Engagement in distracting tasks: Subjective and physiological responses to interesting and boring information and the implications for driving performance

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1. Introduction

Many studies in the driving context have shown that more demanding secondary (distracting) tasks result in greater performance decrements in driving-related tasks (e.g., Briem & Hedman, 1995; Patten et al., 2004). However, tasks employed in laboratory studies, although mimicking the information processing demands of real world activities, often fail to capture any semblance of personal investment or interest on the part of the participant (e.g., performing mental arithmetic tasks). Motivation and interest in the to-be-performed tasks are likely to influence the individual's attentional allocation policy when performing concurrent activities. We refer to this as the quality of task engagement (e.g., O'Brien & Toms, 2008).

The purpose of this study was to explore the concept of engagement as it relates to secondary activities while driving. In the first experiment, we examined the subjective and physiological responses (cerebral blood oxygenation, heart rate, pupil diameter) of participants listening to boring or interesting material. In the second experiment, we examined the performance implications for drivers listening to boring and interesting material in a driving simulator.

2. Method

Forty-six participants participated in Experiment 1 (M = 41.5 yrs, SD = 9.5; balanced by gender). Participants sat at a computer workstation and listened to short audio clips gathered from online news sources. The 73 audio clips varied in duration (range 12-38 s; M = 24 s) and were classified as being either boring or interesting. Audio clips also varied by three levels of difficulty, determined by the Flesch-Kincaid Grade Level: Low (grade ≤ 10); Medium (grade 11-12); High (grade ≥ 13). During each audio clip, participants made continuous ratings of degree of interest in the material using a dial controller. Following each clip, participants made several additional ratings using 7-point Likert scales. Additional physiological measurements were gathered for a subset of participants: pupil diameter (SMI iView x HED head mounted eye tracker), cerebral blood oxygenation (NIRO-300 noninvasive Near-Infrared Spectroscopy, NIRS) and heart rate (Finometer PRO blood pressure system) (N = 12 each).

In Experiment 2, 31 participants completed a driving simulator study (M = 37 yrs, range: 25 to 55). The simulator was a fixed-based simulator consisting of an open-cab vehicle mock up and a wrap-around, immersive LCD display. Drivers completed 6 blocks of driving each lasting approximately 8 minutes long, including 2 blocks of each: baseline (no audio recordings), boring and interesting audio. The two latter conditions used the same set of stimuli from Experiment 1. All drivers were simultaneously monitored using the NIRS, blood pressure and eye tracking systems. The driving task consisted of a car following and braking task as well as an intermittent turn signal task. Measures of headway distance, and braking and signal response time were recorded.

3. Results

In Experiment 1, subjective ratings distinguished between boring and interesting stimuli (p < .05); subjective ratings of interest also tended to decline with increasing difficulty for both types of audio. Interestingly, the perceived difficulty of the material showed a Difficulty x Interest interaction, with increasing objective difficulty being matched by increasing subjective ratings for boring material, but not for interesting material.

The findings for physiological measurements were mixed: cerebral oxygenation, measured and aggregated from left and right forehead regions, showed an effect of task engagement that approached significance (p = .09). However, although increasing across the levels of difficulty, there were no significant effects of heart rate or pupil diameter.

In Experiment 2, car following distances were longer while listening to interesting material, compared to the boring or baseline conditions (p < .01). The variability in following distances was reduced for both the
boring and interesting auditory conditions compared to baseline (p < .01). Signal response time did not vary across the different conditions (p = .48); however, braking response times were longer for the interesting condition, compared to boring and baseline conditions (p < .05). Subjective workload ratings were lowest for the interesting condition (p < .01); yet, the post-experiment recall performance suggested that the drivers processed the interesting material more deeply than the boring material (p < .01). Additionally, the physiological measures (cerebral oxygenation, eye scanning) showed some discrimination among the various conditions.

4. Discussion
The subjective ratings largely corroborated the manipulation of interest level in Experiment 1 (boring versus interesting audio clips). However, the subjective ratings also revealed a dissociation between task difficulty and degree of interest; the appraisal of task difficulty might be moderated by degree of self-interest. The physiological measures were less sensitive to differences in task engagement, although the NIRS-derived measures of cerebral oxygenation approached significance, with a pattern reminiscent of that observed for perceived difficulty. Experiment 2 revealed how interesting auditory material can impact performance and information processing in a more applied setting. The implications will be discussed.

Keywords
Driver distraction, task engagement, cerebral blood oxygenation, driving performance, individual differences

References