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Walking while talking: Young adults flexibly allocate resources between speech and gait

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ABSTRACT

Background: Walking while talking is an ideal multitask behavior to assess how young healthy adults manage concurrent tasks as it is well-practiced, cognitively demanding, and has real consequences for impaired performance in either task. Since the association between cognitive tasks and gait appears stronger when the gait task is more challenging, gait challenge was systematically manipulated in this study.
Objective: To understand how young adults accomplish the multitask behavior of walking while talking as the gait challenge was systematically manipulated.
Methods: Sixteen young adults (21 ± 1.6 years, 9 males) performed three gait tasks with and without speech: unobstructed gait (easy), obstacle crossing (moderate), obstacle crossing and tray carrying (difficult). Participants also provided a speech sample while seated for a baseline indicator of speech. The speech task was to speak extemporaneously about a topic (e.g. first car). Gait speed and the duration of silent pauses during speaking were determined. Silent pauses reflect cognitive processes involved in speech production and language planning.
Results: When speaking and walking without obstacles, gait speed decreased (relative to walking without speaking) but silent pause duration did not change (relative to seated speech). These changes are consistent with the idea that, in the easy gait task, participants placed greater value on speech pauses than on gait speed, likely due to the negative social consequences of impaired speech. In the moderate and difficult gait tasks both parameters changed: gait speed decreased and silent pauses increased.
Conclusion: Walking while talking is a cognitively demanding task for healthy young adults, despite being a well-practiced habitual activity. These findings are consistent with the integrated model of task prioritization from Yogev-Seligmann et al., [1].

1. Introduction

Walking while talking is a commonly performed multitask which is cognitively demanding. Gait requires awareness of a destination, appropriate control of trunk and limb movements, and complex terrain navigation [2]. Extemporaneous speech requires the retrieval of information from memory, identifying appropriate words and grammatical forms, and translating these words into motor commands [3]. While these tasks can be described as overlearned, both have consequences for poor execution, including loss of stability and the social consequences associated with impaired speech [4,5].

The dual-task paradigm is commonly used to understand multitasking and compares performance when motor and cognitive tasks are performed both independently and concurrently [6,7]. Generally, impaired performance is observed in one or both tasks when completed concurrently [1,2,6,7], which suggests that processes that appear 'automatic' require some degree of cognitive processing. A comprehensive understanding of how motor behaviors, such as gait and posture, are influenced by a concurrently performed task is complicated by the wide range of tasks that have been adopted including arithmetic, memorization, visuospatial, and Stroop tasks [2,8]. The difficulty of many of these cognitive tasks can be systematically scaled, allowing insight into the relationship between difficulty and motor performance. However, these tasks – termed 'traditional cognitive tasks' in this document – do not represent the cognitive tasks of daily life. Further, participants may not be compelled to perform these tasks with full effort since poor performance has little consequence. For example, gait speed is reduced more when performing extemporaneous speech (a task with

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consequence for poor performance) compared to an auditory Stroop task (a task with little consequence for performance) [9]. Results from more traditional cognitive tasks may not be generalizable to everyday activities due to underlying differences in the consequences of failure.

Speech is an ideal concurrent task because it is continuous, challenging, well-practiced, often performed during gait, and has consequence if performed poorly. Adequate speech skills are associated with social and cognitive competence [4,5]. It is important to distinguish extemporaneous speech from reading or reciting speech as the former requires more cognitive effort than the latter [3,10–12]. Social judgement associated with compromised speech may motivate healthy adults to prioritize speech over walking, consistent with the idea that tasks with higher value are prioritized [13,14]. However, when fall risk is increased with more challenging gait tasks, healthy adults may be more likely to modify speech to ensure adequate resources are available to prevent a fall. Modification of prioritization as a function of task complexity is consistent with the integrated model of task prioritization [1].

The challenge associated with walking while talking is clearly demonstrated by the finding that walking while talking is related to falls in both older adults [15,16] and young adults [17]. Changes in gait performance of an older adult when they are speaking is associated with a higher risk of falling, indicating the ability to manage the two tasks concurrently is compromised in fallers [15,16]. More recently, the most common multitask activity associated with falls in young adults was identified as walking while talking to a friend [17]. Therefore, even young adults, presumably at optimum cognitive ability and physical fitness, may demonstrate challenges associated with walking while talking.

The purpose of this study was to understand how young adults accomplish the multitask behavior of walking while talking. Gait performance was quantified with gait speed, as speed includes spatial and temporal measures of gait. Further, gait speed is commonly assessed in dual-task paradigms [2,9]. Speaking performance was measured with speech pauses that reflect cognitive and physiological processes involved in speech production and language planning [3,10,11,18–20]. Previous evidence shows that subjects can prioritize one task over another when they are specifically instructed [2,21]; therefore, in this study, no prioritization instructions were provided in order to quantify self-selected prioritization. The gait task included three levels of increasing gait complexity: unobstructed (easy), obstacle-crossing (moderate), and obstacle-crossing while carrying a loaded tray (difficult). We hypothesized that 1) when gait challenge is easy, there will be no speech dual-task cost (DTC), but there will be gait DTC, 2) when gait becomes more challenging, both gait and speech DTC will be observed. These hypotheses are consistent with the idea that individuals use prioritization strategies that allow flexible allocation of resources based on the nature of the task goals.

2. Methods

Sixteen volunteers (21 ± 1.6 years, 9 males) signed an informed consent form approved by the institutional review board. All participants were native English speakers and free of disorders that impacted gait or speech. Gait was measured on a 4.3 m pressure-sensing mat (GAITRite, CIR Systems, NJ) centered on an 8.3 m walkway. Speech was recorded using a microphone attached to the shirt.

2.1. Protocol

Gait tasks were unobstructed gait (easy), obstacle crossing (four obstacles in the 4.3 m walkway; moderate), and obstacle crossing with tray carrying (difficult) (Figs. 1 and 2). These gait tasks were performed with and without speech. A baseline task for speech was also included – talking while seated (Fig. 1). Each trial consisted of the participant walking back and forth for one minute, and each trial was completed twice. Before the protocol began, participants selected 11 topics from 28 options to speak about (e.g., pets, first job, favorite sport). One of the 11 selected topics was randomly chosen for each of the eight speaking trials, no topics were repeated. Instructions were provided before each trial, “Walk at a self-selected pace while speaking about the topic as if you are walking to class with a friend,” such that no prioritization strategy was cued by the researchers.

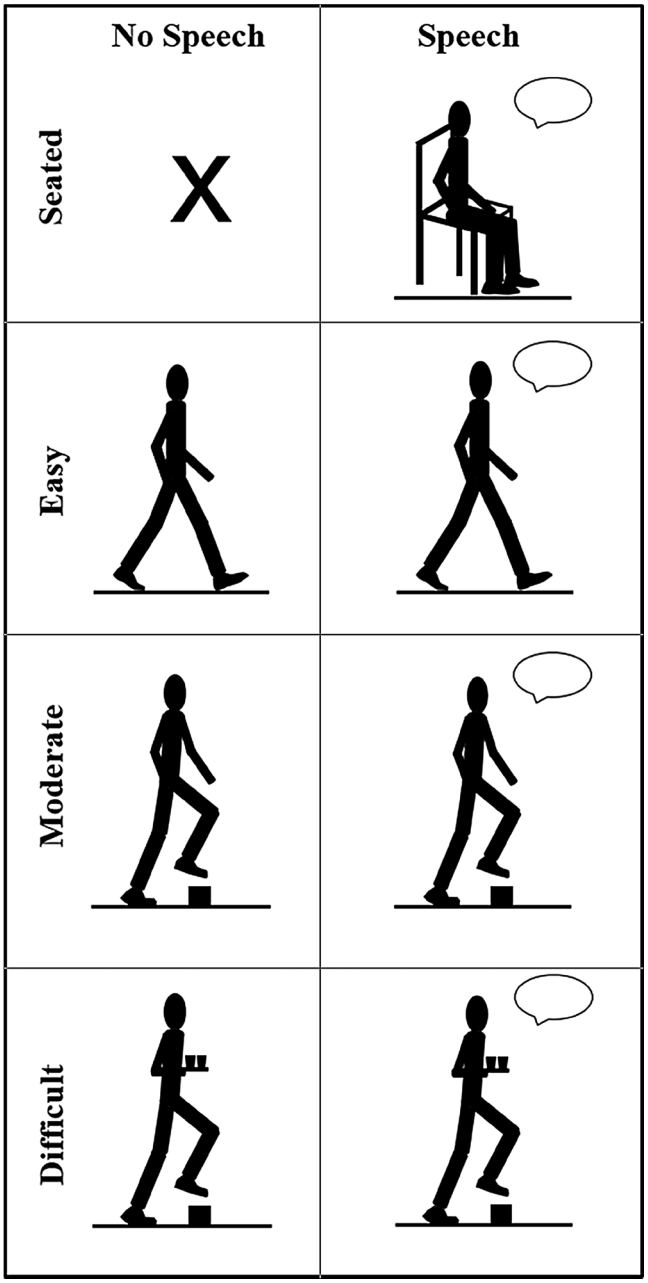

Fig. 1. Summary of experimental tasks; each task was completed two times with one minute duration (walking back and forth on 8.3 m walkway). The seated while talking condition (upper right panel) was used as the baseline condition for the walking while talking tasks to assess speech dual-task cost (DTC). The three gait tasks in the left column were the baseline tasks for each of the three gait tasks in the right column to asses gait speed DTC.

2.2. Data analysis

Gait speed was determined by GAITRite software (v. 4.7.4). The duration of silent speech pauses was used to evaluate interruptions to