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Effect of electronic device use while driving on cardiovascular reactivity

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ABSTRACT

Motor vehicle collisions are the leading cause of death in people ages 5–34 in the US, and secondary task engagement, such as talking on a cell phone, is a leading contributor to motor vehicle collisions. The negative effects of secondary task engagement on driving performance has become a prominent recent topic of study given the increasing amount of time drivers engage in distracted driving. However, few studies have examined the effects of secondary task engagement while driving on health related outcomes such as cardiovascular reactivity. Cardiovascular reactivity, as measured by heart rate and blood pressure, has been used in previous studies as a means of measuring effort in task engagement as well as a means to predict cardiovascular disease and stroke. This study investigates the effect of secondary task (talking on a cell phone, texting, and driving with no task) while driving in a simulator on cardiovascular reactivity. Using difference scores between baseline (a period of inactivity) and stimulus (driving with no task and driving with secondary tasks), a repeated measures analysis of variance using a mixed model approach was used to determine the effect of secondary task on cardiovascular reactivity. Findings indicated that talking on a cell phone while driving significantly increased cardiovascular reactivity via heart rate and blood pressure compared to driving with no task. Texting while driving did not differ significantly from driving with no task. This study demonstrates the need for more research on the long term effects of secondary tasks while driving on cardiovascular reactivity and for assessing the risks associated with secondary task use while driving on developing cardiovascular disease or stroke.

1. Introduction

1.1. Motor vehicle collisions and distracted driving

Motor vehicle collisions (MVCs) are the leading cause of death in people ages 5–25 (Centers for Disease Control and Prevention [CDC], 2015). Engaging in secondary tasks while driving is one of the leading contributors to MVCs, with cell phone use as the most popular activity behind the wheel (Centers for Disease Control and Prevention [CDC], 2014). Cell phones, particularly text messaging, are one of the most dangerous forms of secondary tasks because it involves all three levels of distraction: (1) visual—eyes off the road, (2) manual—hands off the wheel, and (3) cognitive—mind off of the road

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(National Highway Traffic Safety Administration [NHTSA], 2013). Many studies have examined the detrimental effects of secondary task engagement on driving performance via surrogates of safety such as speed control, collision risk, lane control, etc. (Neale, Dingus, Klauer, Sudweeks, & Goodman, 2005a; Stavrinos, Garner, et al., 2013). However, few studies have examined the effects of secondary task use while driving on cardiovascular (CV) reactivity.

1.2. Cardiovascular reactivity and driving

Many studies have examined how to measure effort-related response via the sympathetic nervous system. The sympathetic nervous system influences CV reactivity, such as heart rate and blood pressure, at times when people are actively engaged in effortful activities, indicating that CV reactivity is a good measure of effort-related response (Obrist, 1976). CV reactivity has been linked to an increase in susceptibility to CV disease, such as heart attack and stroke (Everson et al., 2001; Huang, Webb, Zourdos, & Acevedo, 2013). Therefore, theoretically, the more often one engages in tasks that cause an increase in CV reactivity, the more one increases his risks for CV disease. We hypothesize that secondary tasks such as texting or talking on a cell phone, while driving, may be as dangerous to the CV system as other factors such as stress.

Few studies have considered the effect of secondary task engagement on CV reactivity. Reimer, Mehler, Coughlin, Roy, and Dusek (2011) conducted a study examining the effect of talking on a hands-free cell phone while driving on heart rate and driving performance, stratified by two age groups – young (19–23 years) and older (51–66 years). Reimer et al. (2011) found that heart rate increased in young adult drivers when talking on a cell phone while driving, but not in older adults. The authors speculated that older adults may not have had an increase in heart rate when talking on a cell phone while driving due to compensatory behavior as they drove more slowly compared to the young adult drivers.

Stuivera, Brookhuisa, de Waarda, and Mulderb (2014) conducted a study that focused on the effects of mental workload on cardiovascular reactivity. Varying workload conditions were measured using two traffic densities (low and high) with and without fog (used as additional workload demands), and cardiovascular reactivity was measured using heart rate and blood pressure. Stuivera et al. (2014) found that driving in high traffic density conditions (medium-high workload) was associated with an increase in systolic blood pressure and decreased blood pressure variability. On the other hand, driving in foggy, low traffic density conditions (medium-low workload) was associated with a decrease in heart rate and blood pressure variability. It is hypothesized that engaging in a secondary task while driving may affect CV reactivity in a similar manner to driving in these particular traffic conditions.

As used in previous efforts (Stuivera et al., 2014), blood pressure may be a better measure of CV reactivity and effort, particularly systolic blood pressure and diastolic blood pressure; however, due to the restrictive nature of current blood pressure measurement mechanisms, blood pressure is not commonly studied in driving studies, both naturalistic and simulator. The current study is the first to consider blood pressure measurements in addition to heart rate as a means of examining the effects of secondary task use while driving on cardiovascular reactivity. The present study aims to fill in the gaps in the literature on the effects of secondary tasks (cell phone conversation, text messaging, no secondary task) while driving have on CV reactivity as well as including another meaningful measure of CV reactivity (blood pressure).

1.3. Purpose

The current study examined the relationship between CV reactivity and secondary task engagement while driving in undergraduate college students. Addressing potential limitations of previous work (e.g., Reimer et al., 2011; Stuivera et al., 2014), participants operated a virtual driving simulator while engaging in a variety of commonly used secondary tasks ((a) talking on a cell phone, (b) text messaging, or (c) driving with no task) while heart rate and blood pressure measurements were recorded across driving scenarios. It was hypothesized that participants would exhibit the greatest increase in CV reactivity in the texting condition as it is the more effort-demanding task, taking away attention from the cognitive, visual, and manual demands of driving, and CV reactivity being the lowest in the no task condition.

2. Method

2.1. Participants

After providing written informed consent, participants were screened for eligibility from a convenience sample of Introductory Psychology students, who would earn research credit for participation in the study. The following protocol was approved by the Institutional Review Board of the University of Alabama at Birmingham.

Inclusion criteria for all participants were: (1) being between 17 and 30 years of age, (2) having a valid driver's license, and (3) owning a cell phone with text messaging capability. Exclusion criteria for all participants included: (1) physical disabilities so severe that they precluded their ability to participate, fully, in any aspect of the experimental protocol, (2) use of beta blockers that could inhibit cardiovascular reactivity, and (3) history of cardiovascular disease, which could affect cardiovascular reactivity.

Of the 152 individuals meeting all eligibility criteria, 64 individuals came in for a laboratory session. The resulting sample of 64 participants was recruited to be half male and half female to have a balance of gender. Two participants developed