Laboratory Experiment on Visual Attention of Pedestrians While Using Twitter and LINE with a Smartphone on a Treadmill

Shigeru Haga(✉) and Taimon Matsuyama

Department of Psychology, Rikkyo University,
1-2-26 Kitano, Niiza, Saitama 352-8558, Japan
haga@rikkyo.ac.jp

Abstract. Effects of smartphone use for SNS's while walking were investigated in a laboratory setting. Participants walked on a treadmill for 3 min and performed a visual detection task at the same time while using (under the Twitter and LINE conditions) or not using (under the control condition) an iPhone SE. In front of the treadmill, there was a screen on which a video taken in a crowded underpass was projected. The detection task was to respond to a target (red circle) displayed on the screen 6 times at random intervals in the 3-min trial. Results showed that the number of missed targets was significantly greater and the reaction times to the visual targets were significantly longer under the Twitter and LINE conditions than under the control condition. The results indicated visual inattention of pedestrians using smartphones for Twitter and LINE while walking.

Keywords: Smart-phoning while walking · Pedestrian safety · Detection task
Reaction time

1 Introduction

Pedestrians' inattention while on crowded sidewalks or underpasses sometimes causes injuries and other problems. Lately, many people have been using their smartphones for social networking systems (SNSs) such as Twitter, Facebook, and LINE. The purpose of this study was to collect data from a laboratory experiment on the phenomenon of inattention caused by using Twitter and LINE with a smartphone.

There have been many studies of distracted drivers using cell phones (e.g. [1–5]) while we found relatively few studies concerning cell phone use by pedestrians (e.g. [6–8]).

The first author of this paper has conducted several experiments on the inattention of pedestrians operating a cell phone [9–11]. In his recent study [12], participants read email messages (email-reading condition), exchanged messages through LINE (LINE-chat condition), or just held a phone (control condition) while walking on a treadmill. A movie made using a wearable video camera in an underground passage was projected onto a large screen in front of the treadmill. The participants pressed a hand-held button as quickly as possible when they saw a girl wearing a red cap. Reaction

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times were longer and the number of missed targets greater under the email-reading and the LINE-chat conditions than under the control condition. Contrary to our expectation, however, the participants missed many more targets under the email-reading condition than under the LINE-chat condition. We had assumed that participants would be more distracted under the LINE-chat condition because texting messages should be more distracting than just reading messages.

This experiment had a shortcoming. Because the target (girl with a red cap) came into view by walking from a distance in a crowded underpass, timing of the stimulus onset was so ambiguous that the reaction time was not precisely measurable (Fig. 1). Therefore, in the present study, we superimposed targets generated and controlled by a computer program and considered that we could more precisely record responses of participants than with the previous procedure.

Fig. 1. Scene in the movie projected on the screen in the first author's previous study [12]. The girl wearing a red cap was the target to be detected.

2 Methods

2.1 Participants

Fifteen undergraduate students (7 males and 8 females, average age 20.73 years) participated in the experiment. However, due to noncompliance with the instructions, 3 students were excluded from the analysis. As a result, data from 12 participants (7 males and 5 females, average age 20.67 years) were analyzed. All had their own smartphones, with which they were familiar.

2.2 Visual Detection Task

A treadmill (Johnson Citta T82) was placed in front of a 120-in screen (2438 × 1829 mm). Distance from the center of the screen to the eyes of the participants was approximately 3 m (Fig. 2). A movie recorded in advance by one of the authors using a wearable video camera (SONY FDR-X3000R) while walking on a sidewalk on Rikkyo Street by the university campus was projected by a projector

(SONY VPL-CX6) hung on the ceiling while the experimental tasks were carried out. Figure 3 shows a scene from the movie.

The participants walked on the treadmill at a velocity of 3 km/h while they performed a visual detection task for 3 min.

The stimulus for reaction was a red circle 10 cm in diameter presented on the screen by a second projector (EPSON EB-535W) placed on the floor. The circle appeared 6 times during the 3-min trial with a duration of 4 s at an unexpected location (lower half of the screen) and randomly within a 30-s window. Participants were required to respond to the target as quickly as possible by pressing a button held in the hand that was not holding the phone. The button for reaction (Kokuyo ELA-FP1) was connected wirelessly to a laptop computer (Lenovo Thinkpad X1 carbon) that controlled the stimulus presentation. Every reaction time was recorded on the computer.

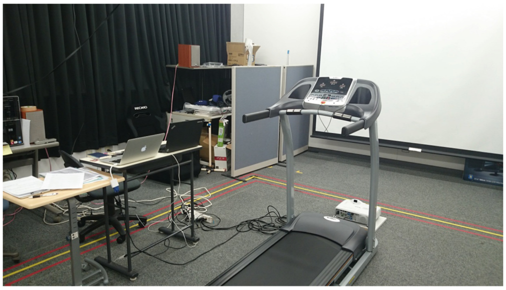

Fig. 2. The treadmill and screen used in the experiment. A projector hung on the ceiling projected the motion picture and a second projector placed on the floor in front of the treadmill displayed the visual targets.

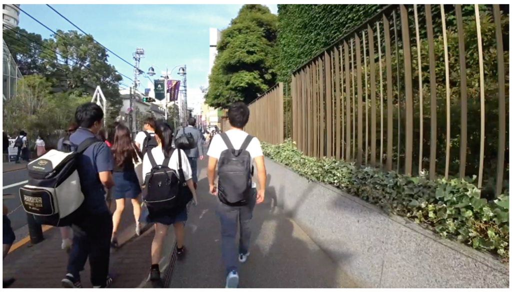

Fig. 3. Scene in the movie projected on the screen.

2.3 Smartphone Tasks

The participants performed the detection task while walking on the treadmill under the following three smartphone use/non-use conditions:

(1) control condition, participants only held the phone (iPhone SE) in one hand.

(2) Twitter condition, participants read a designated part of past timeline on an account that had been created by the authors. In order to make sure that participants read all the "tweets" in the timeline, they were asked about the contents of the tweets after the trial. In addition, participants were warned before the trial that they could be tested regarding the content of the tweets.
(3) LINE condition, participants were given a LINE account created by the authors and chatted with the experimenter, one of the authors, who sent the participants simple questions one after another. Approximately 15 Q&A's were exchanged throughout the experiment.

2.4 Workload Ratings

After the 3-min trial, the participants rated the subjective workload of the task with the Japanese version of NASA-TLX [13]. As with the original NASA-TLX [14], the rating scale consisted of 6 subscales: mental demand, physical demand, temporal demand, participant's own performance, effort, and frustration. Workload scores were calculated by averaging the ratings from 0 to 10 on a visual analogue scale for the total of the 6 subscales. It was reported that the average rating highly correlated with the formal weighted workload score using paired comparison of subscales according to the specific importance of the task [15].

2.5 Procedure

After giving informed consent for participation in the experiment and performing practice trials of the detection task and smartphone tasks, the participants performed three trials under each experimental condition: control, Twitter, and LINE conditions in a random order. The participants rated the workload after each trial, then rested for 3 min before the next trial. Figure 4 shows how the experiment has carried out.

Fig. 4. Using a smartphone while walking on the treadmill in the laboratory.

3 Results

A missed target was declared when the participant did not respond to the target within 4 s before it disappeared. No target was missed under the control condition. As shown in Fig. 5, mean number of missed target was significantly greater under the Twitter and LINE conditions than under the control condition. A statistical test using one-way analysis of variance (ANOVA) showed that the difference between the conditions was significant ($F(2, 24) = 17.24$, $p < .001$) and post-hoc analysis demonstrated that the differences between the Twitter condition and the control condition and between the LINE condition and the control condition were significant ($p < .05$ and $p < .001$ respectively).

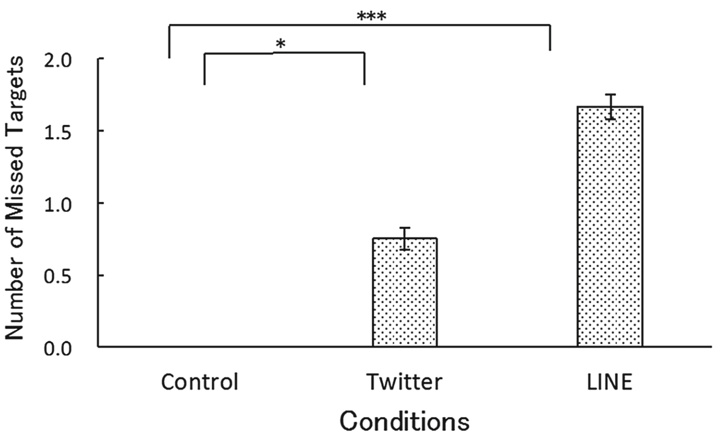

Fig. 5. Mean number of missed targets. No target was missed under the control condition. Error bars represent standard errors. $^{***}p < .001$, $^{*}p < .05$

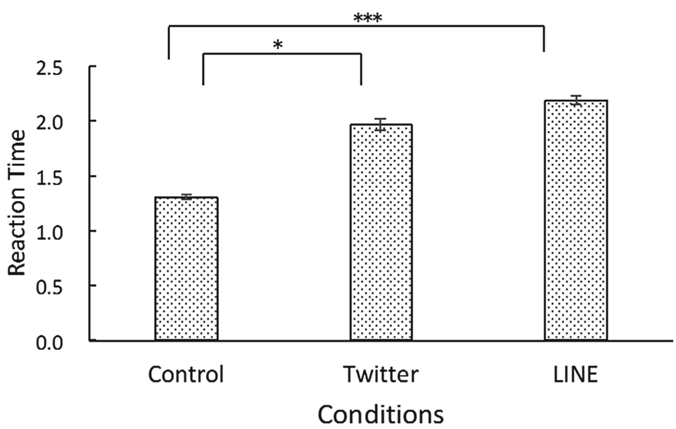

Fig. 6. Mean reaction time to the visual targets under three conditions. Error bars represent standard errors. $^{***}p < .001$, $^{*}p < .05$

Reaction times to targets detected within 4 s were averaged for each trial, then were compared between the conditions (Fig. 6). One-way ANOVA showed a significant difference ($F(2, 24) = 10.00$, $p < .01$). Post-hoc analysis demonstrated that the participants responded to the targets more quickly under the control condition than under the Twitter condition ($p < .05$) and LINE condition ($p < .001$). However, they reacted less quickly under the LINE condition than under the Twitter condition.

Workload ratings on the Japanese version of NASA-TLX were significantly different between the conditions ($F(2, 24) = 54.39$, $p < .001$) (Fig. 7). Post-hoc pairwise comparisons demonstrated that workload ratings were higher under the Twitter and LINE conditions than under the control condition ($p < .001$).

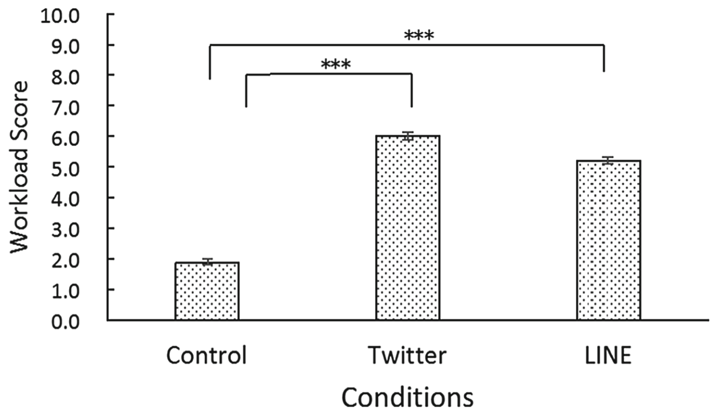

Fig. 7. Workload ratings for the experimental tasks under the three experimental conditions. Error bars represent standard errors. $^{***}p < .001$

4 Discussion

The results demonstrated that the participants detected fewer targets and reacted more slowly to the targets and that the workload of the experimental tasks was greater when they were operating a smartphone while walking on the treadmill. Performance was worse under the LINE condition than under the Twitter condition. This is understandable because the participants under the LINE condition had to text answers in response to questions given by the experimenter, while they only read texts under the Twitter condition although they rated the workload higher for the Twitter condition. These results suggest that visual attention of pedestrians is deteriorated through the use of a smartphone for SNSs while walking on the street.

Further research should be directed toward effective measures to regulate or discourage the use of smartphones while walking.

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