



Inattention behind the wheel: How factual internal thoughts impact attentional control while driving



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ABSTRACT

Commonly defined as “task-unrelated thoughts”, the mind wandering (MW) state is one of the causes of inattention to on-going tasks. Such a concept includes various kinds of thoughts from unaware ones to emotional/ruminative or distractive ones (i.e. all thoughts unrelated to an emotional state). Some researchers have investigated emotional ruminative thoughts in the daily driving context and found an indisputable impact on the focus of attention on the driving scene. Although more frequent in driving situations, no study has focused on distractive thoughts. The aim of this paper is to determine how this kind of task-unrelated thought impacts driving behavior. To induce distractive thoughts, participants were instructed to encode picture/word (retrospective thoughts) and picture/intention (prospective thoughts) pairs during a distractive thought induction phase. Then, in the simulated driving phase, encoded pictures were presented on highway road signs, and served as cues of recall. Drivers had to recall either the word or the intention associated with the picture as soon as they saw it, requiring self-activation of thoughts by participants. Distractive thoughts led to less micro-regulation of both speed and lateral position and narrowed visual scanning of the driving scene. Participants also declared that it increased their mental workload. Theoretical and methodological aspects of the study were discussed regarding the literature on mind-wandering and distraction in driving.

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1. Introduction

1.1. Mind wandering as a cause of inattention behind the wheel

Imagine yourself thinking about the bottle of milk you had to buy before coming home, or the last meeting you attended, while driving along a motorway. These thoughts are currently considered to be examples of the hold-all “mind wandering” concept.

Commonly defined as “task-unrelated thought” (Smallwood et al., 2004), mind-wandering (MW) is one of the causes of attentional lapse (Carriere et al., 2008) and is observed during very monotonous tasks – such as driving, in some situations. In accordance with Posner’s prior framework on attentional control

(1980), and more recently with Lemerrier and Cellier’s study on inattention and driving (2008), it could be argued that MW is the cause of an endogenous orientation of attention from the current activity to internal thoughts, making the processing of thoughts the priority (Smallwood et al., 2007a,b; Regan et al., 2009). The consequence of such orientation of attention may be supposed to lead first to an alteration of the attentional control on the current task – because of the difficulty of paying attention to several information sources at the same time – and second to a mental workload cost – because of the necessity of mobilizing attentional resources to process information (Schumacher et al., 2001; Smallwood and Schooler, 2006).

While frequent in daily life activities such as driving – it seems that we spend almost one third of our time in MW (Kane et al., 2007; McVay et al., 2009) – only a limited number of studies have investigated this phenomenon. He et al. (2011) showed in a simulated driving experiment, that participants in MW state (1) drove closer to the right hand side of the lane, (2) decreased the

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variability of their vehicle speed and (3) horizontally narrowed their visual scanning.

1.2. Various kind of thoughts impact driving performance

Various kinds of thoughts can be activated during mind wandering, characterized in particular by the degree to which they involve emotional content, from distractive neutral thoughts (i.e. all thoughts unrelated to emotional content), to more emotional ruminative thoughts (i.e. thoughts related to negative or positive emotional content). A recent epidemiological study by Galéra et al. (2012) demonstrated that the content of MW is of great importance in the determination of its impact on driving. They indicate that MW with high distracting content was a statistically significant risk factor regarding responsibility for car crashes. This finding revealed the need to identify the thoughts involved in mind wandering in order to assess the impact of specific thoughts on driving performance.

1.2.1. Emotional thoughts

The damaging effects of emotional thoughts on driving performance are illustrated by previous data about the impact of negative emotional state and ruminative thoughts on driving (Dula and Geller, 2003; Lagarde et al., 2004; Pêcher et al., 2011; Violanti and Marshall, 1996). Indeed, drivers involved in a dramatic personal event such as a divorce (Lagarde et al., 2004), or thinking about personal problems while driving (Violanti and Marshall, 1996) showed a higher accident risk. In accordance with Pêcher et al. (2009), some characteristics of music, such as its emotional valence, could also have an impact on drivers' attentional focus. The authors therefore argued that when drivers listened to sad music, their attention was caught by some of its characteristics (such as its rhythm), requiring the attentional focus to be oriented to this internal stimulus. Ruminating emotional off-task thoughts while driving could therefore be considered as a time-sharing dual-task situation, involving switching attentional control from vehicle control to the processing of these thoughts (Schumacher et al., 2001). More generally, we argue that processing off-task thoughts consciously while driving could be assimilated to a dual-task situation, leading to an increase in mental workload. However, although ruminative thoughts have an indisputable impact on driving behavior, they are fairly infrequent MW thoughts while driving.

Distractive thoughts (i.e. all thoughts unrelated to emotion) are very frequent in everyday life, but they have not previously been investigated in the driving field. These kinds of thoughts are principally based on memory retrieval: from the past or to the future. Such thoughts involve either retrospective memory – referring to the recollection of past events (Crawford et al., 2006) – or prospective memory – involving the accomplishment of intentions and of actions associated with them (Ellis, 1996), and both can either be activated by contextual or temporal cues, or occur spontaneously (Crawford et al., 2006; González-Ramírez and Mendoza-González, 2011).

This is the kind of thought that may occur to all of us, thinking that we need bread when seeing a bakers shop, or remembering that we did not respond to an urgent e-mail when looking at the clock. Some evidence indicated that people reported future-oriented thoughts every 16 min during a typical day (D'Argembeau et al., 2009). Such thoughts may help anticipate and plan relevant personal future goals (Baird et al., 2011).

1.3. Aim of this paper

Commonly, studies about MW are based on self-caught or probe-caught methods of thought sampling (Smallwood et al., 2007a,b; Smallwood and Schooler, 2006). Such methodologies

consist only in reporting real-time episodes of MW, without taking the specific content of the episodes into account, making it difficult to study the influence of one particular kind of thought on the on-going activity. Our experiment is therefore the first to investigate the on-line effect of one type of MW (i.e. distractive thoughts), using an original method of thought induction. To generate distractive thoughts and to measure their effects on driving performance, we first asked participants to encode picture/word (retrospective condition) and picture/intention (prospective condition) pairs for them to recall later. All these pairs were unrelated to the driving theme, but associated with activities or objects from daily life. This encoding process constituted the distractive thought induction phase. We next asked participants to drive along a simulated 2×3 lane road in which some highway road signs (HRS) were presented. Previously encoded pictures were printed in these HRS, and served as cues to remember either the related word or intention. This protocol is consistent with the recent addition of key elements to the definition of the MW state advanced by Christoff (2012), who argues that such a state could occur either spontaneously or deliberately. Finally, as argued by Braboszcz (2012), an MW experience involves (1) the appearance of the subject's internal or external distractors during the on-going task (which first attract the subject's attention), (2) initial shifts of attention (when the distractor is increasingly present, causing the subject to turn their attention towards the thoughts triggered by it) and (3) finally, attentional lapses, corresponding to the moment when the attention is entirely dedicated to the processing of thoughts. We thus expected that HRS would activate distractive thoughts and as a consequence hypothesized that the processing of distractive thought would lead to variations in driving behavior.

2. Method

2.1. Participants

Twenty participants (11 male and 9 female), aged between 21 and 38 years ($M = 28.85$; $SD = 5.02$) were recruited at the University of Toulouse II. They had held a driving license for at least 3 years ($M = 9.5$; $SD = 4.35$) and had normal or corrected-to-normal visual acuity.

2.2. Materials and procedures

2.2.1. Induction of distractive thought: encoding phase

The memory task consisted of an adaptation of the “memory for intentions” task developed by Cohen et al. (2001). The study phase involved a presentation of 36 pictures on a computer screen. The pictures were all printed in black and white and represented everyday objects, or people. Each picture was paired with an unrelated word or an intention. Words and intentions were written below the picture in lowercase letters (Times New Roman, size 52). There were 18 associations of pictures with unrelated words (retrospective condition: e.g. the picture of a piece of cake – “*gâteau*” in French – and the word “owl” – “*hibou*” in French) presented for 6 s each – and 18 associations of pictures with intentions (prospective condition) presented for 12 s each, including 6 pictures associated with unrelated intentions (e.g. the picture of a grape and the intention “to do the dishes”, “*faire la vaisselle*” in French), 6 pictures associated with slightly related intentions (for example, a picture of banknotes and the intention “*aller à la banque*” (“go to the bank”, in English) and 6 pictures associated with strongly related intentions (e.g. a picture of eyeglasses and the intention “*aller chercher les lunettes*” (“pick up eyeglasses” in English). All pictures were randomly intermixed.

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