When the Mind "Flies": the Effects of Mind-Wandering on Driving

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Abstract

Mind wandering (MW) refers to a shift of attention away from a primary task toward internal information, such as memories, future thoughts, or fantasies. Several lines of research showed that MW has a costly influence on many cognitive processes, such as reading comprehension, sustained attention and working memory. The aim of the present study was to assess whether MW impairs, like secondary-task distraction, driver's performance. Results showed that MW is indeed pervasive during daily driving, as indicated by the participants' answers to an ad-hoc questionnaire assessing the source of inattentiveness during daily driving; furthermore, MW states detected during simulated driving were found to affect driving performance.

Keywords: Mind-wandering; driving; probe-caught; questionnaire.

Introduction

When people drive, attentional resources can be directed to secondary tasks, irrelevant to the driving task at hand (e.g., use of cell-phone, interaction with assistance devices inside the car etc.). Distraction arising from these secondary tasks has been extensively investigated (e.g. Burns et al., 2002; McKnight & McKnight, 1993; Strayer et al., 2003). It is well known that also spontaneous mental activity may cause distraction. Such mental activity consists of memories, future thoughts, concerns, and it is often referred to as *mind-wandering* (MW; Smallwood and Schooler, 2006). There is evidence showing that MW may negatively affect performance in laboratory tasks assessing, for example, attention, reading comprehension and memory, which are boring or low in processing demand (e.g. Giambra, 1995; Teasdale et al., 1995; Smallwood et al., 2004; Christoff et al., 2009). Little is yet known, however, about the effects of MW on driving performance. Recently, Galéra et al. (2012) found that drivers reporting intense MW just before a crash were significantly more likely to be responsible for the crash. This study highlights a link between MW and crash risk in the real world. However, only two studies experimentally assessed driving performance consequences of MW using a car-following procedure in a driving simulator (He et al., 2011; Yanko & Spalek, 2013). Results of these studies provided initial evidence that MW compromises indeed driving performance (for instance, by increasing response times to sudden events, by shortening headway distance and by narrowing visual attention on the road ahead). The purpose of the present study was to further investigate whether and how MW affects driving performance. More precisely, the present study intended to assess (a) the occurrence of MW in everyday driving, (b) the viability of real-time detection of MW states during simulated driving, (c) the effect of MW on vehicle control and (d) whether there is a relation between the frequency of occurrence of MW during driving and the efficiency of executive control processes. An ad-hoc questionnaire has been developed in order to assess the sources of inattentiveness during daily driving. MW states were recorded using the probe-caught sampling techniques during a lane-keeping task performed in a high-fidelity driving simulator. Results showed that MW is indeed pervasive during daily driving; furthermore, MW states were found to affect driving performance.

Method

Participants

99 adults (58 male; 41 female) were presented with the questionnaire on driving inattentiveness. Their mean age and education were 36.4 years (SD = 12.7; range 20-64) and 15.37 years (SD = 2.6; range 8-18), respectively. All participants had their driving license for at least one year, and reported that they, on average, drive for at least one hour each day. All participants had normal or corrected-to-normal vision and they all had no history of neurological or psychiatric disorders. Seventeen young adults (mean age = 22.3 years, SD = 2.9; mean level of education = 15.7 years, SD = 1.0) were randomly selected to perform the lane-keeping task.

Questionnaire

It consisted of 19 questions assessing the following measures: driving frequency, length of driving path, presence of passengers, road accidents, frequency of mind-wandering, contents of mind-wandering, causes of mind-wandering, monitoring of attention, risk perception associated to mind-wandering.

Simulated Driving

Data were collected in a high-fidelity simulator that was composed by a 22 inch screen LCD TFT WIDESCREEN FULL HD in order to have a more realistic and extended vision, wheels and pedals Thrustmaster T500RS 1:1 for a more realistic driving, and gear Thrustmaster TH8RS. The software used to create driving environment was the Racer 0.8.34. Before the experimental session, all participants had the possibility to familiarize with the simulated driving task for 6 minutes. The driving task consisted of a *lane-keeping task* (low cognitive-perceptual load) lasting 20 minutes. The aims of the task were to maintain the trajectory into the lane and to observe the speed limit of 130 km/h. Furthermore, each participant was presented with the mental state definition that they might experience during the driving task (i.e., “on the task”, “aware wandering”, “wandering without awareness”, “blank mind”) at the moment of probe presentation. The probe consisted of blanking the simulator screen. During the experimental session, 4 probes were presented at irregular intervals. Nevertheless, the first and second probes were presented, respectively, between the 3rd and the 5th minute, and the 7th and the 9th minute; whereas the third and fourth probes were presented, respectively, between the 13th and the 15th minute, and the 17th and the 19th minute. This decision was taken in order to make sure that the first and second probes would fall within the first half, whereas the third and fourth probes within the second half of the experimental session.

In order to assess whether there is a relation between the frequency of occurrence of MW during driving and the efficiency of executive control processes, all participants were presented, in a counter-balanced order, with 3 cognitive tests: Verbal span (in order to assess working memory), Stroop test (to assess executive control), and phonological fluency (to investigate cognitive flexibility). In addition, before starting with the experimental session, the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982) was given to participants to measure the tendency to be distracted during everyday life.

Dependent variables taken into account were as follow: (a) frequency of mind-wandering after the presentation of the probe, (b) speed, as measured by mean speed (M-SPEED), and standard deviation of mean speed (SD-SPEED), (c) vehicle stability, as measured by standard deviation of the lateral position (SD-LP) and by standard deviation of the steer (SD-STEER). Speed and vehicle stability indices were recorded during the 10 seconds preceding the probe, and from 10 seconds to 20 seconds after the probe presentation.

Results

Questionnaire

Only the answers to specific questions, relevant to the purpose of this study, were initially analyzed; i.e., frequency of MW, contents of MW, and awareness of potential risks associated to MW. To date, 58% of the respondents reported that they often wander while driving (distribution of responses: 1% never, 16% rarely, 25% sometimes, 41% often, 17% very often); this result indicates that MW is, indeed, pervasive during driving. As concerns the contents of MW, the distribution of responses was the following: 71% planning of something to do, 65% thinking about problems or personal concerns, 30% thinking back on something you did or said and you should not have or would not have wanted, 28% thinking about something positive that could happen, 24% thinking about something neutral that could happen and thinking about negative past events, 21% blank mind, 20% thinking about positive past events, 16% thinking about something negative that could happen, 12% thinking back on neutral events. With respect to risk perception associated to MW, only 12% of respondents believe that MW is an important risk factor for crash involvement (distribution of responses: 2% not at all; 25% slightly; 32% medium, 28% quite a lot, 12% a lot).

Simulated driving

Overall, 94% of the participants reported, at least once, a MW state. It is interesting to note that the frequency of mind-wandering state increased during the driving task (% of participants that reported a mind-wandering state: 1° probe; 24%; 2° probe: 41%; 3° probe: 71%; 4° probe: 53%). Each dependent variable was analyzed by means of a 2 (mental state before the probe: attention vs. mind-wandering) x 2 (attention state after the probe differentiated depending on the mental state before the probe: attention vs. mind-wandering) ANOVA. Results showed that M-SPEED was significantly lower during mind-wandering episodes than during attentive driving, $F_{1,14} = 6.38$, $\eta p2 = .313$, $p < .02$. Furthermore, the variability of driving speed, as measured by SD-SPEED, was significantly lower when participants were wandering as compared to when they were concentrated on the task, $F_{1,14} = 24.68$, $\eta p2 = .64$, $p < .0001$. The stability of the vehicle (as measured by SD-LP and SD-STEER) was not affected by the participants’ mental states.

Correlations

Correlations between simulated driving and cognitive tests were not significant, as was the correlation between the frequency of mind-wandering and the CFQ.

Discussion

Results of this study showed that MW significantly affects driving performance. Indeed, participants drove slower and maintained a more constant speed during episodes of MW as compared to when they were engaged in attentive driving. It is interesting to note that 84% of episodes of MW were categorized as states of aware wandering. This pattern of results seems to suggest that drivers, as long as they are aware that their mind is “flying”, can spontaneously engage in a compensatory behavior that leads them to maintain a lower speed. This hypothesis is, however, difficult to reconcile with the answers given to the questionnaire as most of the drivers indicated MW as not particularly dangerous for driving. Further investigations are indeed necessary to deepen our understanding of this mechanism, which appears to be most relevant for road safety.

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