Technology on-the-go: understanding the risks of mobile phone use during walking

Tal Krasovsky
Department of Physical Therapy
University of Haifa
Pediatric Rehabilitation Department
Sheba Medical Center
Israel
tkrasovs@univ.haifa.ac.il

Yasmin Felberbaum
Information Systems Department
University of Haifa
Haifa, Israel

Joel Lanir
Information Systems Department
University of Haifa
Haifa, Israel

Rachel Kizony
Department of Occupational Therapy, University of Haifa and Center of Advanced Technologies in rehabilitation, Sheba Medical Center
Israel

Abstract

Technology increasingly forces individuals to attend to multiple concurrent stimuli including virtual stimuli such as from the smartphone. The current work compared dual-task costs (DTCs) of concurrent reading/writing during walking among N=30 healthy individuals. Task performance was correlated with visual scanning and executive function. Results demonstrated that writing while walking is associated with increased gait variability and larger gait DTCs compared with reading. Similar costs to reading/writing speed were identified, but text comprehension was more impaired by writing than by reading and was related with attention and executive function. These results emphasize that greater interference in dual-task mobile phone use occurs when concurrent tasks share resources. This should be taken into consideration when developing mobile applications.

Keywords—Smartphone, Texting, Reading, Dual task

I. Introduction

The modern world forces individuals to attend to various stimuli arriving from billboards, street signs, subway announcements as well as virtual stimuli from their mobile devices, i.e. tablets and cellphones. Different actions performed during walking with a mobile phone (i.e. reading, talking, texting) require varying amounts of cognitive, visual and motor resources [1], which may differ in older adults [2] and clinical populations [3]. Studies that compare walking while reading (non-motor demand) versus while writing (added motor demand) are rare. Both tasks affect the ability to detect virtual road events while walking on a treadmill [4] and writing was found to affect overground walking more than reading [5], [6]. However, these studies did not directly address dual task costs (DTC) and interference to both tasks. Thus, to better understand what aspect (i.e. motor, visual or cognitive) of the use of technology causes more risk to the individual, there is a need to examine the interference caused to each task i.e. walking, texting or writing when performed as dual task. This will help focus development of technological solutions that will minimize the risk involved in performing these tasks together. The objectives of the current study were: 1. to compare DTC of walking as well as of the secondary task (reading or texting) between two conditions; walking while texting and walking while reading from a smartphone and 2.to examine the correlations between visual search and executive functions to DTC in both conditions.

II. Methods

A. Participants

Thirty healthy young individuals (age 18-40y) participated. Participants were asked to have corrected to normal vision, be native Hebrew speakers and able to read and write while walking (i.e. no dizziness). All participants signed an informed consent form according to the University of Haifa's ethics committee guidelines.

B. Instruments

A Nexus 5 mobile phone was used (dimensions 137.9x69.2x8.6 mm, 130g) with custom-written Android applications. We used texts labelled at 5th grade level of difficulty by the ministry of education, and divided into segments of 20 words per screen.Using the applications, the number of words read/written in each task were obtained.

Movement kinematics were obtained from 3 inertial movement sensors (Mobility Lab, APDM Inc, Portland, Oregon) on ankles and waist (48.5x36.5x13.5 mm, 22g). Spatiotemporal gait kinematics were calculated using custom-written Matlab code (Mathworks, Natick, MA). In this paper we report on gait speed and gait speed variability (COV).

Trail Making Tests (TMT) A and B that assess visual search and executive functions *[7]* were administered.

C. Procedure

Participants were asked to walk continuously for 1 minute along a quiet university corridor (30m). In reading tasks, participants were asked to silently read a text presented on the mobile phone screen in blocks of 20 words (a tap on the screen advanced the text). In texting tasks they were asked to copy texts of similar complexity level presented using a custom-built mobile app. Participants were also asked to walk without an additional task, as well as to perform each secondary task (reading, texting) while sitting. Order of tasks was randomized. After each trial of reading or writing the participants were asked to answer four comprehension questions about the text.

D. Data analysis

Gait speed and gait speed variability (COV) were computed from motion sensors and the number of

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words/letters read/written were obtained from the mobile apps. Dual task costs were computed for each variable using the standard formula (e.g. [2]):

DTC (%)=100(Dual Task – Single Task / Single Task)*

Text comprehension was calculated by dividing the number of correct answers on comprehension questions by the total number of relevant questions (i.e. the total number of questions minus the ones which relate to text that the participant did not read).

E. Statistical analysis

Data were analyzed with SPSS and since it was not normally distributed non-parametric tests were used. Wilcoxon signed rank test was used to examine differences between reading and writing in DTCs and text comprehension. Spearman's rho test was used to examine correlations between DTCs and text comprehension and TMT A and B.

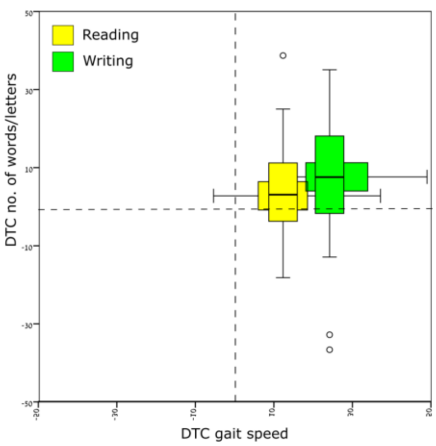

Fig. 1. Dual task costs for walking (DTC gait speed; X axis) and reading/writing (DTC no of words/letters; Y axis) in the two tasks (yellow: reading; green: writing). While the addition of walking similarly affected reading and writing perfornance, the walking task was more affected by writing then by reading. Whiskers denote 1.5*Inter-quartile range.

III. Results

Thirty participants (50% women, 26±4.1y) participated. Time to complete TMT A was 25.5±8.4 and TMT B was 46.9±12.0 seconds. Walking and reading outcomes are presented in Table 1 and DTCs are presented in Fig. 1.

DTC of gait speed was significantly larger in the writing condition (z=-4.68, p=.0001). Gait speed variability was significantly higher during walking and writing than during walking and reading (z=-3.97, p=.0001). No significant differences were found in DTC of reading/writing capacity (Fig.1). Comprehension scores after walking and writing were significantly lower than walking and reading (z=-2.64, p=.008), whereas no significant differences were found in the single task condition (Table 1). Finally, a significant correlation was found between text comprehension and TMT B after walking and writing (r=-.49, p=.007) suggesting that participants with better cognitive flexibility had better understanding of the copied texts.

TABLE I. Walking, Reading and Texting outcomes for the different conditions

Outcome	**Task (Median (Interquartile range -IQR))**		
	Single task (walking/writing/reading)	***Dual task reading***	***Dual task writing***
Gait speed (m/s)	1.24 (1.09-1.43)	1.1(0.88-1.29)	0.95 (0.76-1.06)
Gait speed COV	0.04 (0.03-0.05)	0.05 (0.03-0.06)	0.06 (0.05-0.09)
Comprehension Reading %	75 (67-100)	75 (67-100)	--
Comprehension Writing %	75 (25-100)	--	50 (0-100)
Words read (N)	212.5 (180-232.25)	195.5 (161.75-222.25)	--
Letters written (N)	134 (124.5-170)	--	140 (105.5-167.5)

IV. Conclusions

Findings of the current study suggest that both reading and texting while walking interfere with performance of both tasks. However, texting while walking further affects gait variability, which is related to fall risk. The larger reduction in text comprehension during walking and writing, together with the relationship with TMT B, suggest that the additional motor demand of texting interferes with the cognitive aspect of the task and requires executive function in order to be able to divide attention between tasks. These findings suggest that the motor aspect of using smartphone technology should be addressed in future technological developments.

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