



Are anxiety and fear separable emotions in driving? A laboratory study of behavioural and physiological responses to different driving environments



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ABSTRACT

Research into anxiety and driving has indicated that those higher in anxiety are potentially more dangerous on the roads. However, simulator findings suggest that conclusions are mixed at best. It is possible that anxiety is becoming confused with fear, which has a focus on more clearly defined sources of threat from the environment, as opposed to the internal, thought-related process associated with anxiety. This research aimed to measure feelings of fear, as well as physiological and attentional reactions to increasing levels of accident risk. Trait anxiety was also measured to see if it interacted with levels of risk or its associated reactions. Participants watched videos of driving scenarios with varying levels of accident risk and had to rate how much fear they would feel if they were the driver of the car, whilst skin conductance, heart rate, and eye movements were recorded. Analysis of the data suggested that perceptions of fear increased with increasing levels of accident risk, and skin conductance reflected this pattern. Eye movements, when considered alongside reaction times, indicated different patterns of performance according to different dangerous situations. These effects were independent of trait anxiety, which was only associated with higher rates of disliking driving and use of maladaptive coping mechanisms on questionnaires. It is concluded that these results could provide useful evidence in support for training-based programmes; it may also be beneficial to study trait anxiety within a more immersive driving environment and on a larger scale.

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1. Introduction

It has become increasingly apparent in recent studies that emotions can have a subsequent impact on driving behaviours (Pêcher et al., 2009; Trick et al., 2012). However, some research has gone into more detail and looked at how negative emotions can influence driving; as a result we are now aware that trait characteristics are important when considering negative behaviours such as aggressive driving (Stephens and Sullman, 2014), as they could result in increased acceleration and increase steering wheel use, as indicated by an increase in standard deviation (Stephens and Groeger, 2009).

Yet it is the relationship between anxiety and driving that has gained increasing interest. Anxiety is a feeling of tension or unease at the prospect of a threatening, but not guaranteed event, and can take form in a person's state or trait (Rachmann, 2013). There are

two ways that anxiety can have an impact on driving. Firstly, it can result in a restriction of behaviour that may result in maladaptive consequences. Higher levels of anxiety are generally positively correlated with a higher frequency of, and preferences for, low self-paced activities such as housework and reading, as opposed to driving (Moller and Siguroardottir, 2009). This may be due to the fact that anxiety can lead to preoccupying and dysfunctional thoughts (da Costa et al., 2014) such as the risk of mortality (Ben-Ari et al., 2000). As a result this may reduce the desire to drive, therefore reducing the mobility and independence of the driver (Taylor et al., 2011). In normal populations people prefer driving to public transport regardless of financial cost (Innocenti et al., 2013), possibly due to a need to maintain a high level of social and psychological well-being (Stanley and Stanley, 2007; Vella-Brodrick and Stanley, 2013). If this is the case then it is important for research to clarify if anxiety subsequently influences driving behaviour, or if there is any relationship between anxiety and risk of accident.

This leads on to the second way in which anxiety, specifically trait anxiety, may negatively impact driving. Based on questionnaire data it has been suggested that those who are high in trait

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anxiety are more prone to showing signs of dangerous driving behaviours. A study conducted by [Ulleberg and Rundmo \(2003\)](#) identified six subtypes of driver; one of these subtypes, characterised by high levels of sensation-seeking, aggression and anxiety, was suggested to be a risky driving group. Many questionnaire-based studies have since provided support for this theory. A positive correlation has been found between trait anxiety and mistakes on the road ([Panayiotou, 2015](#)), as well as between trait anxiety and the Driver Behaviour Questionnaire ([Pourabedian and Azmoon, 2013](#); [Shahar, 2009](#)). The fact that the Driver Behaviour Questionnaire measures the amount of errors, lapses and violations indicates that higher trait anxiety could make a driver more dangerous on the road. A recent questionnaire study suggested that those with higher levels of anxiety caused more accidents, and were responsible for dangerous behaviours such as tailgating and driving under the influence (DUI) ([Dula et al., 2010](#)). Recently released statistics by the UK's Department of Transport reveal that in 2013, tailgating and DUI episodes contributed to over 12,000 accidents, 16 and 159 of which were fatalities for each behaviour respectively ([Department for Transport, 2014](#)). If anxiety is contributing to such behaviours then it is clear that more research needs to focus on the relationship between anxiety and dangerous driving.

However, it is important to note that questionnaires alone are dependent on self-report, and may not necessarily reflect real-life driving behaviours. As well as this, some questionnaire studies provide little or conflicting evidence to support the idea that anxiety is related to dangerous driving. For example, some studies suggest that anxiety has little ([Oltedal and Rundmo, 2006](#)) or no ([Nordfjaern et al., 2012](#)) influence on dangerous or risky driving. Others have even suggested that those high in anxiety may aim to alleviate these feelings by adopting safety conscious behaviours such as speed reduction and increased distance from vehicles in front ([Clapp et al., 2011](#)), which contrasts to other questionnaires that suggest anxiety contributes to increased speeding ([Roidl et al., 2014](#)) and tailgating ([Dula et al., 2010](#)). Therefore it may be more important to measure variables in alternative paradigms, such as laboratory and simulator-based studies. In particular, it has been recommended that research into anxiety and driving should examine more objective variables such as physiological and behavioural measures ([Dula et al., 2010](#)).

Findings on both physiological and behavioural measures indicate that there is some evidence that anxiety may be detrimental to driving. Simulator research has found that those higher in anxiety are worse at detecting specific signs amidst other distractors, and may take longer to brake at pedestrian crossings ([Morton and White, 2013](#)). When discussing a fearful topic whilst driving, those higher in state anxiety also show evidence of visual tunnelling ([Briggs et al., 2011](#)), in a similar fashion to what is seen when participants are faced with dangerous situations ([Chapman and Underwood, 1998](#)). Whilst this may reflect an attempt to direct attention to a potential source of threat as a result of anxiety ([Ohman et al., 2001](#)), this may not necessarily be advantageous behaviour in the real world. In support of this idea, real-road research has also suggested that higher anxiety can result in a greater number of errors on the road ([Taylor et al., 2007](#)), and that high state anxiety can lead to a greater likelihood of failing the British Driving Test; this latter finding was also associated with a significant increase in heart rate ([Fairclough et al., 2006](#)). These findings may imply that high anxiety could make someone not safe enough to drive on the roads.

It is also worth noting, however, that other simulator research has produced mixed findings. In a recent simulator study looking at a wide range of emotions and their impact on subjective risk, workload and driving performance, anxiety was found to increase levels of subjective risk, but did not result in a statistically greater amount of driving errors compared to controls ([Jeon et al., 2014](#)).

As well as this, there are other practical reasons why anxiety effects have been found in previous research. For example, in [Fairclough et al.'s \(2006\)](#) study, the presence of an additional tester in the car with the participant is unusual for the British Driving Test, and thus could have elevated heart rate. In [Briggs et al.'s \(2011\)](#) study, the fact that a conversation was taking place could have led to differences in attention. Other research has already suggested that holding conversations can have negative effects on attention ([Amado and Ulupinar, 2005](#)) and situational awareness ([Heenan et al., 2014](#)).

Taking these findings into consideration, it is not surprising that some researchers believe that emotions such as anxiety only have a minor influence on driving behaviours ([Sjoberg, 2006](#)). However, one possible reason for these inconclusive findings is that anxiety may be confused in the literature with another emotion, fear ([Dula and Geller, 2003](#)). For example, in [Jeon et al.'s \(2014\)](#) paper, they interchange the terms 'anxiety' and 'fearful'. In fact, whilst both signal the presence of threat, fear arises as the result of known environmental sources whereas anxiety can be objectless with little probability of threat occurring ([Rachmann, 2013](#)).

Research conducted into the studies of physical and social fear highlights that fear of physical danger is best predicted by threat and the likelihood of its outcome ([Rapee, 1997](#)). This could suggest that fear of physical danger within the driving environment could thus be predicted by the degree to which a driver is involved in a situation that increase the likelihood of injury or death. This has been acknowledged within the driving research, where it is claimed that fear can depend on external demands ([Schmidt-Daffy, 2012, 2013](#)). Thus by worsening visibility in fixed-speed computer-based drives, feelings of threat and skin conductance responses can increase ([Schmidt-Daffy, 2013](#)).

This concern about the distinction between fear and anxiety has been made apparent with the driving literature ([Taylor et al., 2008](#)), and research has suggested within the driving context that people perceive driving anxiety and driving fear as similar concepts ([Taylor and Paki, 2008](#)). Yet the differences between the two are important for two reasons. Firstly, emotions of the same valence have been shown to produce different responses. Research into emotions and risk perception has suggested that fear and anger are positively and negatively related to perceived risk respectively ([Lerner and Keltner, 2000](#)), and differences in decision making are also found between sadness and disgust ([Lerner et al., 2004](#)). Secondly, the difference between anxiety and fear suggests that the former is based on top-down, internal influences and the latter is based on environmental influences. The transactional model of stress suggests that the person and the environment interact to produce a stress response ([Lazarus and Folkman, 1984](#)). Thus it is possible that fear and anxiety interact to produce differential responses within the driving environment, or that anxiety may modulate the degree to which responses are made within different driving environments.

Based on the fundamental difference between the two emotions with respect to the presence of threat, it is possible to suggest that fear and anxiety manifest as a result of bottom-up and top-down cognitive influences respectively. [Schmidt-Daffy's \(2013\)](#) research could provide some empirical evidence for this suggestion. In [Schmidt-Daffy's](#) paper, it was acknowledged that the symptoms of the two emotions are difficult to distinguish and often occur at the same time, in varying proportions. However, it was suggested that whilst fear arises due to task demands, such as those determined by environmental factors, anxiety may manifest as a result of motivational demands. In a computer-based study, participants had to drive using the 'space' bar on a keyboard, and in some trials they had to brake at the presence of a silhouette of a deer. Environmental demands were manipulated by increasing or decreasing visibility of the road leading towards the hazard, and anxiety was manipulated by incurring different levels of monetary penalty if the deer was hit or the drive was not completed fast

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