Effects on Auditory Attention and Walking While Texting with a Smartphone and Walking on Stairs

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Abstract. Effects of texting with a smartphone while walking on stairs in a building were investigated. Twenty-four students performed an auditory detection task for 60 s while using (texting condition) or not using (holding condition) an iPhone 5s. Half of the participants (walking group) performed the signal detection task while walking up the stairs and half of the participants (standing group) performed the task while standing still. Results showed that participants in the texting condition responded significantly more slowly to the targets and missed more targets than in the holding condition. Participants in the walking group missed more auditory targets. We also found a large effect size of smartphone use on a walking performance. Results of our present study can be used as evidence to show the risk of using smartphones, especially on stairs.

Keywords: Cell phone · Texting · Pedestrian · Inattention · Safety

1 Introduction

Our previous studies provided empirical evidence of inattention by pedestrians using cell phones.

Among them, Masuda et al. [1] compared reaction time to visual and auditory stimuli while walking with a cell phone (feature phone or smartphone of their own) in hand under four experimental conditions: texting, conversation, orally repeating words heard, and control (just holding a phone). Results showed that reaction times to either visual or auditory stimuli were significantly longer under the three cell phone-use conditions than under the control condition. Moreover, participants who used smartphones responded more slowly to visual stimuli under the texting condition than those using feature (standard cell) phones.

Haga et al. [2] requested university students with an iPhone 5s to text a message, watch a video, play a game, or just to hold the phone (control condition) in addition to performing visual and auditory detection tasks at the same time. The number of right footsteps that missed the line marking the walking route was greater under cell phone-use conditions than under the control condition. Mean reaction times for both visual and auditory targets were significantly longer under cell phone-use conditions than under the control condition.

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Injury reports show the occurrence of a number of accidents involving cell phone users in railway stations. Commuters use smartphones on board and continue to use them after getting off the train. Some people check the train schedule by phone while walking through stations before getting on a train. Others use the phone in a waiting room or on a platform for communication or amusement, and then start walking to get on a train. Many people now use their smartphones to communicate with others by email, LINE, Facebook, Twitter, etc., all of which involve texting.

The purpose of this study was to measure quantitatively the effects of texting with a smartphone on auditory attention and walking. In this study, we asked our experimental participants to walk on stairs. This differs from previous studies that dealt with cell phone use while walking on a flat floor or a treadmill (e.g. [1–4]).

2 Methods

Twenty-four undergraduate students participated in the experiment and were divided into two groups according to whether they walked up stairs or stayed still while they performed an auditory detection task for 60 s while using (texting condition) or not using (holding condition) a smartphone (APPLE iPhone 5s). The detection task was to respond to designated target signals as quickly as possible by clicking the button held in the hand that was not holding the phone. Auditory stimuli were presented through a pair of earphones (Pioneer SE-E11-Z1) once every second for a duration of 500 ms. The target stimulus for reaction was a higher pitch (460 Hz) among the tones (440 Hz). The button for reaction (Kokuyo ELA-FP1) was connected wirelessly to a laptop computer (SONY VAIO Fit 11) that controlled the stimulus presentation. Every reaction time was recorded. After a 60-s trial, the participants rated the subjective workload of the task with the Japanese version of NASA-TLX [5]. As with the original NASA-TLX [6], the rating scale consisted of 6 subscales: mental demand, physical demand, temporal demand, participant's performance, effort, and frustration.

Participants were asked to describe their travel in detail from their house to the university on the Notes of the iPhone under the texting condition. Under the holding condition they just held the phone in hand.

The experiment took place on a staircase in an 8-story building with a landing between floors. Participants in the walking group were instructed to walk up the stairs at a safe speed and to step with the right foot on the white line drawn in the middle of the stairway. We recorded participants' steps as they walked on the stairs with a video camera (SONY HDR-SR8). The participants wore a hard hat such as worn by cyclists and knee and elbow pads to prevent injury. Figure 1 is a photo taken of a walking trial.

3 Results

3.1 Data Analysis

Data obtained from two participants in the walking group were excluded from analysis due to noncompliance to the instructions. In order to match the number of subjects, two participants in the standing group were chosen at random and removed from our data pool. Hence, data from twenty participants were used for analysis. Within each behavior (walking or standing) group, five participants performed the texting condition followed by the holding condition, and the remaining five performed the task in the opposite order.

Two-way analysis of variance (ANOVA) was applied for dependent variables observed in the detection task and workload ratings. The factor of smartphone use was a within-subject independent variable and the factor of behavior was a between-subject independent variable. Student's t-test was used for variables related to walking performance in the walking group. Cohen's *d* for walking performance and partial eta-squared (ηp^2) for the detection task and the workload ratings were calculated to evaluate the effect size of independent variables.

Fig. 1. Photo of a walking trial

3.2 Results of Detection Task

Mean reaction times to auditory targets are shown in Fig. 2. Interaction between the two factors was not significant. Main effect of behavior was not significant but that of smartphone use was significant ($F(1, 18) = 10.64$, $p < .001$, $\eta p^2 = .37$). The participants responded significantly more slowly to the targets in the texting condition than in the holding condition.

Mean number of missed targets is shown in Fig. 3. Interaction between the two factors was not significant ($F(1, 18) = .16$, $p > .05$, $\eta p^2 = .11$). Main effects were significant both for behavior ($F(1, 18) = 15.84$, $p < .01$, $\eta p^2 = .47$) and smartphone use ($F(1, 18) = 10.68$, $p < .01$, $\eta p^2 = .37$). The participants in the walking group missed more targets than those in the standing group, and they missed more targets under the texting condition than under the holding condition.

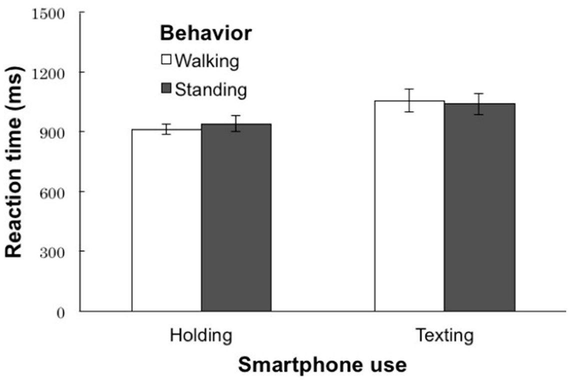

Fig. 2. Mean reaction time to auditory signals. Error bars show standard errors

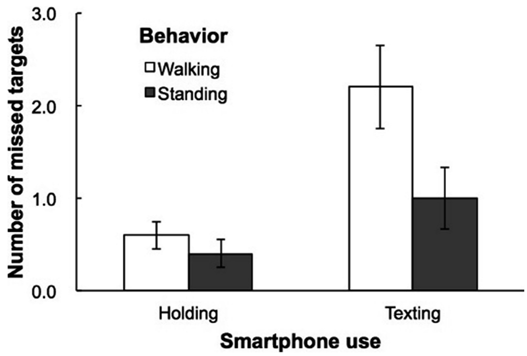

Fig. 3. Mean number of missed auditory signals. Error bars show standard errors

3.3 Results of Workload Ratings

The AWWL score [7] was calculated from ratings on 6 subscales of the Japanese version of NASA-TLX [5] using the weight of 6 for the highest-rated subscale, 5 for the second highest, etc. The result is shown in Fig. 4. Interaction between the two factors was not significant ($F(1, 18) = .01$, $p > .05$, $\eta p^2 = .001$). Main effect of behavior was not significant but that of smartphone use was significant ($F(1, 18) = 58.58$, $p < .001$, $\eta p^2 = .77$). Participants rated the task more demanding after trials with texting than after trials in the holding condition.

3.4 Results of Walking Performance

There were significant differences in the number of floors walked up ($t = 3.34$, $df = 9$, $p < .01$, $d = .80$) and the number of total footsteps taken ($t = 3.13$, $df = 9$, $p < .05$, $d = .51$) between the texting and holding conditions. Participants walked a shorter distance and took fewer steps when they texted with a phone while walking.

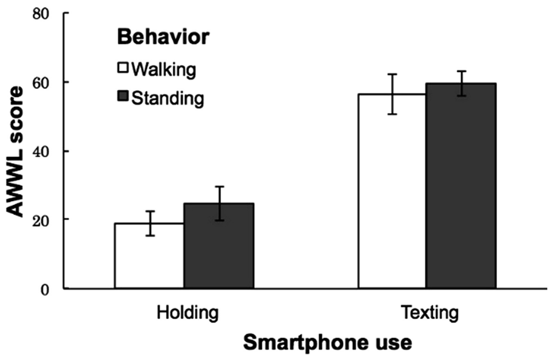

Fig. 4. Subjective mental workload rated on the Japanese version of NASA-TLX. Error bars show standard errors

Difference in the number of right footsteps that missed the line was not significant between the holding and texting conditions (t = 1.47, df = 9, p > .05, d = .69). We calculated the rate of step-outs by dividing the number of step-outs by the total number of steps taken. As shown in Fig. 5, those in the texting condition stepped out at a higher rate. The difference between the smartphone use conditions was not statistically significant (t = 1.83, df = 9, p > .05, d = .89), but the effect size was large.

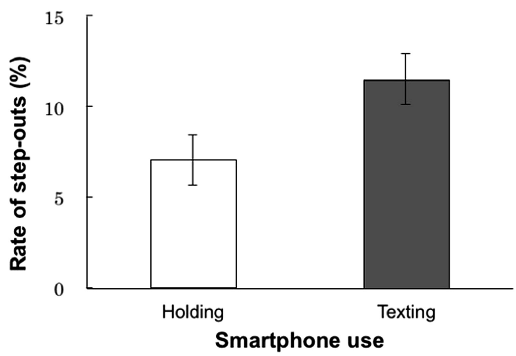

Fig. 5. Rate of steps that missed the line out of total number of steps walked. Error bars show standard errors

4 Discussion

As shown above, participants responded significantly more slowly to auditory targets, missed more stimuli, and felt the task more demanding when they were texting with a phone than when they were just holding a phone. These results demonstrated deterioration of the user's attention when smartphone texting. The facts that participants in the walking group missed more targets and the effect size of smartphone use was large regarding the number of step-outs suggested that walking on stairs makes people less attentive to auditory stimuli and to their own actions. However, the effects were not amplified when walking on stairs since no significant interaction between smartphone use and behavior was found. Smartphone use seemed to equally deteriorate attention no matter whether participants were standing or walking. It might be a consequence of our instruction to walk safely. Participants walked slowly.

Since the risk of injury caused by inattention is much greater for people walking on stairs than people standing still, our present results can be used as evidence to show the risk of using smartphones, especially on stairs.

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