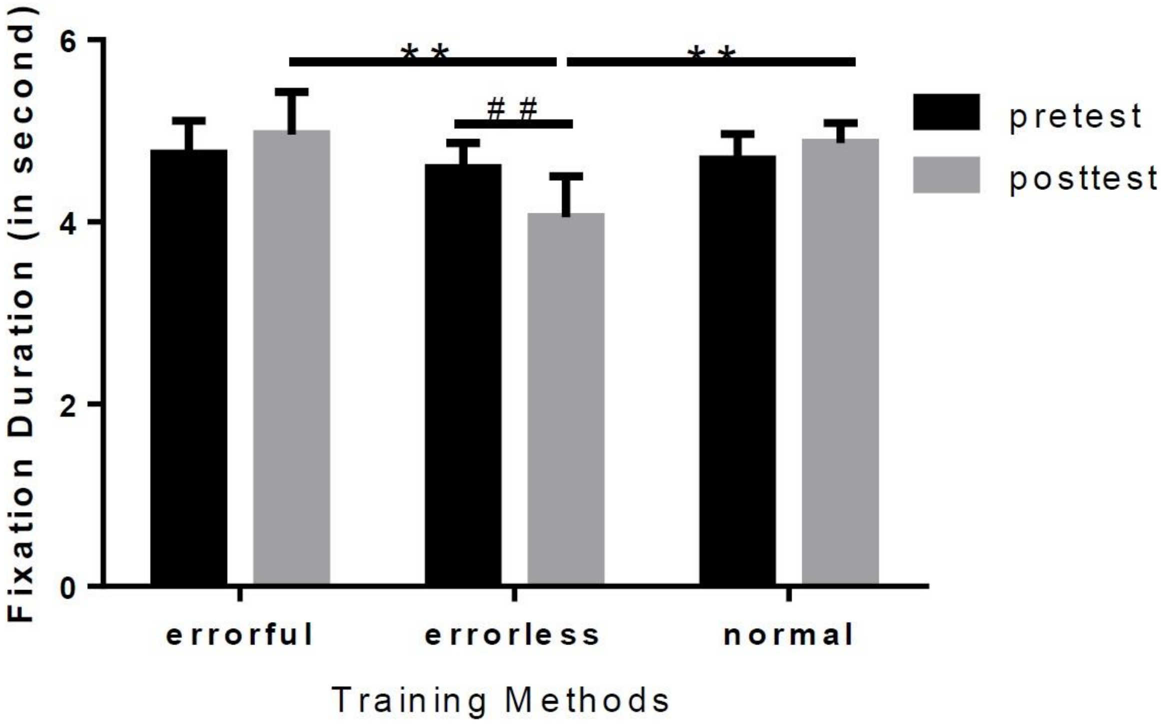

Figure 5 Fixation duration in pre- and post-test among three training methods(mean with standard deviation); ## represents the difference between pre- and post-test is significant (p<.001), ** represents the difference between training methods is significant (p<.001).

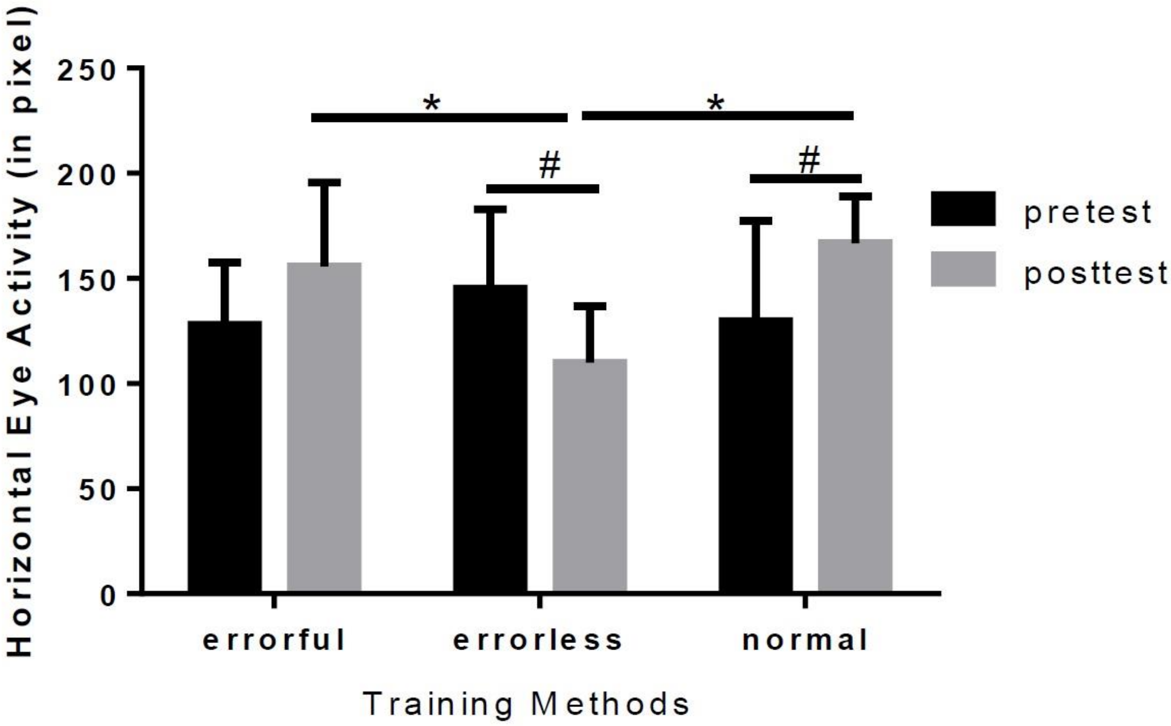

Figure 6 Horizontal eye activity in pre- and post-test among three training methods(mean with standard deviation); # represents the difference between pre- and post-test is significant (p<.05), * represents the difference between training methods is significant (p<.05).

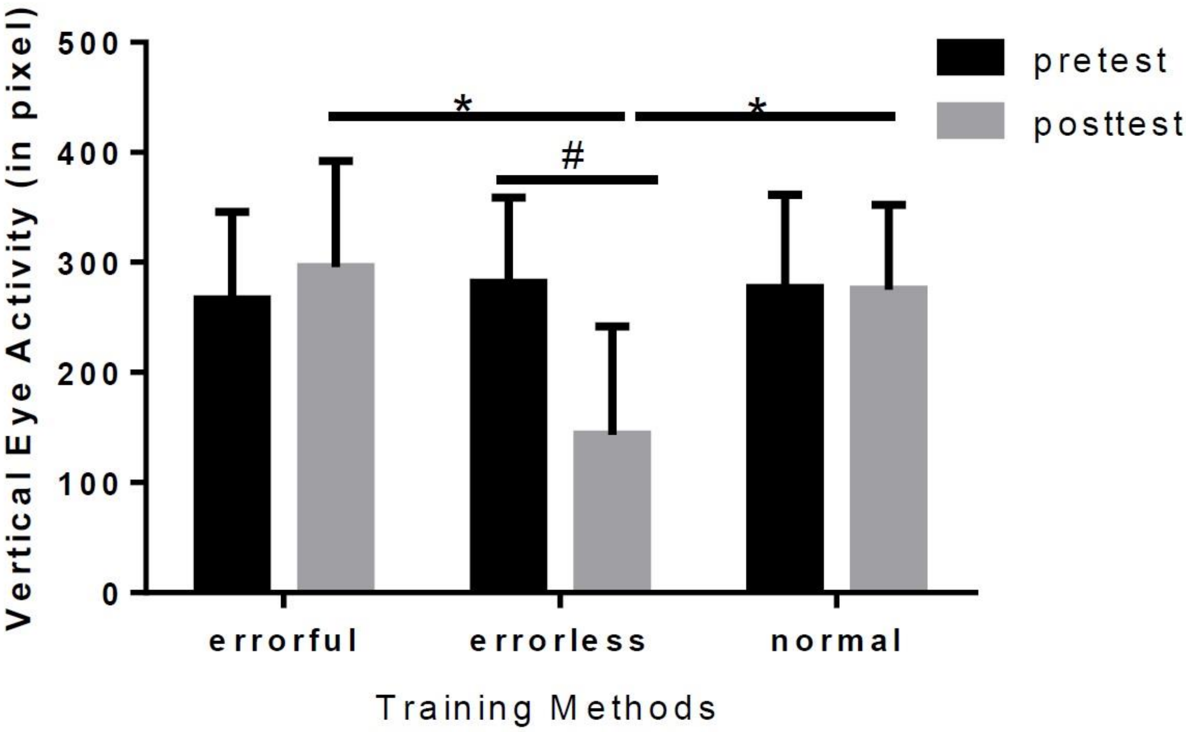

Figure 7 Vertical eye activity in pre- and post-test among three training methods (mean with standard deviation); # represents the difference between pre- and post-test is significant (p<.05), * represents the difference between training methods is significant (p<.05).