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Task difficulty, risk, effort and comfort in a simulated driving task—Implications for Risk Allostasis Theory

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ABSTRACT

Risk Allostasis Theory states that drivers seek to maintain a feeling of risk within a preferred range [Fuller, R., 2008. What drives the driver? Surface tensions and hidden consensus. In: Keynote at the 4th International Conference on Traffic and Transport Psychology, Washington, DC, August 31–September 4, 2008]. Risk Allostasis Theory is the latest version of Task-Difficulty Homeostasis theory, and is in part based on the findings of experiments where participants were asked to rate the task difficulty, feeling of risk and chance of collision of scenes shown in digitally altered video clips [Fuller, R., McHugh, C., Pender, S., 2008b. Task difficulty and risk in the determination of driver behaviour. Revue européenne de psychologie appliqée 58, 13–21].

The focus of the current research was to expand upon the previous video based experiments using a driving simulator. This allowed participants to be in control of the vehicle rather than acting as passive observers, as well as providing additional speed cues. The results support previous findings that ratings of task difficulty and feeling of risk are related, and that they are also highly related to ratings of effort and moderately related to ratings of comfort and habit. However, the linearly increasing trend for task difficulty and feeling of risk described by the previous research was not observed: instead the findings of this experiment support a threshold effect where ratings of risk (feeling of and chance of loss of control/collision), difficulty, effort, and comfort go through a period of stability and only start to increase once a certain threshold has been crossed. It is within the period of stability where subjective experience of risk and difficulty is low, or absent, that drivers generally prefer to operate.

1. Introduction

The underlying controlling factors of everyday driving behaviour have been debated extensively for many years (e.g. Michon, 1989; Ranney, 1994; Rothengatter, 2002). Models put forward have included attitude theories such as the Theory of Planned Behaviour (Ajzen, 1991), learning theories such as the risk avoidance model (Fuller, 1984), economic theories such as Peltzman's (1975) driving intensity model and motivational models such as Risk Homeostasis Theory (Wilde, 1976, 1982, 1988), zero-risk theory (Näätänen and Summala, 1976; Summula, 1997) and the Safety Margin Model (Summala, 2005). However, none of the proposed models has yet managed to achieve wide-spread acceptance amongst a majority of traffic researchers. The lack of a well-agreed understanding of the underlying controlling factors of everyday driving creates problems for road safety professionals. If effective interventions are to be put into place, then a good understanding of exactly what guides driver behaviour is important. It is also vital, given that these models could be used when designing interventions that they are tested in order to determine their validity.

In 2000 Fuller proposed a new model, The Task-Capacity Interface (TCI) model, and its accompanying Risk Allostasis Theory (RAT), states that a feeling of risk, as an indication of task difficulty, is the primary controller of driver behaviour (Fuller and Santos, 2002; Fuller, 2005, 2007, 2008; Fuller et al., 2008a). The basic premise behind TCI is that driving is an interaction between the demands of the environment in which the behaviour is being produced and the capability of the individual producing the behaviour. This interaction produces the difficulty of the task being performed, which is then perceived by drivers. If task difficulty becomes too great then loss of control occurs (Fuller, 2000, 2005; Fuller and Santos, 2002; Fuller et al., 2008a,b). In this way TCI is more a description of the driving task rather than a model which predicts everyday driver behaviour.

It is RAT that takes on the aspect of a predictive model. RAT states that individuals have a preferred range of perceived feeling of risk in which they operate and that they will alter their behaviour to maintain the feeling of risk within this preferred range (Fuller, 2008). An individual's preferred level of feeling of risk is determined by their

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[1] We are sad to report that Professor Rothengatter passed away in February, 2009.

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current and long term motivations, along with how capable they currently perceive they are. This means that this range of preferred feeling of risk is not set and may alter as an individual's motivations and perceptions of their capability change (Fuller and Santos, 2002; Fuller, 2005, 2007; Fuller et al., 2008a,b). That preferred feeling of risk is a range, and that it is flexible differentiates RAT from Risk Homeostasis Theory, where target level of risk was seen as less flexible and more of a discrete target (Wilde, 1976).

However RAT, like Risk Homeostasis Theory, does still rely on the constant monitoring of a variable, in this case feeling of risk, which in turn is an indication of task difficulty, and comparing it to a preferred level. RAT in itself is a replacement for Task-Difficulty Homeostasis (TDH) theory in which a preferred range of task difficulty was monitored (Fuller and Santos, 2002; Fuller, 2005, 2008; Fuller et al., 2008a,b). When the theory was still called Task-Difficulty Homeostasis the monitoring of difficulty was at one point related to the monitoring of mental workload (Fuller, 2005). Furthermore it was originally predicted that feelings of risk would act in a threshold manner and act as a warning to drivers that they were near the edge of their preferred range of task difficulty (Fuller et al., 2008b). However since that time TDH has developed into RAT and feelings of risk that have become a constantly monitored variable. In particular feeling of risk is not seen as a variable that is only salient after a certain threshold has been crossed, as suggested by zero-risk theory, but rather is continuously salient in its influence on driver decision making. However, while feelings of risk are continuously salient, drivers may not be aware of their influence on their decision making. This is seen in the following statement:

> "... the effects of risk feelings on decision making are not binary (one moment they are irrelevant, the next they become salient): task difficulty and feelings of risk are continuously present variables which inform driver decisions (whether consciously or not). However, only when some threshold point is reached may risk feelings become particularly salient in driver consciousness"—Fuller et al. (2008a,b, p. 31).

In combination with this constant monitoring of feeling of risk is a threshold type relationship thought to warn individuals when they are operating outside of their preferred range of feeling of risk. It is also perhaps the point which feelings of risk may begin to consciously effect decision making of drivers. This risk threshold also seems to also be around the same time at which individuals report feeling at risk of being involved in a crash (Fuller et al., 2008b).

That feelings of risk are being constantly monitored and compared to a preferred range opens the theory of RAT to many of the same criticisms that had previously been aimed at Risk Homeostasis Theory (Evans, 1986; McKenna, 1990; Summala, 1988; Summula, 1997). In psychology, a feeling is a subjective and conscious experience of an emotion, with emotions being seen as objective physiological and mental states (Damasio, 1994, 2003; VandenBos, 2006). That is to say, feeling implies conscious awareness at some level. If this is the case the most important objection to RAT is that most of the time drivers report feeling no risk during day-to-day driving and it is only when a performance related safety margin is crossed that drivers become aware of any feelings they could label as risk (Summala, 1988; Summula, 1997). In the past these objections do tend to relate to the monitoring of crash or statistical risk. But objection that that it would be stressful and demanding mentally to be constantly directing attention towards a subjective variable in order to continuously compare it to a preferred level or range of experience of that variable is still relevant even when the variable is "feeling of" rather than "statistical" risk.

Similarly if mental workload is examined it is true that people do tend to adjust their behaviour in order to operate at an optimum level of workload (Fuller, 2005). However it seems that it is the absence of under or over load that indicates that an individual is operating at optimal mental workload. This is demonstrated in Fig. 1 where a range of measurement tools and their ability to detect mental workload is shown. As can be seen in the figure both objective physiological and subjective assessments of workload are unable to detect operation in the optimal A2 area. Rather operation in this area has to be inferred by the finding that an individual is not operating in any the under or over load areas which can be detected (De Waard, 1996).

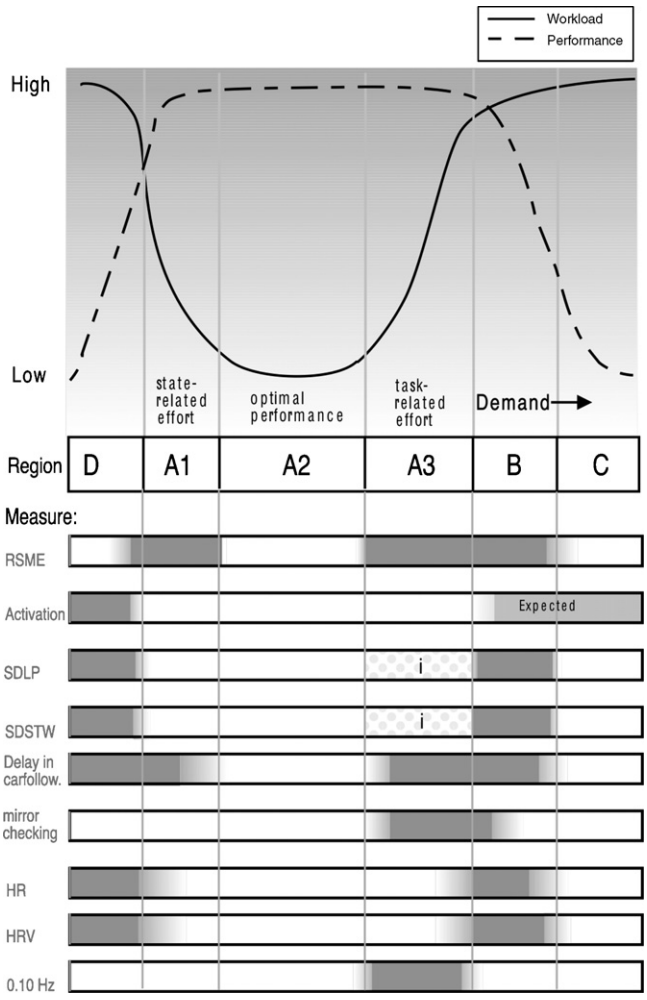

Fig. 1. The relation of workload to performance in six regions and the sensitivity of different measures to driver mental workload. Shading indicates the measure is sensitive to workload in this region (from De Waard, 1996, p. 101).

In this way mental workload is similar to a threshold type relationship with under and over load thresholds, and optimally functioning individuals feeling no load at all, or a stable low load, creating a U-shaped curve (De Waard, 1996).

Fuller (2007, 2008) attempts to address these concerns around the constant monitoring of a feeling of risk, with reference to Damasio's Somatic-Marker Hypothesis (Damasio, 1994, 2003). The Somatic-Marker Hypothesis claims that through past experience specific stimuli become marked by associated emotions, which are underlying body states. Damasio refers to this as a somatic marker, and argues that when the marked stimulus is encountered then this marker is also triggered. These markers can also be in some cases present from birth (Damasio, 1994). Activation of the somatic marker could produce greater attentional capture for these stimuli, resulting in feeling. In addition, as these emotions are seen as changes in the body state of the individual they are also speculated to be able to bias an individual into behaving in a specific way due to the resulting changes in the internal psychology and associ-