Gait & Posture 41 (2015) 7–12

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Review

How fear of falling can increase fall-risk in older adults: Applying psychological theory to practical observations

William R. Young *, A. Mark Williams

Centre for Sports Medicine and Human Performance, Brunel University, UB83PH, UK

ARTICLE INFO

Article history:
Received 28 October 2013
Received in revised form 19 August 2014
Accepted 13 September 2014

Keywords:
Older adults
Fear of falling
Anxiety
Stiffening
Attentional control theory

ABSTRACT

It is widely reported that fear of falling (FOF) has a profound and largely detrimental effect on balance performance in older adults. However, the mechanisms by which FOF influence postural stability are poorly understood. In the current article, we use psychological theory to explain FOF-related changes to postural control. First, we review literature describing associations between FOF and the 'stiffening' strategies observed during control of posture, including observations of eye and head movements. Second, we present a framework illustrating the interactions between increased age, FOF, and altered attentional processes, which in turn influence balance performance and fall-risk. Psychological theory predicts that anxiety can cause attentional bias for threatening and task-irrelevant stimuli and compromise the efficiency of working memory resources. We argue that while the adoption of stiffening strategies is likely to be beneficial in avoiding a loss of balance during simple postural tasks, it will ultimately compromise performance in dynamic and highly demanding functional tasks. The adoption of stiffening strategies leads to inadequate acquisition of the sensory information necessary to plan and execute dynamic and interactive movements. We conclude with some suggestions for future research.

1. Introduction

The detrimental effect of fear of falling (FOF) in older adults (OA) has received much attention in the literature since the early 1980s. FOF has been identified as an independent risk factor for reduced quality of life, activity restriction, loss of independence, and fall-risk; a leading cause of injury, morbidity, and mortality [1]. Moreover, FOF is prevalent in community-dwelling older adults, with estimates of the frequency of falls ranging between 29% and 77% [1].

Hadjistavropoulos et al. [1] presented a model depicting strong associations between FOF and reduced balance performance. However, the mechanisms underpinning this relationship were not articulated. In the current article, we review literature describing FOF-related alterations in the control of posture and gait. Moreover, we review existing psychological theory surrounding the influence of anxiety on the attentional processes required for maintaining postural control. We argue that the influence of FOF on fall-risk is mediated by changes in the allocation of attention and associated alterations in motor control. We present a framework that rationalizes how FOF can influence attentional processes and jeopardize the acquisition and retention of sensory information necessary for the planning of safe stepping actions during complex locomotor tasks. In latter sections, we discuss the implications of our approach for future work and identify specific empirical questions that have yet to be adequately addressed in the literature.

2. Anxiety and postural control

With respect to the control of posture and gait, many researchers have investigated behavioral responses to perceived threat, mostly by raising the height (or perceived height) of a support surface (for a review, see Staab et al. [2]). These researchers have consistently shown that behavioral correlates of FOF are indicative of a conservative 'stiffening strategy'. When adopting this stiffening strategy people reduce the range of motion of their center of mass by reflexively co-contracting tibialis anterior, soleus, and gastrocnemius muscles, resulting in lower amplitude and higher frequency postural sway [3,4]. These adaptations vary linearly with platform height [4]. Furthermore, when standing at height, people: (1) self-report increased FOF and reduced balance confidence [2]; (2) show hallmarks of increased autonomic activity, such as greater galvanic skin conductance [2]; and (3)

* Corresponding author. Tel.: +441895 265449.
E-mail address: will.young@brunel.ac.uk (W.R. Young).

http://dx.doi.org/10.1016/j.gaitpost.2014.09.006
0966-6362/

lean backwards away from the platform edge [5]. These adaptations are exacerbated by increased cognitive demands [6,7]. For example, when performing a non-threatening second task (e.g., mental arithmetic), modest reductions in postural sway are observed [6]. These trends are more evident in OA compared to young adults, indicating age-related increases in the attentional demands of postural control [6]. Conservative behaviors are also seen during walking, where anxious people will reduce the range of motion and joint angular velocities in their lower limbs, resulting in shorter strides and reduced gait speed [2,8].

The majority of researchers have interpreted stiffening strategies as an intuitive preparatory strategy aimed at accommodating potential destabilizing factors [3,4,8]. Providing the demands of the task are relatively low (such as during quiet stance), it is likely that a stiffening strategy will be beneficial in avoiding potentially destabilizing motor patterns [3,8]. However, activities of daily life are seldom simple as we are required to interact with features of our environment in a complex and dynamic fashion, often requiring a series of precise movements when negotiating multiple constraints. For example, a common activity for many OA would be to walk along an uneven pavement. The walker must gather precise information regarding the position and characteristics of environmental features and potential hazards in order to plan stepping actions toward areas of the intended path that are deemed safe, while, at the same time, orchestrating appropriate adaptations, such as evasive actions. Stiffening strategies may reduce the capacity to achieve these dynamic tasks, increasing the likelihood of misguiding balance, failing to produce a sufficient response to external perturbations and/or misplacing a step that could lead to tripping, slipping, and falling. Therefore, it is surprising that relatively few researchers have attempted to examine links between FOF and reduced performance in tasks that are more representative of functional activities of daily life.

3. Link between anxiety, visual behavior, and fall-risk

It seems plausible that falls resulting from tripping and slipping might be avoided with better movement planning. Several researchers have attempted to address this topic by measuring eye movement behaviors as an indicator of visual attention during adaptive locomotor tasks. It has been reported that OA with high self-reported anxiety will fixate a target (such as that illustrated in Fig. 1) earlier during the approach and for longer durations compared to OA with low self-reported anxiety [9]. These changes in visual search may reflect a compensation for age-related decline in central nervous system function by providing additional time to acquire spatial information regarding the target in order to ensure an accurate and safe approach. Such a compensatory strategy seems intuitive. However, when faced with multiple stepping targets anxious OA will demonstrate other visual behaviors that jeopardize walking safety [9,10]. Young et al. [9] found that when stepping on a target OA with high self-reported anxiety would transfer their gaze away from the target earlier (in order to fixate the subsequent stepping constraint in their path) compared to OA self-reporting lower levels of state-anxiety. High-risk OA would generally look away from the target approximately 400 ms before foot contact inside the target, resulting in poorer stepping accuracy and increased incidence of their foot contacting the raised edges of the target, thus increasing the risk of tripping and falling [9,10].

More recently, using a single case-study design, Young and Hollands [11] showed that prior to falling on two occasions, participant P8 (an 87-year-old female) self-reported low FOF and demonstrated both eye movements and stepping behaviors typical of a low-risk OA. However, thirteen days following the latter of the two falls, across a range of questionnaire-based assessments of balance confidence and state-anxiety, P8 self-reported 15%, 23.3%, and 37.5% increases in FOF. Furthermore, in the absence of any observed general decline in visual function (acuity, contract sensitivity, size of peripheral field), cognitive processing, visual-spatial working memory, or muscle strength, when stepping over multiple constraints P8's eye movement and stepping behaviors changed significantly and were indicative of that typically seen in high-risk OA with FOF [11]. Collectively, these studies show that FOF is associated with visual behaviors that are known to compromise walking safety in OA, by increasing the risk of producing an inaccurate step and tripping. However, the studies do not directly specify the underlying mechanisms through which FOF drives premature gaze transfer from the target. Young and Hollands [9] showed that FOF-related changes in the visual behaviors exhibited by OA existed during their entire approach to the initial stepping target. When facing a target followed by two obstacles, low-risk OA (who self-reported low FOF) frequently transferred visual fixation between each of the stepping constraints during their entire approach (Fig. 1a). However, high-risk OA (who self-reported higher FOF) demonstrated a different visual strategy, by fixating the initial target for the majority of their approach toward it, and fixating the subsequent constraints on significantly fewer occasions and for shorter durations compared to OA without FOF (Fig. 1b).

Without visually fixating the future constraints in their path, high-risk OA would be less able to generate a 'spatial map' of these

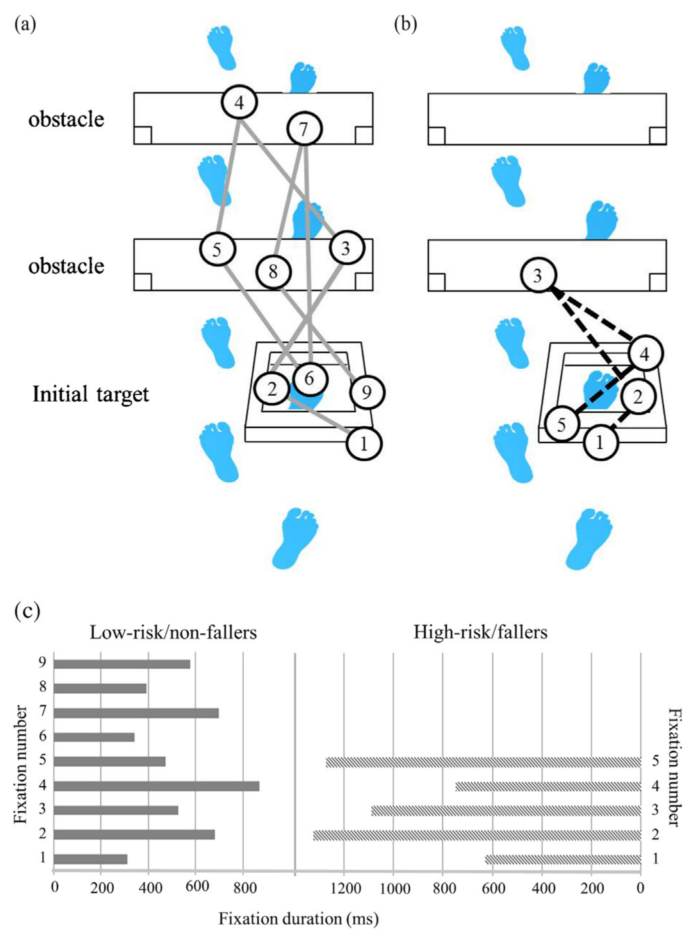

Fig. 1. A stylized representation of visual search behaviors exhibited by: (a) low-risk older adults with low fear of falling, and (b) high-risk older adults with high FOF, when approaching a series of stepping constraints on a level 8 meter walkway. The circled numbers represent the order of visual fixations on each constraint. The bar chart X-axis (c) illustrates the durations of each fixation on prior to stepping into the initial target. The number in the bar chart Y-axis corresponds to the fixation number in diagrams (a) and (b).