The effects of taboo-related distraction on driving performance

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ABSTRACT

Roadside billboards containing negative and positive emotional content have been shown to influence driving performance, however, the impact of highly arousing taboo information is unknown. Taboo information more reliably evokes emotional arousal and can lead to greater attentional capture due to its inherent 'shock value.' The objective of the present study was to examine driver distraction associated with four types of information presented on roadside billboards: highly arousing taboo words, moderately arousing positive and negative words, and non-arousing neutral words. Participants viewed blocks of taboo, positive, negative and neutral words presented on roadside billboards while operating a driving simulator. They also responded to target (household-related) words by pressing a button on the steering wheel. At the end of the session, a surprise recall task was completed for all the words they saw while driving. Results showed that taboo words captured the most attention as revealed by better memory recall compared to all the other word types. Interestingly, taboo words were associated with better lane control compared to the other word types. We suggest that taboo-related arousal can enhance attentional focus during a complex task like simulated driving. That is, in a highly arousing situation, attention is selectively narrowed to the road ahead, resulting in better lane control.

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1. Introduction

According to the National Highway Traffic Safety Administration (NHTSA), driver inattention contributes to over 25% of motor vehicle crashes. Driver distraction, one form of driver inattention, is estimated to be involved in over half of these crashes (Stutts, Reinfurt, Staplin, & Rodgman, 2001). More recent findings place this estimate higher. In 2012, driver distraction accounted for 10% of all fatal crashes and 18% of injury crashes, making it the leading cause of motor vehicle accidents (NHTSA, 2014).

While distraction and inattention are often used interchangeably, NHTSA defines driver distraction as "a specific type of inattention that occurs when drivers divert their attention from the driving task to focus on some other activity instead" (NHTSA, 2014). Secondary task distraction, including cell-phone use, use of in-vehicle information systems (e.g., GPS units), and interactions with passengers, has been estimated to contribute to over 23% of all traffic accidents (Young & Salmon, 2012).

A key element of driver distraction is the voluntary or involuntary diversion of attention toward a competing activity (event, task, object, or person) inside or outside the vehicle. When a cell phone suddenly rings or a baby is screaming in the backseat, the driver is involuntarily compelled to look for the phone or turn to the screaming baby. On the other hand, when a driver reaches for the cup of coffee in his vehicle, he voluntarily chooses to devote his attention to the activity. In general, competing activities that capture attention involuntarily are unpredictable, sudden, and highly salient (Regan, Hallett, & Gordon, 2011); in other words, they are difficult to ignore.

One competing activity that has the potential to compel attention is roadside billboards. The amount of attention that drivers give to billboards and other irrelevant objects is estimated to vary from 30% to 50% (Hughes & Cole, 1986). Studies have found that distraction by foreign objects (including signs) is a significant cause of crashes (Stutts et al., 2001) and that drivers do look and process billboards (Hughes & Cole, 1986). However, little is known about the influences of emotional content on billboards, even though emotional stimuli have been widely reported to capture attention (for review, see Compton, 2003). In a recent study, roadside billboards containing negative and positive emotional content were shown to have differential effects on driving performance (Chan & Singhal, 2013). Drivers drove slower in the presence of negative information, while positive information was associated with faster driving speeds. Moreover, drivers recalled the content of negative billboards better than positive billboards. Another study found that viewing positive images led to better steering performance than negative images (Trick, Brandigampola, & Enns, 2012). Finally, in Jones, Chapman, and Bailey (2014), emotional images were shown to reduce the ability to detect driving-related hazards compared to neutral images. Together, these findings demonstrate that emotionally valenced information can be a significant factor in driving performance, and suggests that emotional distraction can modulate attention.

Moreover, these effects appear to generalize to other sensory modalities, such as audition. In Chan and Singhal (2015), it was found that negative auditory distractions led to slower driving speeds compared to positive and neutral distractions, suggesting that the processing of emotional stimuli during driving likely reflects the impact on higher-order cognitive process rather than lower level sensory and perceptual processes.

While these results shed some light on the influence of emotional distraction on driving, the impact of taboo information on driving has not been investigated. Taboo (e.g., sexual-related) information have been shown to more reliably evoke emotional arousal than other types of emotional information (Jay, Caldwell-Harris, & King, 2008; Kensinger & Corkin, 2003; LaBar & Phelps, 1998; MacKay et al., 2004; Madan, Caplan, Lau, & Fujiwara, 2012; Madan, Shafer, Chan, & Singhal, in press). Previous studies have found that taboo stimuli can lead to greater attentional capture, presumably due to its inherent 'shock value' (Arnell, Killman, & Fijavz, 2007; Bertels, Kolinsky, & Morais, 2010; Madan et al., in press; Mathewson, Arnell, & Mansfield, 2008). Arnell et al. (2007) showed that in a rapid serial visual presentation (RSVP) task, accuracy was worse when the target was preceded by a sexual word compared to a threat, anxiety, positive, negative, or neutral word, suggesting involuntary attentional capture of arousing sexual words. In another study, Aquino and Arnell (2007) showed that sexually explicit words presented between two digits increased reaction times on a digit-parity task, compared to emotionally neutral and negative words. Additionally, it was revealed that more sexual words were later encoded into memory for recall compared to the other word types.

The effects of taboo distraction on driving have ecological relevance as many North American roadways are lined with billboard advertisements that contain highly arousing and/or sexual content (e.g., an anti-smoking billboard depicting mouth cancer or an advertisement with a woman in a bikini). In the present study, we examined driver distraction associated with four different types of information presented on roadside billboards. The five conditions were driving with: (1) highly arousing taboo words, (2) moderately arousing positive words, (3) moderately arousing negative words, (4) non-arousing neutral words, and (5) no billboard distraction. At the same time, participants responded to target words (household-related items) presented in the context of the four types of words. At the end of the study, participants were given a surprise free recall test in which they were asked to recall as many as words as possible from all conditions.

We hypothesized that driving performance would be most impaired by taboo words compared to all the other word types, as attention would be most involuntarily captured by the taboo distraction. As a result, less attention would be devoted to the driving task, which would impair driving performance. Alternatively, there is evidence that arousal can enhance focus. The narrowing of attention under highly arousing situations has been demonstrated in several studies (Agnew & Agnew, 1963; Bacon, 1974; Easterbrook, 1959; Eysenck & Willett, 1962; Hancock & Dirkin, 1982). It is suggested that as the level of arousal increases, observers tend to become more selective in their patterns of attending, a process known as "cognitive tunneling" (Dirkin & Hancock, 1985). As observers focus their attention on one specific aspect of the environment, information outside this highly attend area is excluded (Dirkin, 1983; Thomas & Wickens, 2001). Thus, it is possible that in the presence of highly arousing taboo words, driving performance would show no decrements as attentional focus would be enhanced towards the road ahead.

2. Methods

2.1. Participants

39 introductory psychology students from the University of Alberta participated for partial course credit. Data were excluded from nine participants because they did not drive to criterion (see Procedure) or due to technical issues, resulting in a final sample of 30 participants (13 males; $M = 19.5$, $SD = 3.3$). All participants had a valid driver's license, normal to corrected-to-normal vision, and were in the age range of 18 to 35 years old. The study was approved by the University of Alberta Ethical Review Board.

2.2. Materials

2.2.1. Word lists

Five 16-word lists were used in the study: one list of highly arousing taboo words; one list of moderately arousing, positive words; one list of moderately arousing, negative words; one list of non-arousing, neutral words; and one list of household-related ("target") words that participants were asked to respond to.

All of the words were selected from the Janschewitz (2008) normative word database. In the database, several subjective ratings were used for each word, including: arousal, valence, tabooness (the extent to which the rater found the word offensive to people in general), offensiveness (the extent to which the rater found the word personally offensive), familiarity (how often the rater encountered the word in any setting), personal use (how often the rater used the word on him or herself), and imageability (conduciveness to mental imagery), as well as number of letters and syllables.

Words were additionally selected based to match within-list similarity between the word lists using the latent semantic analysis method (LSA; Landauer & Dumais, 1997), and were matched for word frequency (occurrences in the English language, per million words), number of orthographic neighbors (number of words of the same length that differ in only one letter), and average word frequency of orthographic neighbors (per million words) were calculated with MCWord (Medler & Binder, 2005) based on the CELEX Lexical Database (Baayen, Piepenbrock, & Gulikers, 1995). See Table 1 for the word property statistics and the appendix for the specific words used. See Madan et al. (in press) for similarly constructed lists of taboo, positive, negative, and neutral words.

2.2.2. Driving simulator

Participants drove a STISIM Drive™ fixed-based driving simulator (Systems Technology Inc., Hawthorne, CA, USA), modeled as a small automatic transmission passenger vehicle. The simulator included a steering wheel, gas and brake pedals, and a projected display of approximately 60° horizontal and 40° vertical on a 22″ widescreen computer monitor. The simulated display included a dashboard, speedometer, and rear-view mirror.

2.3. Design

The driving scenario was 4.4 km in length and consisted of a two-lane (one in each direction) rural road that was mostly straight, with some winding turns. Road events included pedestrians crossing the road, stop signs, and traffic lights. Pedestrians were programmed to cross the road when the participant's vehicle was within 200 m of the pedestrian. Traffic lights were programmed to turn red when the participant's vehicle was within 200 m of the traffic light. Other features included buildings, trees, and other vehicles approaching in the opposite lane.

Participants completed five different driving conditions that each took approximately 5 min: (1) In *Control*, participants drove without billboard distraction. (2) In *Taboo*, participants drove with 16 taboo words and four target words on billboards. (3) In *Positive*, participants drove with 16 positive words and four target words on billboards. (4) In *Negative*, participants drove with 16 negative words and four target words on billboards. (5) In *Neutral*, participants drove with 16 neutral words and four target words on billboards. The order of conditions was counterbalanced across participants using a Latin-square procedure. Fig. 1 shows a screenshot from the taboo condition.

Similar to Chan and Singhal (2013), billboards were placed on the right-hand side of the road every 200 m. The words on the billboards were legible to the driver when the vehicle was approximately 70 m