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Influential factors affecting age-related self-overestimation of step-over ability: Focusing on frequency of going outdoors and executive function

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ABSTRACT

Objective: Self-overestimation of step-over ability among older adults may result in a potential fall risk. However, the behavioral causal factor(s) of older adults' self-overestimation is unclear. We examined whether older adults' overestimation of step-over ability was mediated by an inactive lifestyle and/or poor executive function.
Methods: A sample of 194 community-dwelling older adults was assigned to either a high (HG, once a day or more) or low (LG, every 2–3 days or less) frequency of going outdoors group. Executive function was determined by the Trail-Making Test (TMT). Both the HG and LG participants performed Step-Over Tests (SOT) in two ways: self-estimation of step-over ability and the actual step-over task. During the self-estimation task, participants observed the horizontal bar at a distance of 7 m and predicted the self-estimated maximum height (EH) of successful SOT trials. The motor task was then performed, determining the actual maximum height (AH) of successful trials.
Results: A total of 36.1% of LG participants failed to successfully perform SOT trials at their EH (i.e., overestimation), whereas only 11.3% of HG participants failed. A multiple linear regression analysis showed that SOT overestimation was associated with an inactive lifestyle (low frequency of going outdoors) but not with executive function. Analyses of fall experience showed that both executive function and lifestyle significantly correlated with SOT overestimation among fallers, whereas only lifestyle was significantly correlated among non-fallers.
Conclusion: Our results suggest that an inactive lifestyle is a possible correlate of SOT overestimation among older adults, while executive function further influenced overestimation only among fallers.

1. Introduction

Physical ability generally declines as we age (Ahmed, Matsumura, & Cristian, 2005; Callisaya, Blizzard, Schmidt, McGinley, & Srikanth, 2008; Oberg, Karsznia, & Oberg, 1993). If older adults are unaware of their age-related physical decline, it is likely that they will overestimate their physical ability (presumably recalling previous conditions of their physical ability when younger). This self-overestimation of physical ability may be a serious causal factor in movement-related accidents among older adults. When considering step-over ability, older adults' overestimation of physical ability may lead to tripping on an obstacle while walking, possibly resulting in a fall.

Regarding older adults' self-estimation of step-over ability, we recently showed that older adults tend to overestimate their step-over ability (Sakurai et al., 2013). Furthermore, the number of older adult fallers who overestimate step-over ability is almost double that of non-fallers. This suggests that overestimation of step-over ability may be a potential risk factor for falling. A similar finding of overestimation among older adults was evident when assessing reaching ability (Butler, Lord, & Fitzpatrick, 2011;

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Gabbard, Cacola, & Cordova, 2011; Liu-Ambrose, Ahamed, Graf, Feldman, & Robinovitch, 2008; Robinovitch & Cronin, 1999). Although several previous studies have highlighted behavioral evidence for older adults' overestimation of physical ability, the significant causal factors affecting older adults' overestimation remain unclear.

Regarding likely causal factors, Liu-Ambrose et al. (2008) proposed that deficits in working memory might affect older adults' self-estimation of physical abilities. The authors showed that older adults with low working memory capacity (measured by a cognitive test) tended to overestimate their reaching ability more than older adults with better working memory performance. However, that study only included a small sample of fallers, and no non-fallers. Despite this limitation, it is likely that working memory capacity, as an element of executive function (which also comprises inhibitory function and mental flexibility: see Diamond, 2013; Miyake et al., 2000), may be essential in enhancing older adults' self-estimation of physical ability.

Given that poor working memory capacity is related to self-overestimation of physical ability among older adults, the specific memory (or awareness) of current physical ability may also be deteriorated to some extent, which could influence older adults' overestimations. The specific memory or awareness of physical ability is probably updated through daily physical activities. For example, decreased frequency of going outdoors may reduce daily experiences of re-estimation (and conscious awareness) of age-related decline in physical ability; this could lead to a lack of updating specific memory/awareness of physical ability. If this is the case, an inactive lifestyle may be an influential factor for both deficits in general working memory (executive function) and specific memory/awareness of current physical ability (Fujita, Fujiwara, Chaves, Motohashi, & Shinkai, 2006). Therefore, we hypothesize that deficits in cognitive/executive function, as mediated by an inactive lifestyle, may lead to older adults' overestimation of physical ability.

Another pertinent question is how closely inactive lifestyles and cognitive/executive function are related to, or independent from, each other, and to what extent these respective lifestyle and cognitive factors influence older adults' overestimation of physical ability. Therefore, we investigated the relationships between activity level, executive function, and self-estimation of physical ability using a step-over task in an attempt to identify influential factors of age-related self-overestimation. To this end, healthy community-dwelling older adults were assigned to two groups with a HG (go out daily) and LG (every few days or less) groups. These two groups were tested using our original SOT. The accuracy of self-estimation was evaluated in terms of the difference between EH and AH during the SOT. Executive function was examined using an established neuropsychological assessment, the TMT (Demakis, 2004; Sanchez-Cubillo et al., 2009). To examine likely conventional confounds affecting the frequency of going outdoors, the TMIG Index of Competence (TMIG-IC) (Koyano, Shibata, Nakazato, Haga, & Suyama, 1991) and Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) were administered. The TMIG-IC is a questionnaire consisting of three subscales used to measure older adults' functional capacity: instrumental activities of daily living (IADL: e.g., using public transportation with no aid), intellectual activity (e.g., reading newspapers), and sociability (e.g., visiting friends). The MMSE, widely used as a tool for assessing overall cognitive functioning, consists of seven cognitive subdomains/functions: orientation to time, orientation to place, registration of three words, attention and calculation, recall of three words, language, and visual construction (Tombaugh & McIntyre, 1992). Based on these measures, we then examined the relationships between self-estimation of step-over ability, frequency of going outdoors, and executive function.

2. Methods

2.1. Participants

One hundred ninety-four older adults (mean age = 73.6, SD = 5.3 years; 78.4% female) participated in the study. Participants were screened for the following exclusion criteria: (i) major disease or injury (e.g., stroke, heart disease, or injury-related fall) within 3 months prior to the study; (ii) problems with motor functions (e.g., use of a walking aid such as a cane); (iii) severe mental disorders or cognitive impairment (MMSE score $<$24); and (iv) vision insufficient to identify the experimental device (corrected binocular visual acuity $<$1.0 identified by Landolt ring chart examination). Written informed consent was obtained from all participants before examination. The study was conducted in accordance with the Declaration of Helsinki (1983). The Tokyo Metropolitan Institute of Gerontology approved the research protocol.

2.2. Health characteristics and frequency of going outdoors

A physician or physical therapist collected information regarding participants' health conditions and lifestyles through an interview. Information assessed was age, education, anamnesis (hypertension, cerebrovascular disorder, cardiac disease, diabetes mellitus, and arthropathy), and daily practice of going outdoors (including shopping, taking a walk, going to the hospital, and gardening; Fujita et al., 2006). The daily practice of going outdoors was scored as 1 point for once a day or more, 2 points for once every 2–3 days, and 3 for once a week or less according to Jacobs et al. (2008); participants were then assigned either a HG (score of 1) or LG (scores of 2 and 3) group. For the TMIG-IC, rating scores for the three subscales (IADL, intellectual activity, and social roles) ranged from 0 to 13, with higher scores indicating greater functional capacity. Fall experiences over the previous year were also assessed and rated as falls including an unintentional drop or fall to the ground, except for bicycle accidents, accidental contact with environmental structures (e.g., furniture and walls), and sudden cardiovascular or central nervous system events (Gibson, Andres, Isaacs, Radebaugh, & Worm-Petersen, 1987).

2.3. Overall cognitive and executive function

We used the MMSE (Folstein et al., 1975) and TMT (Sanchez-Cubillo et al., 2009) to evaluate overall cognitive and executive function (Diamond, 2013; Miyake et al., 2000), respectively. The MMSE has a maximum score of 30 points, with higher scores indicating higher overall cognitive function. The TMT consists of TMT-A and B (Demakis, 2004; Sanchez-Cubillo et al., 2009). In the TMT-A, to test simple visual search and motor speed skills (Gaudino, Geisler, & Squires, 1995; Sanchez-Cubillo et al., 2009), participants are asked to draw a line with a pencil to connect 25 printed numerals from 1 to 25 in ascending order (Gaudino et al., 1995; Sanchez-Cubillo et al., 2009). In the TMT-B, to test higher-order cognitive skills such as working memory and mental flexibility (Kortte, Horner, & Windham, 2002; Sanchez-Cubillo et al., 2009), participants perform a visual-motor task similar to the TMT-A, except this includes connecting 13 numerical numbers and 12 Japanese hiragana characters (Hirota et al., 2010) (the original TMT uses 12 letters) while alternating numbers and letters in ascending order (i.e., a number followed a hiragana character and vice versa). Both the TMT-A and B were performed after ensuring that the participants were fully familiarized with the task procedures. The elapsed time taken to complete the TMT-A and B was recorded; the difference in time between the two (Δ TMT) was calculated by subtracting TMT-A time from TMT-B time for a