



The relationship between attentional bias toward safety and driving behavior



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ARTICLE INFO

Article history:

Received 25 March 2016

Received in revised form 25 July 2016

Accepted 25 July 2016

Keywords:

Driving behavior
Attentional bias
Implicit cognition

ABSTRACT

As implicit cognitive processes garner more and more importance, studies in the fields of healthy psychology and organizational safety research have focused on attentional bias, a kind of selective allocation of attentional resources in the early stage of cognitive processing. However, few studies have explored the role of attentional bias on driving behavior. This study assessed drivers' attentional bias towards safety-related words (ABS) using the dot-probe paradigm and self-reported daily driving behaviors. The results revealed significant negative correlations between attentional bias scores and several indicators of dangerous driving. Drivers with fewer dangerous driving behaviors showed greater ABS. We also built a significant linear regression model between ABS and the total DDDI score, as well as ABS and the number of accidents. Finally, we discussed the possible mechanism underlying these associations and several limitations of our study. This study opens up a new topic for the exploration of implicit processes in driving safety research.

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1. Introduction

The exploration of cognitive factors related to driving safety has been the subject of several recent research studies, and may help to reduce traffic accidents and improve road safety. Information is typically processed via two types of processes: “explicit processes,” which require consciousness and “implicit processes,” which do not. Like most studies on human cognitive resources, those concerning driving safety have primarily focused on explicit cognitive processes, exploring how these processes can affect and predict driving behavior. These studies have explored the relationships of driving behavior with speed perception (e.g., Milošević and Milić, 1990), working memory (e.g., Ross et al., 2014), executive control function (e.g., Almahasneh et al., 2014), and so on. During these explicit processes of cognition, subjects are generally consciously aware of and able to monitor their performance, which is usually measured using self-reports. However, researchers have gradually realized the significant influence of information processing that occurs outside of consciousness (i.e., the implicit processes) on our attitudes, emotions, thoughts, and behavior (Olson and Fazio, 2003; Evans, 2008; Dijksterhuis, 2010). Related work in the field of driv-

ing safety is still scarce. Through analyzing early research, we began to realize that some possible bias and selectivity of attention during the early stages of information processing may have important effects on individuals' safety-related behaviors, which have long been neglected in traffic-safety research. One factor that deserves further investigation is the concept of “attentional bias,” meaning the selective allocation of attentional resources toward specific aspects of stimuli (Williams et al., 1988). This is important because we need to process a lot of information most of the time, and it is necessary to apply some strategies for noting those cues that are fatal for life (e.g., natural enemies). This is especially true during driving, because this task continually requires attentional resources and involves a certain risk. Fortunately, researchers in a domain closely connected to driving, the safety research domain, which primarily explores employees' safety behaviors in the workplace, have recently focused on the role of implicit processes in safety behavior (e.g., Barsade et al., 2009; Harms and Luthans, 2012). They have found that several implicit processes can indeed predict employees' safety behaviors in the workplace, including automatic association (reflecting individuals' implicit attitudes) (Marquardt et al., 2012) and attentional bias toward safety-related stimuli (Xu et al., 2014). This implies that attentional bias may also affect people's safety behavior when they are driving cars, considering the interconnection between organizational safety behavior in the workplace and safety behavior while driving.

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1.1. Implicit processes and safety behavior

Typical underlying implicit processes include (a) automatic association, (b) attentional bias, and (c) automatic approach–avoidance tendencies (Wiers and Stacy, 2006). Automatic association reflects people's attitudes toward specific stimuli stored in long-term memory, and is usually measured through the implicit association test (IAT), while automatic approach–avoidance tendencies are a behavioral mode of approach or avoidance that is automatically activated by environmental stimuli (Hofmann et al., 2009).

In our work, we focus on attentional bias, which refers to the selective allocation of attentional resources toward specific aspects of stimuli (Williams et al., 1988). This process, which is automatic and occurs outside of consciousness, reflects individuals' selective addressing of stimuli relevant to their particular goals and concerns in order to save their limited cognitive resources in the early stage of environmental information processing (Williams et al., 1988). Numerous studies were conducted on attentional bias toward emotional information, especially the negative affect (MacLeod et al., 1986; Williams et al., 1996; Fox et al., 2001; Yiend, 2010), which are generally linked to emotional disorders (Van et al., 2014). It was then observed that attentional bias also occurs in the case of some other categories of stimuli. Evidence shows that individuals with particular psychological characteristics (Teachman et al., 2007) or behaviors (Cohen et al., 1998; Brevers et al., 2011; Veenstra et al., 2010) display attentional bias toward specific stimuli or cues. For example, heavy drinkers exhibit greater attentional bias toward alcohol-related cues than do social drinkers (Fadardi and Cox, 2009). An individual's further suicide attempts can be significantly predicted by attentional bias toward suicide-related cues (Cha et al., 2010). Optimism is associated with a greater attentional bias toward positive stimuli relative to negative stimuli (Segerstrom, 2001). Attentional bias reflects a relatively stable characteristic of one's cognitive processes in the early stage. When something becomes a major goal in a person's life, the corresponding motivational state called *current concern* (Cox and Klinger, 1990, 2004), will activate, direct, and maintain goal-related cognitive processes in implicit, automatic ways (Cox and Klinger, 2004). Having a current concern will energize and direct the person's thoughts and behavior toward goal-related stimuli, then develop attentional bias toward these stimuli. More importantly, attentional bias is not simply a by-product of behavior but plays a vital role in behavioral causation and maintenance (Williams et al., 1996). For example, the causal and maintenance effect of attentional bias on emotional disorders have been generally studied and discussed (see Van et al., 2014).

Among these implicit processes, automatic association has been relatively well investigated in safety research. Marquardt et al. (2012) used the IAT and found that an automatic association between "I" and "safety" could significantly predict safety performance. With regard to driving behavior, it was recently discovered that an automatic association between "positive/negative" and "safe/risky driving" predicted participants' real driving behavior (Martinussen et al., 2015), suggesting that implicit processes indeed have some effect on driving behavior. Recently, an early attempt began to explore attentional bias (Xu et al., 2014), in which researchers reported that in high-risk industries in which safety is a priority, employees who value safety highly may pay more attention to and be more sensitive to stimuli and cues relevant to safety (i.e., show attentional bias toward safety, ABS) compared to employees who value safety poorly. Thus, ABS may be an indicator for safety performance. The authors explored the relationship between the ABS of workers in a nuclear power plant and a coal company and their safety performances; the results showed a significant positive correlation between ABS and two types of safety

behavior: safety compliance and safety participation. They also examined the possible underlying mechanism, and concluded that ABS may lead to greater perceived safety climate and safety motivation, and thereby influence behavior. That is to say, people with higher ABS may find it easier to perceive cues relevant to safety in a given context (e.g., safety posters, feedback of experience from events) and thus perceive a more positive safety climate; they would also be more highly motivated to adopt safety measures. Mounting evidence from safety research studies shows that implicit processes do indeed influence safety behavior (e.g., Marquardt et al., 2012; Xu et al., 2014). Researchers also have attempted to investigate the effects of implicit processes on driving behavior, but the related work remains scarce.

1.2. Driving behavior and organizational safety behavior

Thus far, we have focused on findings pertaining to implicit processes from safety research, since direct evidence from driving research is absent. Safety research, unlike driving research, which focuses on a more specific behavior (i.e., driving), is aimed at organizational safety behavior in a work organization, and primarily concerns the effects of situation- and person-related factors on employees' safety behavior (i.e., safety compliance and safety participation) and subsequent injuries and accidents in the workplace (Christian et al., 2009). Strictly speaking, the road traffic system cannot be regarded as completely equivalent to a work organization, considering that typical hazardous industries, such as nuclear power plants and coal companies, differ in many ways from the road traffic context (Nævestad and Bjørnskau, 2012). Even so, some researchers think that it is possible to apply some concepts and factors from safety research to the domain of road traffic and driving safety research, for example, safety culture and safety climate, which have recently attracted widespread attention. Nævestad and Bjørnskau (2012) discussed the possibility of the safety culture perspective being applied to road traffic (i.e., traffic safety culture), and concluded that the key is to find an analytical unit equivalent to organizations in the road traffic system. They thought that the peer group alternative seemed to be a proper one. There are studies designed to explore organizational safety culture and safety climate among professional (or work-related) drivers in road transport (e.g., Davey et al., 2006). In fact, many ideas of safety research have provided new insights into traffic safety problems.

1.3. ABS and driving behavior

As discussed earlier, implicit processes, including automatic association and attentional bias toward surrounding environmental cues, affect our safety behavior without us being aware of it, when we are working or more specifically, driving. This raises the question of whether ABS influences driving safety performance in the way it affects organizational safety behavior as reported in previous studies (e.g., Xu et al., 2014). We think the mechanism via which ABS influences safety behavior (i.e., through safety climate and safety motivation) is also applicable to driving behavior. Drivers with higher ABS may allocate more attentional resources toward safety-related cues and perceive a greater safety climate, and may also be more willing to adopt safety measures (i.e., have a greater safety motivation) and thus drive more safely. Considering that previous studies have primarily focused on explicit processes rather than implicit processes, which may also influence drivers' behavior, our aim in this study is to determine whether ABS can predict the safety of drivers' daily driving behavior.

Based on our analysis above, we made the following hypotheses: (a) drivers' ABS is negatively correlated with the scores of self-reported dangerous-driving indicators, and drivers with fewer self-reported dangerous-driving behaviors show greater ABS than

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