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The effect of text messaging on reactive balance and the temporal and spatial characteristics of gait

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ABSTRACT

The aim of this study was to determine the effects text messaging has on gait characteristics and reactive balance. Thirty-two subjects were recruited. Data was collected on texting ability in standing, while walking and while in perturbed stance. Data on gait parameters using the GAITRiteTM were collected while walking normally and while walking and texting. Data on reactive balance in perturbed stance (DMA score) using the PROPRIO 5000^{TM} was collected while standing and while standing and texting. Repeated measures statistics were applied. No practical difference in texting ability was found between the three conditions of standing, walking and perturbed stance. A significant difference was found between mean gait characteristics of velocity, cadence, double limb support and mean step length during normal walking and walking while texting ($p < .05$). No statistical significance was shown between mean heel to heel support. A significant difference was found between reactive balance ability (mean DMA score) in perturbed stance and perturbed stance while texting ($p < .05$). The data imply that gait and balance are negatively impacted while texting and that subjects will maintain their baseline texting speed and accuracy at the expense of gait speed and impaired balance.

1. Introduction

Text messaging with cellular devices has become a ubiquitous activity. On average, an individual sends and receives 40 text messages per day. Eighteen to 24-year-olds average more than 100 text messages per day [1]. Though texting is a seemingly harmless activity, it is widely known that texting while operating a motor vehicle can have negative consequences. Less known are the effects of texting on the bipedal activities such as walking and reacting to perturbations while standing. Only recently has using mobile devices while walking been reported in pedestrian related accidents, and the yearly incidence of these pedestrian related accidents is increasing [2,3]. Serious injury could occur using mobile devices while walking. Schwebel et al. demonstrated a true potential for serious harm could occur while using mobile devices when walking across a street. In their study, participants distracted while talking on a phone, texting, or listening to music were more likely to be hit by a vehicle in a virtual crosswalk than undistracted participants [4].

The observed changes in gait while texting are generally attributed to the changes in the difficulty of performing concurrent tasks, which ordinarily results in the deterioration of the performance of one or both tasks. This dual task phenomenon has been widely researched in other contexts. Woollacott et al. found a task's complexity, as well as the simultaneous task's complexity in healthy and balanced-impaired elderly patients, affects the level of attention required for postural control during gait [5]. Similarly, a study by Pellecchia found as a cognitive task's difficulty increases so does the amount of postural sway, indicating that cognitive and motor performance are inherently related [6]. A study by Hausdorff et al. examined the effect a dual task such as subtracting numbers and phoneme monitoring had on gait in healthy older adults and found that the participants altered their gait patterns by reducing speed, increasing stride to stride variability and decreasing swing time in the dual task situations [7]. These and other studies indicate that a concurrent cognitive task will generally bring about a slowing of gait and increased postural sway in balance tasks.

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Researchers have recently attempted to quantify the specific effects of texting on bipedal activity. Demura and Uchiyama compared the gait characteristics of healthy college students walking a straight path and then walking while using the email function on their phones. Participants who were emailing demonstrated decreased velocity and stride width and increased stance phase time [8]. Schabrun et al. had participants walk normally and walk while reading and while texting and measured the differences using 3D motion analysis. This study revealed decreased velocity, greater medial and lateral step deviation, and reduced neck range of motion with both reading and texting. In addition, they found the head to move in-phase with the thorax, which is likely related to stabilizing the eye gaze to the device [9]. Lamberg and Muratori also saw decreased velocity while texting and talking. They also noted a deviation in the gait path while texting and walking toward a target [10]. A recent study by Plumber et al. demonstrated that young adults were flexible in the prioritization between texting and walking based on the instructions given to the participants. However when participants were not given instructions to focus on either texting or gait, they slowed their walking to improve their texting accuracy and speed [11]. The effect that the prioritization of the task has on gait has been studied in other dual task experiments that did not include texting [12,13].

Despite the fact that the effects of dual task activities on postural control have been well researched, little has been done related to gait and postural control with this ubiquitous and real-world task of texting. The purpose of this study was to examine the effect of cell phone texting on gait and reactive balance, as well as to examine the effect of gait and a reactive balance task on cell phone texting ability. It was hypothesized that cell phone texting will have the effects of slowing gait and increasing the center of mass displacement in perturbed stance.

2. Methods

2.1. Participants

Thirty-two participants 18–40 years old were recruited (6 males, 26 females, average age of 24). Individuals were required to own a cell phone and be familiar with texting to be included. Individuals with health issues or gait and balance deficits were excluded. The participants were fully informed of the methods regarding their participation and provided written informed consent. The study was approved by Bradley University's Committee on the Use of Human Subjects in Research (Bradley University's Institutional Review Board).

2.2. Equipment

The temporal and spatial parameters of gait were measured using the GAITRite™ system (GAITRite™ CIR Systems, Inc., Havertown, PA). This is a computerized gait mat that is 4.27 meters long. The following gait parameters were measured: velocity, cadence, percent of cycle in double limb support, heel to heel base of support, and step length. Heel to heel base of support is specifically the medial-lateral distance from heel center of one footprint to the line of progression formed by two footprints of the opposite foot [14].

For the reactive balance measures, the PROPRIO 5000™ (Perry Dynamics, Decatur, IL) was used. The PROPRIO 5000 consists of a platform that provides multidirectional tilt perturbations to a participant who is standing. An ultrasonic sensor is placed on the low back and is able to precisely detect multiplanar movement of the participant as they respond to the platform perturbations. The standard PROPRIO test, which was already programmed into the machine, was used. This test provides standardized multidirectional perturbations in which the amplitude and velocity of the perturbation is progressively increased over two minutes. To the participant, the direction of the perturbation appears random and even after multiple trials, thus the direction of the perturbation is unpredictable. The PROPRIO test has been found to be a valid measure of center of mass movement when compared to the NeuroCom Sensory Organization Test [15]. All the participants performed the test with a safety harness that did not hinder their movements, but would prevent a fall.

2.3. Procedures

Baseline measurements of cell phone texting ability were taken first. A standardized question was texted to each participant to which each responded to the researcher while in the standing position (TEXT BASELINE). Individuals were asked to refrain from using abbreviations and shortcuts. This was repeated two more times with different questions. The following is a sample question to which the participants responded with a text: "Where do you see yourself in five years?" The texts were received and stored for later analysis with regard to the number of errors and velocity of the texting (characters per second). Baseline gait was then measured (GAIT BASELINE). Individuals were asked to walk across the GAITRite™ at a normal pace. Participants walked three times on the mat starting one meter behind the mat and stopping one meter beyond the mat. Measures from the three trials were averaged to use in the final analysis. Participants then completed three additional trials while texting (GAIT TEXT). The researchers sent the participants a different standardized question. When the participants were ready to respond to the question, they began texting and walking across the GAITRite™. This was repeated two more times each with a different question. Again the measures from the three trials were averaged.

Participants then encountered three reactive balance trials. First the participants did the two-minute PROPRIO test as a warm up. Since the platform perturbations were potentially novel to the participants, the first trial allowed them to experience the perturbation before the actual data were recorded. In the second PROPRIO test trial, the participants stood with a comfortable stance with their hands holding their cell phone and eyes focused on their cell phone (BALANCE BASELINE). In the third PROPRIO test the participants received a standardized question and responded by texting while the platform was moving during the test (BALANCE TEXT). The sequence of the perturbations during the PROPRIO test is complex enough that it is very unlikely that a participant would be able to predict a perturbation over the three trials.

2.4. Measures

The mean number of errors and characters per second from the TEXT BASELINE, GAIT TEXT, and BALANCE TEXT were calculated, as were the numerical values of the parameters of the three GAIT BASELINE trials and three GAIT TEXT trials. The Dynamic Motion Analysis score (DMA score) was the value from the PROPRIO test that was used in the BALANCE BASELINE and BALANCE TEXT conditions. The DMA score is a numerical summation of the multiplanar movements of the sensor during the PROPRIO test. A lower DMA score represents overall less center of mass movement during a perturbation and thus indicates better overall postural control. In a study by Bedient, non-fallers had a lower DMA score (mean 799) compared to older adults classified as fallers (mean 904). Non-fallers were presumed to have a better ability to control a displacement of the center of mass [16].