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Does the walking task matter? Influence of different walking conditions on dual-task performances in young and older persons ☆

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Previous literature suggests that age-related deficits of dual-task walking are particularly pronounced with second tasks that require continuous visual processing. Here we evaluate whether the difficulty of the walking task matters as well. To this end, participants were asked to walk along a straight pathway of 20 m length in four different walking conditions: (a) wide path and preferred pace; (b) narrow path and preferred pace, (c) wide path and fast pace, (d) obstacled wide path and preferred pace. Each condition was performed concurrently with a task requiring visual processing or fine motor control, and all tasks were also performed alone which allowed us to calculate the dual-task costs (DTC). Results showed that the age-related increase of DTC is substantially larger with the visually demanding than with the motor-demanding task, more so when walking on a narrow or obstacled path. We attribute these observations to the fact that visual scanning of the environment becomes more crucial when walking in difficult terrains: the higher visual demand of those conditions accentuates the age-related deficits in coordinating them with a visual non-walking task.

1. Introduction

The gait pattern of older people is affected by fundamental changes with advancing age. For example, stride-time, stride-time variability as well as double-support time increase while walk-

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ing speed, step-length and step-height decrease (Beurskens & Bock, 2011; Bock, Engelhard, Guardiera, Allmer, & Kleinert, 2008; Hollman, Kovash, Kubik, & Linbo, 2007; Schrager, Kelly, Price, Ferrucci, & Shumway-Cook, 2008). Some of the observed changes are compensatory mechanisms to stabilize body posture and allow safe locomotion; some of them co-vary between individuals indicating a common cause. Older people primarily reduce their walking speed as a precautionary measure and other gait measures change (e.g., stride-time increases, step length decreases) as a consequence thereof (Winter, Patla, Frank, & Walt, 1990). Many studies describe changes in gait behavior as impairments that are correlated with a higher risk of accidental falls (Hausdorff, Rios, & Edelberg, 2001; Maki, 1997). Therefore, the observed gait changes seem to illustrate a mixture of deficits and countermeasures that affect temporal measures as well as spatial ones.

The changes of walking capabilities in older age have been attributed, among others, to a decrease in cognitive capabilities (Bock, 2008), potentially caused by an age-related shrinkage of prefrontal grey matter and the associated decline of executive functions (McDowd & Shaw, 2000; Raz et al., 1997). Indeed, the crucial role of cognition for elderly walking is supported by the circumstance that age-related changes are more pronounced in persons with cognitive detriments (Hausdorff, Edelberg, Mitchell, Goldberger, & Wei, 1997; Holtzer, Verghese, Xue, & Lipton, 2006) and can be emphasized even in healthy seniors when walking in dual-task conditions (Li, Lindenberger, Freund, & Baltes, 2001; Lindenberger, Marsiske, & Baltes, 2000; Lundin-Olsson, Nyberg, & Gustafson, 1997). The latter note is of practical importance for older peoples' everyday life. It suggests that the risk of falling increases when a person is engaged in walking and concurrently handling another activity, e.g., watch street signs or navigate around a crowded environment.

A recent review showed that the amount of deficits that occur while dual-task walking depends on the demands that a secondary task creates (Beurskens & Bock, 2012). Dual-task interferences seem to be more pronounced in older than in young subjects when the non-walking task requires continuous visual processing, but is similar in both age groups when the non-walking task does not require the processing of visual information (Beurskens & Bock, 2011; Bock & Beurskens, 2011a, 2011b). Especially, in dual-task walking, subjects have to coordinate two sources of visual information, one related to navigating through visually defined spaces (Imai, Moore, Raphan, & Cohen, 2001; Nomura, Mulavara, Richards, Brady, & Bloomberg, 2005), and the other to the solution of a visual non-walking task (Beurskens & Bock, 2011). This kind of information processing is similar to everyday demands where different visual inputs have to be coordinated, e.g., while walking in a crowded mall or along a street while watching for street signs. One aspect that has attracted little attention in recent dual-task walking studies is the role of different walking tasks and their demands for dual-task walking. Only a few studies evaluated the influence of different terrains (Gates, Wilken, Scott, Sinitski, & Dingwell, 2012; Marigold & Patla, 2008) or the presentation of obstacles (Chen et al., 1996; Patla & Vickers, 1997) on human locomotion and found that even young participants contacted the floor with a flatter foot and with an increased knee and hip flexion when walking on variable surfaces (Gates et al., 2012). Furthermore, the role of visual information and the processing thereof becomes more crucial when obstacles have to be avoided (Patla & Greig, 2006; Patla & Vickers, 1997) or when walking over different surfaces (Marigold & Patla, 2008). For example, older people contact more obstacles when vision is perturbed (Menant, St George, Sandery, Fitzpatrick, & Lord, 2009), but unfortunately the latter study did not include young adults for control to distinguish age-related differences, which is a methodological constraint of several recent studies (Hawkes, Siu, Silsupadol, & Woollacott, 2012; Hegeman et al., 2012).

Despite these facts, the role of visual processing for human dual-task walking in different walking terrains is largely unknown. Therefore, the presented study tries to answer the questions (1) how different walking task difficulties influence dual-task performance in young and older individuals and (2) whether this impact of different locomotor task difficulties differ between visually dominated versus non-visual secondary tasks? To find out, participants were asked to walk either at normal speed, at a fast pace, on a narrow path, or to avoid obstacles presented in their path.