The relationship between cue utilisation, state anxiety and prospective memory on performance during a novel task

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Declaration

This report contains no material which has been accepted for the award of any other degree or diploma in any University, and, to the best of my knowledge, this report contains no materials previously published except where due reference is made.

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Abstract

The ability to extract, utilise and apply environmental cues is a key component for expert performance. Previous research has suggested that cues can reduce the effect of cognitive load, particularly in high workload conditions. However, in high workload conditions, individuals are potentially switching between multiple tasks, hence prospective memory is required to remember to complete the switched tasks in the future. Additionally, such conditions can be stressful, sometimes leading to anxiety. Currently, the interaction between cue utilisation and anxiety, and their effect on task and prospective memory performance is unknown and will be covered in the scope of this research.

The relationship between cue utilisation, state anxiety and prospective memory on performance during a novel task

Situation Assessment and Cue Utilisation

Naturalistic environments are characterised by ill-structured problems, uncertainty, dynamic environments, high time pressure, high stakes, and ill-defined or competing goals (Orasanu & Connolly, 1993). For example, the domains of medicine, aviation, electricity transmission control and sport are all high-risk technical environments in which operators are required to respond and make decisions under a unique and sometimes demanding set of circumstances. During a high-level tennis match where the tennis ball is flying at speeds of more than 100 km/h, for example, how does the player react fast enough to return the shot? Alternatively, how does an emergency medical doctor make sense of the copious amounts of information regarding a patient's condition fast enough to save a life? Due to the complex and dynamic nature of situations in such naturalistic environments, successful performance in such environments requires accurate and rapid decision making, (Ericsson & Lehmann, 1996).

Expert operators utilise environmental cues. Conceptually, cues are thought to be associations in memory between environmental features and events (Ericsson & Kintsch, 1995). Cue associations are formed when features in the environment (e.g., the presence of rain clouds, darkening skies) are repeatedly paired with an object/event (e.g., rain) such that the presence of the features they hold meaning for an operator (Brunswik, 1955; Lipshitz, Klein, Orasanu, & Salas, 2001) As a function of extensive experience, an operator is thought to develop a nuanced network of cue associations that represent different situations and events within a particular domain (Coderre, Mandin, Harasym, & Fick, 2003; Klein, 1993). These environmental cues are held within Long Term Memory (LTM) and can be auditory, olfactory, tactile or visual in nature (Wiggins, 2006).

Support for cue utilisation as a process that underpins expert performance comes from the expert-novice paradigm. According to the expert-novice paradigm, an expert in a field is more likely to be capable of consistently discriminating between relevant and less relevant stimuli within his/her domain of expertise (Weiss & Shanteau, 2003). This is facilitated by their ability to maintain and recall more information in working memory (Loveday, Wiggins, Harris, O'Hare, & Smith, 2012). In sports, expert sportsmen are usually are better at anticipating their opponents' intentions, utilise more effective visual search strategies, and better recognise typical patterns of play in their sporting area (Ward & Williams, 2003). For example, Müller, Abernethy, and Farrow (2006) found that expert batsmen are better at using early movement cues to predict the opposite bowler's intentions.

The difference in the uptake of information between expert and novice operators typically occurs without significant differences in reaction time, depth perception or visual acuity, suggesting that the observed differences in performance are a result of differences in information processing (Gabbett & Abernethy, 2013). Hence, rather than a difference in general reasoning or differences in short term memory span, expert operators are distinguishable from novices through their ability to rapidly and accurately assess a situation (Orasanu & Connolly, 1993). Situation assessment refers to the initial stage of the decision-making process which involves understanding the nature of a situation by extracting and interpreting the available information (Kaempf, Klein, Thorsden, & Wolf, 1996). Nevertheless, it is equally important to also consider the limits of expertise, as expert reasoning is domain-specific (Ericsson & Lehmann, 1996). The professional tennis player is unable to perform well as a rugby player, as the cues used to develop such expertise are specific to tennis playing, and hence are not transferable to rugby.

Klein’s (1993) Recognition-Primed Decision model is one theoretical model that purports to describe the cognitive mechanisms that underly the process of situation assessment (Figure 1). The main tenant of this model is that operators engage the process of satisficing, by selecting the option that is good enough, but not necessary the best (Klein, 1993; Orasanu & Connolly, 1993). When operators are faced with familiar scenarios (see ‘Level 1’; Figure 1), the obvious, implicit reaction is implemented. Based on the familiar cues in the scenario, the operator recognises the scenario as ‘typical’. This triggers the implementation of actions consistent with that ‘typical’ scenario. However, when faced with more complex and ambiguous scenarios, (see ‘Level 2’; Figure 1), operators are required to perform conscious evaluation of potential responses. When the satisficing strategy is implemented, operators would select the first satisfactory choice of action, without analysing all workable alternatives.

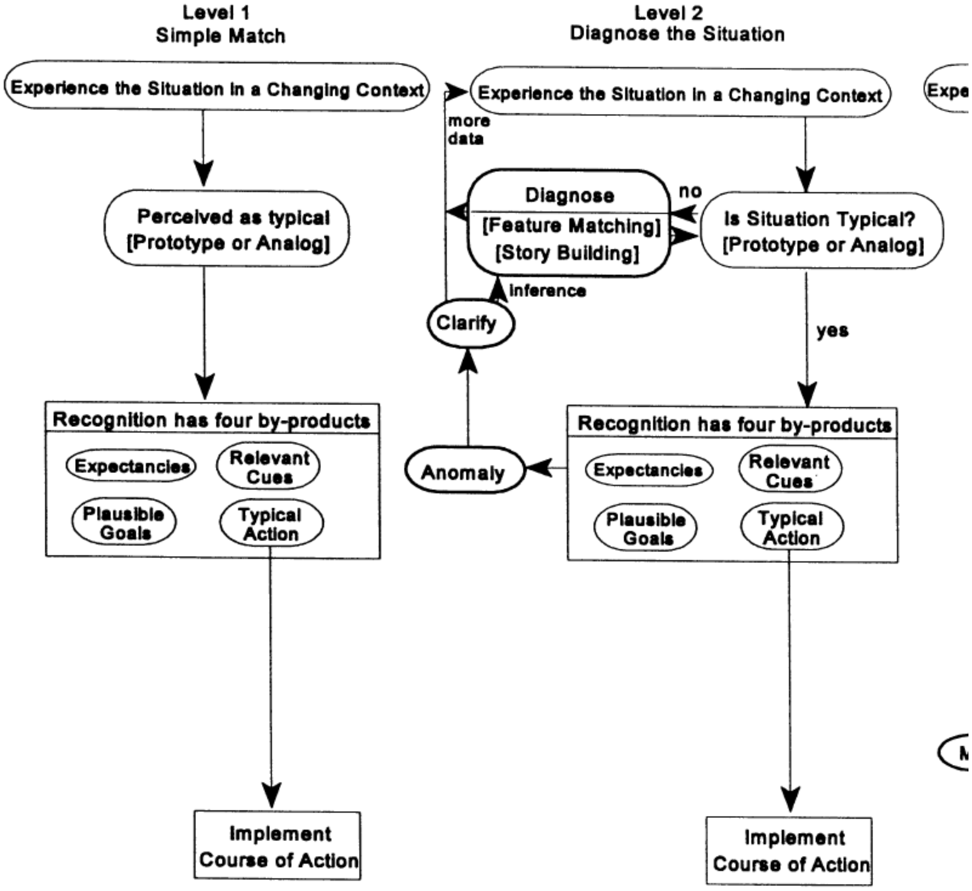

Figure 1. Illustration of the Recognition-Primed Decision model, encompassing both simple (Level 1) and complex (Level 2) recognition-primed decision strategies (Klein, 1997).

In real life, recognition-primed decision making describes how cues are used to aid situation assessment in naturalistic environments. For example, on-scene firefighters adapt to individual firegrounds based on the information (or cues) present on scene and their internal playbook, which was developed through years of experience (Emillio, 2018). In the area of e-commerce, consumers have been found to use strategies similar to recognition-primed decision-making while shopping online, including selecting stores that match their schema of appropriate stores, and using a satisficing strategy to select ideal products (Resnick, 2001). Hence, the usage of cues could assist in making quick decisions.

Anderson's (1982) Adaptive Control of Thought (ACT*) theory of skill acquisition provides an alternate explanation of how cues underpin the cognitive process of situation assessment. ACT* theory posits that situation assessment involves two key stages: the declarative stage and the procedural stage (Anderson, 1982). The declarative stage involves the encoding of factual information regarding a skill domain, which is the process by which expert operators acquire knowledge in the area of expertise. The procedural stage involves the transformation of knowledge into sets of procedural 'rules'.

The procedural rules are encoded through a series of 'IF-THEN' productions (Anderson, 1993). These specify that if a certain state occurs in working memory, then certain actions will occur in reaction to that state (Anderson, 1987). For example, if the operator needed to use the plural of 'man', the following feature-event pair is generated: "IF the goal is to generate the plural of men (feature), THEN say "MEN" (event)" (Anderson, 1982). If an individual lacks adequate productions to assess a situation, the person will attempt to solve the problem by analogy, using similar examples from past experiences (Anderson, 1993). This involves the recollection of similar feature-event pairs and interpreting them through the lens of the current problem. The ease of accessing this association depends on how strongly the knowledge is encoded, which is dependent on the level of practice (Anderson, 1993). If a feature-event pair is retrieved and maintained more often in working memory, this develops into a stronger association, which makes it more readily accessible.

The 'IF-THEN' productions show similarities to the cue utilisation framework, with cue (feature-event) associations encoded within the 'IF' conditions in procedural memory, where the response or action to the cue encoded within the 'THEN' condition. For example, an experienced Adelaidean in winter might reason "IF there are rain clouds and darkening skies (features), it's likely to rain soon (event), THEN I better bring my umbrella to work (typical action in response to the cue). The process of strengthening associations within procedural memory is similar to the development of expertise. Inexperienced individuals often lack the repertoire of associations within their procedural memory, and hence face difficulties in recognising the relevance of cues (Wiggins, 2006). However, with experience, individuals will be capable of matching the presenting situation with one resident in long-term memory, through the usage of cues (Hinds, Patterson, & Pfeffer, 2001).

Hence, dual process systems of reasoning, the Recognition-Primed Decision model and ACT* theory all propose that associative learning through the use of cues underpin the process of situation assessment. These feature-event associations serve as a compensatory mechanism to reduce the amount of mental workload (or cognitive load) imposed on working memory (Cooper, 1998). Current models of working memory suggest that working memory is capacity limited (Baddeley, 2010). As the utilisation of cues consumes less working memory resources, operators who have high levels of cue utilisation have additional cognitive resources available for other activities.

Operators with a greater capability for cue utilisation are expected to be better at identifying and acquiring the key feature-event associations relevant to their tasks (Brouwers, Wiggins, Helton, O'Hare, & Griffin, 2016). The presence of these associations allows operators to anticipate and make predictions, which reduces the impact of cognitive load (Brouwers, Wiggins, Griffin, Helton, & O'Hare, 2017).

To explore whether an individual's capacity for cue utilisation did in fact reduce perceived workload during a novel task, Brouwers et al. (2017) exposed participants to a novel, simulated rail control task, which contained both a low- and high-workload condition. For the low-workload condition, participants completed the rail control task in isolation. During the high-workload condition, participants completed an additional task concurrently with the rail control task. The trains in the rail control task were programmed to appear in a specific, sequential order. The diversion of the trains occurred using a set pattern, where trains on only the first and the fourth track required diversion, however, participants were not informed about the pattern. Participants also completed an assessment of cue utilisation in the domain of driving (EXPERTise 2.0; Wiggins, Loveday, & Auton, 2015).

There were significant differences in performance between participants with higher and lower levels of cue utilisation. In the higher workload condition, participants with higher levels of cue utilisation were faster, and more accurate when diverting trains, compared to those with lower levels of cue utilisation. Additionally, when asked if they recognised the pattern within the rail control task, participants with higher levels of cue utilisation were 11 times more likely to identify the pattern. This suggests that those who have a higher capacity for cue utilisation were more likely to 'pick up' on the pattern. The presence of the pattern was presumed to allow participants to lower the workload, as it allowed participants to only divert the trains travelling on the first and fourth track, while disregarding all the other task features. In doing so, participants were presumably able to reduce the workload imposed by the task by only focussing on the tracks that required diversion, and this resulted in improved performance.

State Anxiety, Working Memory and Cue Utilisation

While it has been shown that experienced operators are typically more skilled at making fast, yet effective assessments of situations under severe time constraints, the research on the influence of emotions on their situation assessment capabilities is somewhat mixed. Due to the high uncertainty, time pressure and potential consequences of a poor decision inherent in naturalistic settings, decision making under such settings can be inherently stressful. Areas in the brain that possess stress hormone receptors, for example the prefrontal region, are also particularly sensitive to stress. The introduction of stress hormones to those regions trigger metabolic changes, and, as these regions are heavily involved in human decision making, these can trigger neural responses that lead to altered decision-making ability (Starcke & Brand, 2012).

Anxiety is one example of an emotion that comes into play during high stress situations. ‘Anxiety’ can refer to two similar yet distinctly different constructs; ‘trait anxiety’ refers to anxiety as a personality dimension, or a person’s tendency to feel threatened or worried when faced with stressful situations (Eysenck & Derakshan, 2011; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). ‘State anxiety’, on the other hand, conceptualises anxiety as a mood state, or the transient anxiety that occurs during a stressful situation itself (Eysenck & Calvo, 1992). ‘Clinical anxiety’ is another separate construct that presents in a clinical population. However, this is significantly different from both trait and state anxiety, as it is characterised by an altered belief system with negative outcomes (Paulus & Yu, 2012). Nevertheless, the focus here will be on state and trait anxiety, as clinical anxiety is less relevant in normal populations.

Eysenck’s (1979) original theoretical framework proposed that anxiety can impair task performance. According to this framework, highly anxious people were akin to be in a divided-attention scenario, as anxiety competed with the task itself for the limited available cognitive capacity within working memory. Hence, Eysenck’s theoretical framework purports that anxious individuals will attempt to compensate for this cognitive load by expending more effort. However, this can only compensate part of the discrepancy, which still results in an overall lower performance.

Higher levels of state anxiety are found in conjunction with a lowered working memory capacity in early research, but the effects of trait anxiety are more mixed (Eysenck, 1979). Research in the area of heuristics and biases has found that trait anxiety influences performance in tasks containing ambiguity, but has minimal effect on a person's level of risk taking (Zhang, Wang, Zhu, Yu, & Chen, 2015). However, the relationship between trait anxiety and ambiguity resembles an inverted U-shaped curve, where individuals with both high and low trait anxiety perform worse in tasks that induce ambiguity. Other research suggests that the effect of trait anxiety is more subtle, and works in conjunction with the current emotional context (Matthews, Panganiban, & Hudlicka, 2011). Hence, this suggests that trait anxiety by itself is less suited for predicting performance. Rather, further research in this field should focus on measures of state anxiety, which encompasses the effect of both trait anxiety and situational stress (Eysenck, Derakshan, Santos, & Calvo, 2007).

The processing efficiency theory is one of the earliest theories which attempts to explain the effect that state anxiety has on task performance (Eysenck & Calvo, 1992). A key component of this theory is the interaction between worry and the central executive system. Worry is defined as self-preoccupation or concern about performance, and processing efficiency theory considers it to be the cognitive component of state anxiety. The central executive, on the other hand, is the component of working memory responsible for decision making itself (Badderly, 1986). Processing efficiency theory argues that worry consumes working memory resources, mainly in the central executive area. Hence, for complex tasks which impose more demands on working memory, the effect of state anxiety will be more pronounced due to the lack of available working memory resources (Eysenck & Calvo, 1992).

Interestingly, processing efficiency theory also places a distinction between performance and processing efficiency (Eysenck & Calvo, 1992). Performance efficiency refers explicitly to the quality of performance in a certain task. On the other hand, processing efficiency is the interaction between the level of performance and the amount of effort required to achieve it. Hence, even though high- and low- state anxiety groups can have similar performance, due to the increased working memory load in highly anxious people, they are predicted to face a reduced processing efficiency. The lowered processing efficiency can manifest through higher levels of self-reported task effort, decreased performance in concurrent secondary tasks, and a reduced overall cognitive capacity (Eysenck & Calvo, 1992).

The distinction between performance and processing efficiency was demonstrated by Calvo, Eysenck, Ramos, and Jiménez (1994), who had low- and high-state anxiety participants read texts under stress or non-stress conditions. While there were no differences in reading comprehension across both state anxiety groups, participants with higher state anxiety took longer to read the text. In order to maintain similar performance, those with higher state anxiety presumably had to apply compensatory strategies to alleviate the reduction in processing speed. This could potentially include applying more effort on the task or increasing the amount of resources allocated for the task, all of which increases the load on working memory (Eysenck et al., 2007). Hence, the adverse effects of anxiety can be said to become more pronounced as the demands on working memory increases, regardless if the increased workload comes from increasing the complexity of the primary task or adding on a secondary task.

Attentional control theory builds upon the previous work done in the field of state anxiety (Eysenck et al., 2007). Similar to processing efficiency theory described, attentional control theory proposes that anxiety impedes cognitive performance by affecting the efficiency of the central executive, which is responsible for the performance of numerous executive tasks (Eysenck &

Derakshan, 2011). Additionally, attentional control theory incorporates the distinction between performance and processing efficiency, which is the key concept of processing efficiency theory.

The main contribution of attentional control theory is the integration of the top-down goal-directed attentional system and the bottom-up stimulus-driven system with anxiety and processing efficiency. The top-down goal-directed attentional system, like its namesake, directs a person's attention based on pre-conceived goals or expectations. The stimulus-driven system, in contrast, focuses a person's attention to salient or conspicuous stimuli (Corbetta & Shulman, 2002). In normal conditions, both systems are in homeostasis and balance each other out. Anxiety disrupts this delicate balance by increasing the influence of the stimulus-driven system, and this is done through affecting the inhibition and shifting functions (Eysenck & Derakshan, 2011).

Without the shifting function, the individual is unable to shift attention to the most relevant stimuli at a certain point in time. For example, when required to shift between different types of mathematical tasks, participants with higher levels of state anxiety performed substantially worse after the switching, compared to those with lower state anxiety (Derakshan, Smyth, & Eysenck, 2009). The lack of inhibition leads to the inability to prevent task-irrelevant stimuli from disrupting performance, leading the individual to be more susceptible to distractions from task-irrelevant external and internal stimuli. The lack of inhibition, as described by attentional control theory, subsumes the processing efficiency theory. As stated earlier, processing efficiency theory proposes worry as the key mechanism for the impairment of the central executive. In attentional control theory, worry can be classified as an internal task-irrelevant stimulus which acts as a potential distractor (Eysenck et al., 2007). On the other hand, external task-irrelevant stimuli can range from something as simple as a conversation distractor, or an extraneous, irrelevant information such as cues. Hence, taken together, these indicate that anxiety leads to inhibition of positive (shifting) and negative (inhibition) attentional control.

Evidence for the influence of distractions on performance comes from studies involving the tracking of eye movements (Hallett, 1978). During this experiment, Hallet required participants to fixate on a central point, and when a sudden stimulus was presented on one side of the fixation point, participants had to direct their gaze to the other side of the fixation point. In order to do so, participants had to inhibit their reflexive rapid eye movement (or saccade) to the intruding stimuli and generate a saccade to the correct position. Results showed that participants with higher levels of state anxiety required significantly more time to make the correct saccade compared to those with lower state anxiety (Hallett, 1978).

Taken together, both the processing efficiency theory and attentional control theory have similar inferences regarding the mediating effect of state anxiety on cue utilisation and task performance. A key component of both theories is that individuals with higher levels of anxiety utilise compensatory mechanisms to maintain a similar level of performance, which increases cognitive load. The utilisation of cues has been found to reduce the cognitive load in high mental workload scenarios (Brouwers et al., 2016). Therefore, it could be argued that during completion of tasks that impose a high mental workload, individuals with high levels anxiety could use domain relevant, pre-existing cue associations as a compensatory mechanism to negate the additional cognitive load from their lowered processing efficiency. However, this would only be the case if individuals were completing a task in a domain where they possessed refined cue associations.

Nevertheless, in the literature, there is a lack of research that directly investigates the relationship between anxiety, cue utilisation and their impact on task performance. In naturalistic, high-risk environments, operators are often required to critically assess the situation, whilst under anxiety provoking situations. Hence, in high-risk environments where cues are frequency used, the impact of state anxiety needs to be further understood.

The Impact of Cue Utilisation and State Anxiety on Prospective Memory

Prospective memory refers to an individual’s ability in remembering to perform tasks at a future point in time (McDaniel & Einstein, 2007). While prospective memory has a variety of applications in regular day-to-day functioning, such as remembering to pick up children after school or taking medication, prospective memory also plays a key role in the performance of tasks in high-risk, safety-critical fields, such as aviation or medicine. For example, prospective memory failures have been associated with errors by airport area controllers in coordinating the flight path an altitude of planes (Shorrock, 2005). Shorrock documented various prospective memory failures, including failing to update details regarding flight progress and forgetting the altitude that the plane needed to be raised to. In the field of medicine, failures in prospective memory have can include failing to perform a count of instruments, leading to the retention of foreign substances in the body post-operation (Gawande, Studdert, Orav, Brennan, & Zinner, 2003).

Laboratory paradigms of prospective memory contain a retrospective and a prospective component. As previously mentioned, participants have to recall the action that was needed to be performed (the retrospective component), and actually perform the action during the appropriate time or when the event occurs (the prospective component; Katai, Maruyama, Hashimoto, & Ikeda, 2003). Both components rely on the individual’s capability to encode and recall such information in long term memory (Harris & Cumming, 2003). Hence, factors that affect the retention and retrieval of information can impact on prospective memory.

There are two major theories of retrieval in prospective memory literature, namely the preparatory attentional and memory processes (PAM) theory and the multiprocess view. The PAM theory proposes that resource-consuming attentional processes (also known as preparatory attentional processes) must be continuously engaged prior to the occurrence of the prospective memory task (Smith, 2003). PAM processes continuously perform recognition checks on the environment to search for cues which signify that it is appropriate to perform the prospective memory task (Smith & Bayen, 2004). Therefore, due to having to constantly attend to the surroundings, prospective memory performance worsens when the operator experiences higher cognitive demands on the ongoing activity (Marsh, Hancock, & Hicks, 2002). An increase in prospective memory performance would incur an increase in expenditure of cognitive resources, due to the increased attention required, resulting in lowered performance in the ongoing activity. This is further supported through studies that introduced a secondary task to increase the cognitive load. As individuals have a limited working memory capacity, there is a trade-off between performance in the prospective memory task and other tasks in high workload conditions. Dedicating more cognitive resources and attention to the concurrent task could result in reduced prospective memory performance (Marsh et al., 2002).

The multiprocess theory is another theory that aims to explain how prospective memory functions (McDaniel & Einstein, 2000). While both theories acknowledge the importance of resource-consuming processes in most prospective memory tasks, the multiprocess theory argues that an external cue can also spontaneously trigger the retrieval of a prospective memory intention (i.e. spontaneous retrieval), even when environment monitoring is not engaged (Harrison & Einstein, 2010). Support for this theory comes from research that deemphasises environmental monitoring, but still the results still demonstrated high prospective memory performance (Einstein & McDaniel, 2005). Interestingly, performance in a prospective memory task was found to be equally high regardless of whether the participants used environmental monitoring or spontaneous retrieval, suggesting that both PAM theory and multiprocess theory play a role in explaining how prospective memory functions (Einstein et al., 2005).

While the relationship between prospective memory and cue utilisation has not been looked at directly, it could be argued that the use of cues during task completion could help improve performance on a prospective memory task. Within the naturalistic decision-making paradigm, operators are often operating under dynamic situations with high uncertainty. Hence, in order to maintain expert performance, operators are required to constantly make quick decisions whilst managing other concurrent tasks using prospective memory. The usage of cues for decision making would reduce the workload of the decision-making tasks, therefore increasing the amount of cognitive resources available for prospective memory. This would suggest that those with a higher capacity for cue utilisation in a given domain, would potentially have spare cognitive resources available to engage in a prospective memory task and thus outperform those with a lower capacity for cue utilisation.

With regards to the relationship between prospective memory and anxiety, early research in the field found a significant, negative relationship between anxiety and prospective memory (Harris & Menzies, 1999). However, when looking at the state and trait aspects of anxiety, the relationship becomes murkier. For trait anxiety, Harris and Cumming (2003) did not find a relationship between it and prospective memory. However, while Kliegel and Jager (2006) found a similar pattern in time-based prospective memory tasks, where trait anxiety was uncorrelated with task performance, higher levels of trait anxiety was associated with worse performance in event-based prospective memory tasks.

Similarly, the relationship of between state anxiety and prospective memory is mixed. In the study conducted by Harris and Cumming (2003), participants were required to complete a prospective memory task that was embedded within a semantic association task. At the start, participants were presented with a list of words to memorise. For the semantic association task, participants were read out a separate series of words, and were required to record a word that is similar in meaning to the words they heard (for example, if ‘zoo’ was the word provided, participants should write ‘lion’). However, for the embedded prospective memory task, when participants heard the words that were present on the memorised list, they had to write down the word itself (for example, if ‘dog’ was on the memorised list of words, participants should write ‘dog’). The study found that state anxiety was a negative predictor of prospective memory, as participants with higher levels of state anxiety failed to perform a higher proportion of the prospective memory task (Harris & Cumming, 2003).

This finding from Harris and Cumming (2003) is consistent with the effect proposed by Processing Efficiency Theory, where the worry generated by state anxiety can interfere with or consume resources required for cognitive processing, which reduces the amount available for attentional processes. However, other studies reported that anxiety instead heightens performance (Kliegel & Jager, 2006). Processing Efficiency Theory, again, proposes a mechanism that explains this contradiction. Crucially, the theory emphasises that the negative effects of state anxiety only emerge when a person is under a high cognitive load (Eysenck & Calvo, 1992). When under a low cognitive load, a person is able to use other compensatory mechanisms to maintain a similar level of processing efficiency and hence performance. Therefore, research still needs to be done to determine the actual relationship between state anxiety and prospective memory.

Overall, while the relationship between cue utilisation, state anxiety and prospective memory has not been investigated directly, a relationship could potentially exist due to similarities in the underlying construct. Those who possess a higher capacity for cue utilisation are likely to have cognitive resources available when completing a task which might put them at an advantage when required to engage in prospective memory. The compensatory effects of triggered by anxiety processes could increase the processing required for situation assessment. This would increase the cognitive load, which could reduce performance on tasks. However, this relationship has not been assessed in the context of cue utilisation.

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The Relationship Between Cue Utilisation, State Anxiety and Prospective Memory on Performance During a Novel Task

[redacted]

Author's note:

This manuscript has been prepared for Ergonomics (see Appendix A). Although the journal submission requirements specify for the images and tables to be placed at the end of the submission, they were instead embedded into the text to aid the readability of the manuscript. Additionally, the author acknowledges that the word limit for the current journal is 5000 words. The manuscript will be shortened before publication.

Abstract

The ability to extract, utilise and apply environmental cues is a key component of expert performance. In addition to the capacity for cue utilisation, prospective memory (remembering to do something in the future) is also a critical skill for operators working within these dynamic and multi-tasked environments. Due to the nature of the environment, state anxiety (transient anxiety occurring during a stressful environment) would also impact task performance. In the present study, 30 participants undertook an assessment of cue cutisation and state anxiety, along with prospective memory tasks and a rail control simulation. The appearance of trains in the simulation followed a consistent but undisclosed pattern. The findings from this study suggested that there was no relationship between cue utilisation and state anxiety on task and prospective memory performance. However, the study was hampered by a small sample size. Implications for selection and training were discussed.

Keywords: Cue utilisation, rail control, state anxiety, prospective memory

The relationship between cue utilisation, state anxiety and prospective memory on performance during a novel task

Naturalistic environments are characterised by ill-structured problems, uncertainty, dynamic environments, high time pressure, high stakes, and ill-defined or competing goals (Orasanu & Connolly, 1993). Performance in naturalistic settings are dependent on rapid and accurate responses, due to the complex and dynamic situations (Ericsson & Lehmann, 1996). In order to maintain performance, expert operators utilise specialised associations that have been established through repeated exposure. These associations between environmental-specific features and events develop into cues, which become representative of similar situation-specific relations (Brunswik, 1955). The development of cues is linked to the encoding of these feature-event relationships within the cognitive architecture (Wiggins, Brouwers, Davies, & Loveday, 2014). Utilisation of cues requires the operator to recognise similar environmental features, allowing the retrieval and subsequent activation of the previously encoded feature-event associations.

The usage of cues by skilled operators has been established in the expert-novice paradigm. Expert operators are typically able to consistently discriminate between relevant and less relevant stimuli within their area of expertise, compared to their less experienced counterparts (Weiss & Shanteau, 2003). This pattern of information processing has been found in various fields, including sports (Ward & Williams, 2003) and aviation (Wiggins, Stevens, Howard, Henley, & O'Hare, 2002). Notably, this difference in discriminability and cue utilisation occurs in the absence of differences in physical capabilities or general reasoning. Rather, expert operators are distinguishable from novices through their situation assessment capabilities (Orasanu & Connolly, 1993).

Situation assessment refers to the cognitive processes involved in understanding the nature of a situation (Kaempf, Klein, Thorsden, & Wolf, 1996). Theories which explain the underlying mechanism of situation assessment, like Klein's (1993) Recognition-Primed Decision model and Anderson's (1982) Adaptive Control of Thought theory, suggest that associative learning through the use of cues underpin the process of situation assessment. These feature-event associations serve as a compensatory mechanism to reduce the amount of mental workload imposed on working memory (i.e. the cognitive load), freeing up cognitive resources for other tasks (Cooper, 1998). Hence, the usage of similar feature-event associations, such as cues, could have similar effects on working memory. Operators with a greater capability for cue utilisation are expected to be better at identifying and acquiring the key feature-event associations relevant to their tasks (Brouwers, Wiggins, Helton, O'Hare, & Griffin, 2016). The presence of these associations allows operators to anticipate and make predictions, which reduces the impact of cognitive load (Brouwers, Wiggins, Griffin, Helton, & O'Hare, 2017). This is facilitated by their ability to maintain and recall more information in working memory (Loveday, Wiggins, Harris, O'Hare, & Smith, 2012)

To determine if cue utilisation was capable of reducing the workload of a task, Brouwers et al. (2017) exposed participants to a novel, simulated rail control task, which contained both a low- and high-workload condition. Participants initially completed an assessment of cue utilisation (EXPERTise 2.0; Wiggins, Loveday, & Auton, 2015) in the context of driving. Participants subsequently completed a rail control task, which required them to periodically divert trains based on the train number and train track label. For the low-workload condition, participants completed the rail control task in isolation, while the high-workload condition had the participants complete an additional task concurrently with the rail control task. The trains in the rail control task were programmed to appear in a specific, sequential order. The diversion of the trains occurred using a set pattern, where trains on only the first and the fourth track required diversion, however, participants were not informed about the pattern.

There were significant differences in performance between participants with higher and lower levels of cue utilisation. In the higher workload condition, participants with higher levels of cue utilisation response faster and diverted the trains more accurately, compared to those with lower levels of cue utilisation. Additionally, when asked if they recognised the pattern within the rail control task, participants with higher levels of cue utilisation were 11 times more likely to report and accurately describe the pattern. This provides support for the effect of cue utilisation on workload. The presence of the pattern was presumed to allow participants to lower the workload, as it allowed participants to only divert the trains travelling on the first and fourth track, while disregarding all the other task features. By using the pattern to complete the rail control task, instead of attending on each track individually, participants with high levels of cue utilisation have minimised the impact of cognitive load on their performance. Their ability to establish and utilise feature-event relationships would have provided an opportunity to reduce cognitive demands.

On the basis that expert operators can use cues as a compensatory mechanism to increase performance in high workload scenarios, it is also important to consider the effect of cues on prospective memory performance. Prospective memory refers to an individual's ability in remembering to perform tasks at a future point in time, and it plays a role in the performance of tasks in high-risk, safety-critical fields, such as medicine (Gawande, Studdert, Orav, Brennan, & Zinner, 2003) or aviation (McDaniel & Einstein, 2007; Shorrock, 2005). For example, prospective memory failures have been associated with errors by airport area controllers in coordinating the flight path an altitude of planes (Shorrock, 2005). Shorrock documented various prospective memory failures, including failing to update details regarding flight progress, and forgetting the target altitude for aircrafts.

Typical prospective memory paradigms contain a retrospective and a prospective component. To successfully engage prospective memory processes, operators have to recall the action that was needed to be performed (the retrospective component), and actually perform the action during the appropriate time or when the event occurs (the prospective component; Katai, Maruyama, Hashimoto, & Ikeda, 2003). Both components rely on the individual's capability to encode and recall such information in long term memory (Harris & Cumming, 2003). Hence, factors that affect the retention and retrieval of information can impact on prospective memory.

While the relationship between prospective memory and cue utilisation has not been studied directly, it could be argued that the use of cues during task completion could help improve prospective memory performance. As operators with high levels of cue utilisation tend to be better at recognising, encoding and retrieving feature-event relationships, they could also be better at the retention and retrieval of prospective memory cues. Additionally, within the naturalistic decision-making paradigm, operators are required to constantly make quick decisions whilst managing other concurrent tasks using prospective memory. The usage of cues for in decision making would reduce the workload of the decision-making tasks, therefore increasing the amount of cognitive resources available for prospective memory.

It is equally important to consider the influence of state anxiety on task performance and prospective memory performance. State anxiety refers to anxiety as a mood state, or the transient anxiety that occurs during a stressful situation itself (Eysenck & Calvo, 1992). In naturalistic, high-risk environments, operators are often required to critically assess the situation, whilst under anxiety provoking situations. While it has been shown that experienced operators are typically more skilled at making fast, yet effective assessments of situations under severe time constraints, limited research has explored the influence of state anxiety on their situation assessment capabilities (Brouwers et al., 2017; Brouwers et al., 2016).

Eyseneck and Calvo's (1992) processing efficiency theory proposes a distinction between performance and processing efficiency. *Performance* efficiency refers explicitly to the quality of performance in a certain task. On the other hand, *processing* efficiency is the interaction between the level of performance and the amount of effort required to achieve it. A key proposal of processing efficiency theory is that individuals with higher levels of anxiety utilise compensatory mechanisms to maintain a similar level of performance. Hence, while the level of performance (i.e. performance efficiency) between high and low state anxiety operators might be similar, the amount of cognitive resources (i.e. processing efficiency) required to reach that level of performance is higher in operators with high state anxiety. This lowered processing efficiency can manifest through higher levels of self-reported task effort, decreased performance in concurrent secondary tasks, and a reduced overall cognitive capacity (Eysenck & Calvo, 1992). Due to the larger amount of cognitive resources consumed to maintain performance, operators with higher levels of state anxiety may experience a greater cognitive load.

The utilisation of cues has been found to reduce the cognitive load in high mental workload scenarios (Brouwers et al., 2016). Therefore, it could be argued that, during completion of tasks that impose a high mental workload, individuals with high levels of state anxiety could use domain relevant, pre-existing cue associations as a compensatory mechanism to negate the additional cognitive load from their lowered processing efficiency. However, this would only be the case if the individual had refined cue associations through their previous experiences.

Harris and Cumming (2003) conducted a study, containing a prospective memory task that was embedded within a semantic association task. At the start, participants were presented with a list of words to memorise. For the semantic association task, participants were read out a separate series of words, and were required to record a word that is similar in meaning to the words they heard (for example, if ‘zoo’ was the word provided, participants should write ‘lion’). However, for the embedded prospective memory task, when participants heard the words that were present on the memorised list, they had to write down the word itself (for example, if ‘dog’ was on the memorised list of words, participants should write ‘dog’). The study found that state anxiety was a negative predictor of prospective memory, as participants with higher levels of state anxiety failed to perform a higher proportion of the prospective memory task (Harris & Cumming, 2003).

This results from Harris and Cumming (2003) were consistent with the effect proposed by Processing Efficiency Theory, where the worry generated by state anxiety can interfere with or consume resources required for cognitive processing. However, it is important to note that Harris and Cumming utilised a typical laboratory design for their study. The current study embedded the prospective memory task within a typical driving scene.

The present study aims to understand the impact of cue utilisation, state anxiety and prospective memory on performance in a novel task. The current study is an extension of the Brouwers et al. (2017) study. Similar to Brouwers’ et al. study, the current study attempts to replicate the interaction between cue utilisation and performance in the high workload condition. However, unlike that study, the current study includes an embedded prospective memory task, and assesses participants’ levels of state anxiety.

Therefore, based on previous research in the areas of state anxiety, cue utilisation, and prospective memory (Brouwers et al., 2017; Harris & Cumming, 2003), the following hypotheses are presented:

Hypotheses: Rail Control Task Performance (Response Latency)

H1a. A main effect for cue utilisation was hypothesised, where participants with low cue utilisation will have higher response latency in the high workload condition of the rail control task, compared to those with high cue utilisation.

H1b. A main effect for state anxiety was hypothesised, where participants with higher state anxiety will have higher response latency in the high workload condition of the rail control task, compared to those with lower state anxiety.

H1c. An interaction between cue utilisation and state anxiety was hypothesised for the high workload condition of the rail control task, where mean response latency for participants with lower cue utilisation would increase as the level of state anxiety increases, to a greater degree, compared to the change in mean response latency for participants with higher cue utilisation.

Hypotheses: Rail Control Task Performance (Error Frequency)

H2a. A main effect for cue utilisation was hypothesised, where participants with low cue utilisation will have a higher frequency of errors in the high workload condition of the rail control task, compared to those with high cue utilisation.

H2b. An interaction between cue utilisation and anxiety was hypothesised for the high workload condition of the rail control task, where the frequency of errors would not differ for participants with low state anxiety. For participants with high state anxiety, participants with low cue utilisation will have a higher frequency of errors, compared to participants with high cue utilisation.

Hypotheses: Prospective Memory Performance (Accuracy)

H3a. A main effect for state anxiety was hypothesised, where participants with higher state anxiety will have lower accuracy in the prospective memory task, compared to those with lower state anxiety.

H3b. An interaction between cue utilisation and anxiety was hypothesised. State anxiety is proposed to have no impact on participants with higher levels of cue utilisation. For the lower cue utilisation group, participants with higher levels of state anxiety will have lower accuracy on the prospective memory task, compared to those with lower levels of state anxiety.

Method

Ethics Statement

This study was approved by the University of Adelaide Human Research Ethics Committee (19/42). Participants were provided with a Participant Information Sheet (Appendix B) and provided their consent (Appendix C) before commencing the study.

Participants

A total of 30 participants were recruited for this study (17 first year University students; 13 members of the general public). The majority of the sample were female (15 female, 14 males, 1 unknown), who ranged in age from 18 to 26 years (*M* = 20.86, *SD* = 2.46) with a mean of 49.66 months (*SD* = 32.07) of driving experience (range 3 to 120 months). In exchange for their participation, first year university students received course credit. Participants from the general public were not reimbursed for their time.

All participants were required to have corrected to normal vision, hold a valid Australian driver's license, and have less than 10 years driving experience. Using a cohort of 18 to 25-year-old drivers enabled comparative assessments of cue utilisation, which controls, to a limited extent, exposure to driving. Additionally, as the study investigated performance in a novel rail control task, participants were required to be naïve to rail control. While two participants had participated in another student's experiment that utilised the same simulated rail control platform as that in the current study, the rail control stimuli differed between the two experiment and thus the researcher (and supervisor) judged that these students were at no advantage and, hence their results were retained.

Study Design

This was a face-to-face lab-based study. The study comprised two factorial experimental designs. The first 2 x 3 design had two cue utilisation typologies (lower, higher) and three state anxiety typologies (low, medium, high) as the between groups factors. Participants were classified as having either lower or higher levels of cue utilisation based on an assessment of cue utilisation within the domain of driving. For state anxiety, participants were classified as having either low, medium or high state anxiety based on their scores on a state anxiety scale. The dependent variables were accuracy and response latency for high workload (Phase 2) phases of the rail control task (addressing H1a, H1b, H1c, H2a and H2b).

Similar to the first experimental design, the second 2 x 3 design had two cue utilisation typologies (lower, higher) and three state anxiety typologies (low, medium, high) as the between groups factors. The dependent variables were accuracy and response latency for the prospective memory task (addressing H2a and H2b).

Materials

Demographics.

Participants were asked to indicate their age, gender, driving experience (in months), daily driving frequency, and experience in similar situational judgement or rail control tasks (Appendix D).

EXPERTise 2.0.

Cue utilisation was assessed using the EXPERT Intensive Skills Evaluation (EXPERTise) 2.0 situational judgement task (Wiggins, Loveday, & Auton, 2015). EXPERTise 2.0 is an online, shell software platform comprising various experimental tasks which can be customised to measure participants' utilisation of cues within a specific domain. Typologies of behaviour are calculated based on performance across all tasks, to distinguish between participants with relatively higher and lower levels of cue utilisation. The validity of EXPERTise 2.0 has been established in power control (Loveday, Wiggins, Harris, et al., 2012), paediatric diagnosis (Loveday, Wiggins, Searle, Festa, & Schell, 2012) and aviation decision-making (Wiggins, Azar, Hawken, Loveday, & Newman, 2014). The test-retest reliability has been demonstrated as satisfactory (Loveday, Wiggins, Festa, Schell, & Twigg, 2013).

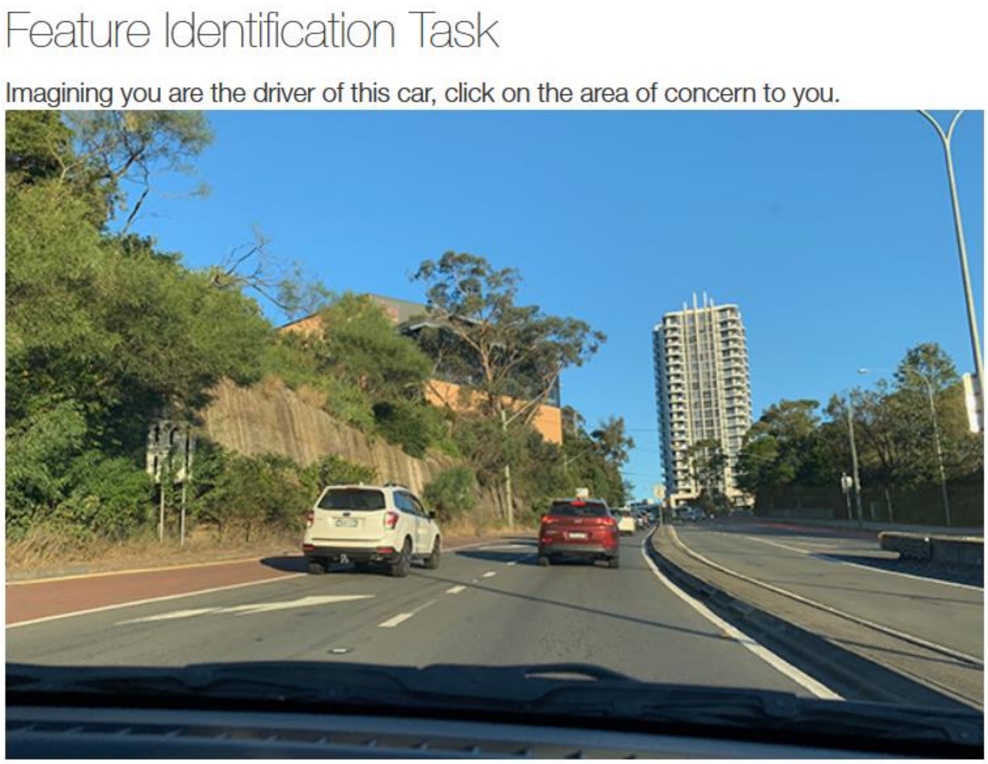
The driving 'edition' of EXPERTise 2.0 was used in this study as it assesses participants' use of cues within a driving (and hence, familiar) context. Consistent with Brouwers et al. (2016), cue utilisation in one domain can predict ability in another domain, hence the level of cue utilisation in a driving context can be used to predict performance in the novel rail control task. Within the driving edition of EXPERTise 2.0, participants were required to complete five tasks; the feature recognition task, the feature association task, the feature discrimination task, the feature identification task, and the feature prioritisation task.

The *Feature Recognition Task* assessed participants' ability to quickly extract key information from a complex scene and make and accurate judgement using that information (Shinar, McDowell, & Rockwell, 1974). Participants were shown 17 different road images, each displayed for 1000ms, and were required to estimate the speed limit for each road from four multiple choice options (50 or 60 km/hr; 70 or 80 km/hr; 90 or 100 km/hr; 110+ km/hr). Response accuracy was recorded and aggregated, and higher number of accurate judgements is presumed to correspond to higher levels of cue utilisation (Shinar et al., 1974).

During the *Feature Association Task*, participants were presented with 15 text-based domain relevant feature-event word pairs, such as 'Bus' and 'School children'. Each word pair was presented on screen simultaneously for 1500ms. After the presentation of each pair, participants were directed to a new screen where they were asked to indicate the extent to which both terms were related on a 6-point Likert scale, from 1(*Extremely Unrelated*) to 6(*Extremely Related*). Response latency and variance in ratings were captured, and scores were calculated by dividing the variance in scores by the mean reaction time. As more experienced operators are expected to possess more domain-relevant feature-event relationships in memory, they should be able to demonstrate a greater discriminability for ratings of association between pairs, compared to their less experienced counterparts (Morrison, Wiggins, Bond, & Tyler, 2009; Schvaneveldt, Beringer, & Lamonica, 2001). Hence, higher cue utilisation is presumed to be associated with a greater ratio of variance to reaction time.

During the *Feature Discrimination Task,* participants were presented with a written description of a way-finding scenario and were required to choose, from four response options, how they would progress in the given situation. Following their selection, participants were directed to a new screen where they were presented with a list of 14 features that were incorporated within the scenario (such as time of day, weather, traffic conditions), and were asked to rate how important they were during their decision making process, on a 10-point Likert scale from 1(*Not Important at all*) to 10(*Extremely Important*). The variance of each participant's ratings was aggregated to form a single discrimination metric where higher variance is presumed to be associated with greater levels of cue utilisation. This is based on the proposition that, compared to their less experienced counterparts, experienced operators are better able to discriminate consistently between features (Pauley, O'Hare, & Wiggins, 2009; Weiss & Shanteau, 2003).

The *Feature Identification Task* assessed participants' ability to extract key features from a scene, where it is presumed that operators with higher levels of cue utilisation will be faster at identifying key features from a complex scene (Loveday, Wiggins, Searle, et al., 2012; Schriver, Morrow, Wickens, & Talleur, 2008). Participants were presented with 20 images of typical road scenes, and were asked to click, as fast as possible, on potential hazards (for example, cyclists or police horses; see Figure 2 for an example scenario). Response latency was aggregated across all scenarios to calculate an overall mean response latency, and lower response latencies are presumed to be associated with higher levels of cue utilisation.

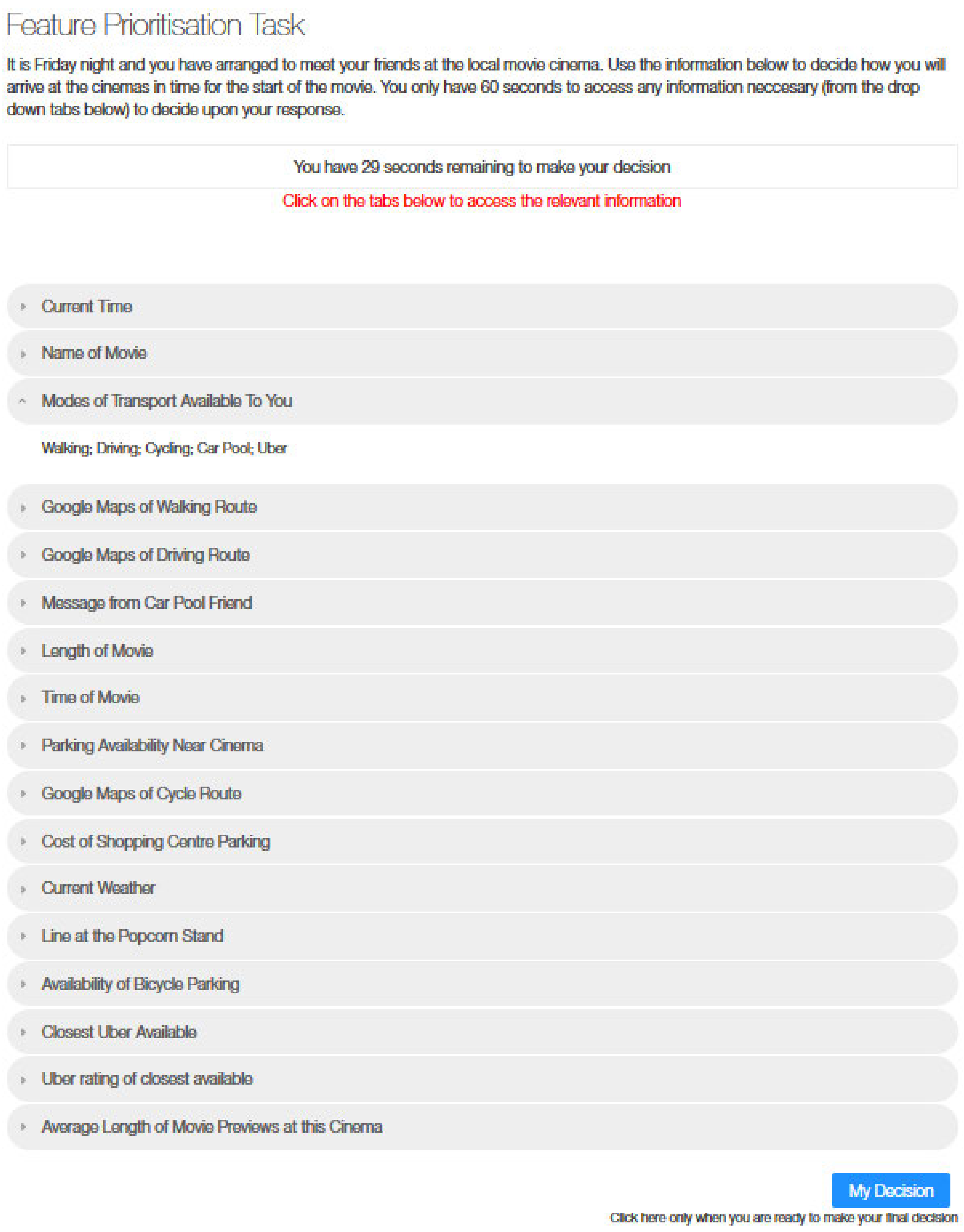


Feature Identification Task

Imagining you are the driver of this car, click on the area of concern to you.

Figure 2. Example of a Feature Identification Task scenario. Participants were required to click on the ‘area of concern’ (which in this scenario, might have been the merging white car).

The *Feature Prioritisation Task* assessed participants’ ability to acquire environmental cues in a prioritised and non-linear manner. Participants were presented a brief written scenario, where additional information could be accessed via a drop-down menu (Figure 3). Each participant had 60 seconds to access the necessary information within the drop-down menus before having to decide. As experienced operators are more likely to access information based on priority, rather than visual layout, it is assumed that participants with higher cue utilisation were more likely to access information in terms of priority, rather than sequentially (Wiggins & O'Hare, 1995; Wiggins et al., 2002). Hence, higher cue utilisation is associated with a lower ratio of drop-down menus accessed sequentially, compared to the total number of drop-down menus accessed.



Feature Prioritisation Task

It is Friday night and you have arranged to meet your friends at the local movie cinema. Use the information below to decide how you will arrive at the cinemas in time for the start of the movie. You only have 60 seconds to access any information neccesary (from the drop down tabs below) to decide upon your response.

You have 29 seconds remaining to make your decision

Click on the tabs below to access the relevant information

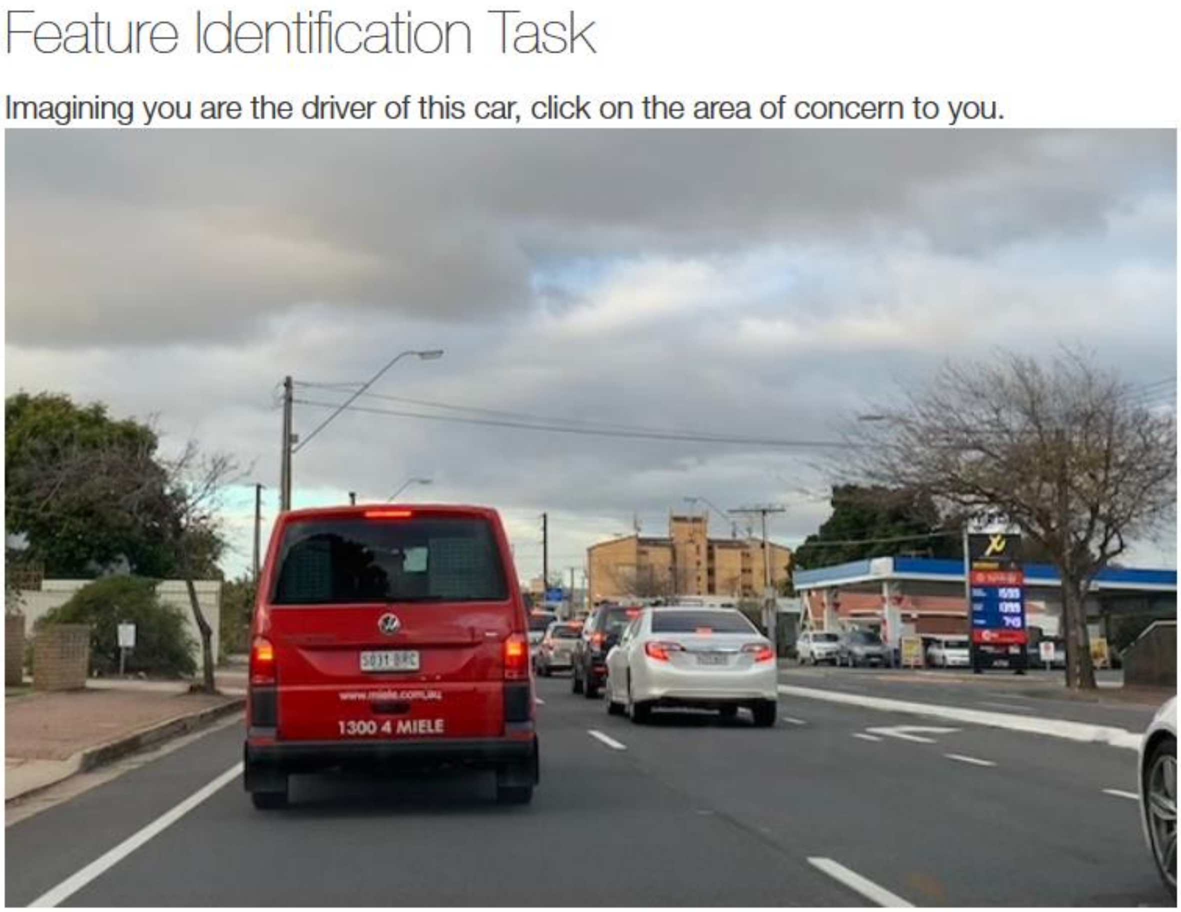
Modes of Transport Available To You: Walking; Driving; Cycling; Car Pool; Uber

Figure 3. Example of the scenario in the Feature Prioritisation Task. Participants were allowed 60 seconds to access as much information as necessary via the drop-down menus (such as the current

time, name of movie, etc.). In this example, the participant has clicked on the 'Modes of Transport Available to You' tab, which revealed further information underneath.

Prospective memory.

The prospective memory task was embedded within the EXPERTise 2.0 platform, but the measurement was completely independent from the cue utilisation measures. Before commencing any tasks in EXPERTise, participants were provided with the following instructions: '*At some stage during this experiment, you may see an image/s containing a service station (e.g., Shell, Caltex). If so, before completing the task associated with the diagram, use your mouse to click on the service station as soon as possible.'* (Figure 4). Participants were instructed to be vigilant for images containing a service station, and to click on the service station when it appeared on the computer screen. The prospective memory task itself comprised of three scenarios towards the end of EXPERTise 2.0, within the Feature Identification Task. Participants were advised to ignore any other task requirements when they saw the service station. Accuracy and response latency were captured for each of the three independent prospective memory measures.



Feature Identification Task

Imagining you are the driver of this car, click on the area of concern to you.

Figure 4. One of the three prospective memory task scenarios. To successfully complete this task, participants were required to click on the service station (located on the right side of the picture). Participants had to ignore the requirements of the Feature Identification Task and adhere to the instructions given for the prospective memory task.

Rail control task.

Similar to Brouwers et al. (2017), a simulated rail control task was used as the novel task (see Figure 5). The horizontal green lines represent railway tracks. Each track contains an intersection (the white portions on the track), which is controlled by a button labelled ‘change’. Trains are portrayed as a red horizontal bar, and each train has an assigned three-digit number (either odd or even). Each train line and its associated branch line are also assigned ‘Odd’ or ‘Even’ labels. During this task, participants were required to ensure that trains run on its corresponding line. Following the task described in Brouwers et al. (2017), 50% of the programmed routes were inconsistent with the train number (for example, the train ‘222’ was assigned to the Odd route), so participants had to use the ‘Change’ icon to reroute the train. In the figure below, for example, the train ‘555’ is moving along the first train line and is assigned to the ‘Even’ route so the participant would be expected to click on the ‘Change’ button to correctly reroute it to the ‘odd’ track (as 555 is an odd number).

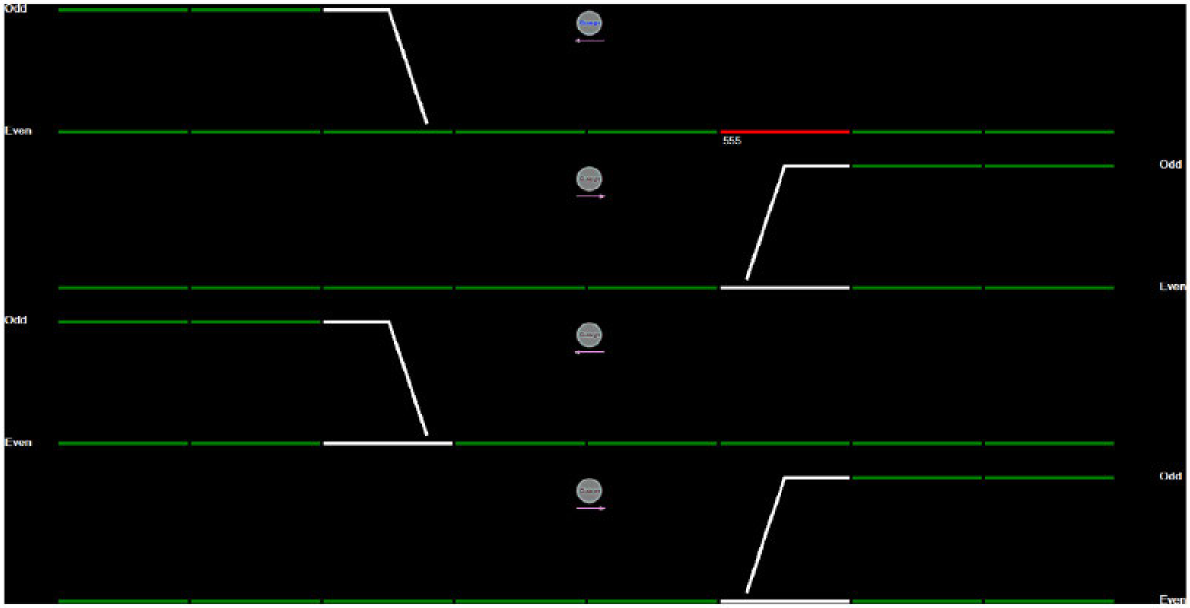


Figure 5. A screen shot of the simulated rail control task, as viewed by participants.

Each train progressed across the screen at the same speed. Trains appear on the screen every 7 seconds in a sequential order, from the uppermost to the lowermost track, and, once the train appears, participants had 7 seconds to decide the need to reroute the train before the change button became inoperatable. The rail control task was split into two phases corresponding to the two workload conditions (Phase 1 [low] and Phase 2 [high]), and 86 trains appeared during each phase, of which 43 had to be rerouted (Figure 6). For this task, participants’ response latency (in ms) and accuracy of responses was recorded.

Pattern within the rail control task.

Consistent with Brouwers et al. (2017), a pattern was embedded within both phases of the rail control task. The pattern was the same for each phase, where all trains that appeared in the uppermost and lowermost lines had to be diverted by the participant (i.e., the participant had to click on the ‘change’ button), while the trains in the middle two lines did not require diversion. At the end of Phase 2, participants were queried whether they successfully identified a pattern within the rail control task. Participants had to state that the trains appeared sequentially from the top to the bottom of the screen, or correctly identified the diversion pattern, in order to be considered as successfully recognising the pattern.

Secondary task (docking sheet).

To create a high workload condition within Phase 2, participants were required to complete a secondary task while completing the demands of the rail control task (Figure 6). This task was used previously as a secondary task in Brouwers et al. (2016) to increase the workload associated with the primary rail control task, as cue utilisation effects were only apparent in high workload conditions. Brouwers et al. hypothesized this was the case because the experimental phases were not counterbalanced, as the intention of Phase 1 was for participants to familiarise themselves with the constraints of the task which also provided them the opportunity of ‘picking up’ on the pattern. However, participants themselves were not made aware of the pattern. The secondary task was in the form of a ‘docking sheet’ (Appendix C), where participants filled in the train number and the time at which the train arrived, according to a clock located under the screen.

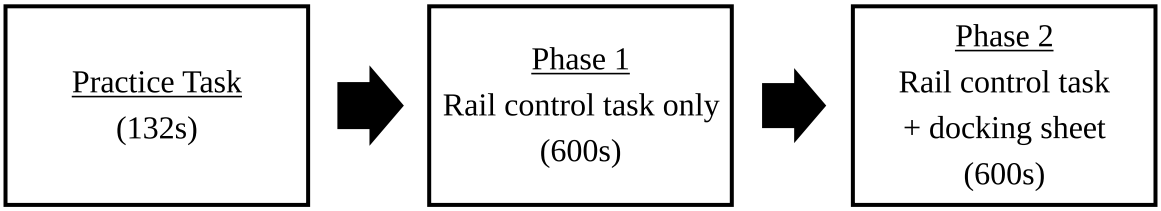


Figure 6. Experimental diagram for the rail control task.

Subjective workload.

Subjective workload was measured using the NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988). The NASA-TLX comprises six subscales, which measure mental, physical and temporal demands, as well as performance, effort and frustration, and higher overall scores correspond to higher levels of subjective workload. The NASA-TLX has good internal consistency ($\alpha > .80$) and test-retest reliability (.52 to .75; Xiao, Wang, Wang, & Lan, 2005). Participants completed this pen-and-paper version of the NASA-TLX twice: once after Phase 1 of the rail control task, and again after Phase 2, as a manipulation check.

State anxiety.

State anxiety was measured using the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The state anxiety section of the questionnaire consisted of 20 items rated on a 4-point Likert scale, from 1*(almost never)* to 4*(almost always)*, and half the items were reverse scored. State anxiety levels were calculating as the sum of ratings, and higher scores signifying higher levels of state or trait anxiety. The scale has considerable evidence towards construct and convergent validity (Spielberger, 1989). Test-retest reliability over a 2-month interval ranged from .65 to .75 (Spielberger et al., 1983).

Procedure

Participants competed an online demographics questionnaire, then progressed through the five EXPERTise tasks, including the embedded prospective memory task within one of the

EXPERTise tasks (Feature Identification Task). Participants then completed the STAI, and finally completed both phases of the rail control task.

For the rail control task, participants were provided with printed copies of the task instructions and completed a 5-minute practice session to familiarise themselves with the base task demands. Once participants indicated that they understood the instructions, the first phase of the rail control task commenced. After completion of the first phase, the task was paused by the researcher, and participants completed the NASA-TLX using paper and pen. At this point, participants were also provided with the docking sheet and further instructions for the secondary task. Phase 2 of the task commenced, and participants simultaneously diverted the trains and performed the secondary task. After another 10 minutes, the task concluded, and participants completed the NASA-TX again. Once participants finished all the tasks, participants were asked: “Did you notice a pattern in the rail task?”, and their answers were recorded verbatim.

Results

Data Screening

Data was screened prior to analysis to check for missing data. Due to an EXPERTise 2.0 software error, the demographic data was not recorded for one participant (and hence, this participant is not represented in the demographic and survey results); however, as the error did not affect the EXPERTise 2.0 data, the participant was still included to create the cue utilisation typologies. There was no other missing data.

Data Reduction

Driving experience.

Participants were asked to indicate the number of hours they typically engaged in driving per week. As participants were presented with this question in the form of a multiple-choice question with a set amount of ranges, the answers were recoded into a numerical value. If participants indicated that they drove for ‘less than 5 hours’ weekly, this was recoded as 2.5 hours; ‘between 5 to 10 hours’ was recoded as 7.5 hours, ‘between 10 to 15 hours’ was recoded as 12.5 hours, and ‘between 15 to 20 hours’ was recoded as 17.5 hours.

EXPERTise 2.0.

Data from EXPERTise 2.0 was reduced using a method consistent with the standard approach to EXPERTise data (Brouwers et al., 2016; Loveday, Wiggins, Harris, et al., 2012). For the Feature Recognition Task, the total number of accurate answers was summed across all 17 scenarios. For the Feature Association Task, the response latency and subjective rating of each feature-event pair was averaged across all 17 scenarios. A ratio score was then calculated for each participant by dividing mean variance by mean response latency. For the Feature Discrimination Task, participants were required to rate the subjective importance of 14 items on a 10-point Likert scale from 1*(Not important at all)* to 10*(Very important)*, and the variance of the responses was calculated for each participant. For the Feature Identification task, the mean response latency was calculated across all 17 scenarios, *excluding* the prospective memory scenarios. Finally, for the Feature Prioritisation Task, the order in which participants accessed features via the drop-down menus was recorded. The ratio of sequential feature pairs accessed compared to the total number of pairs access was calculated for each participant.

Rail control task.

For the rail control task, participants’ error rate and response latency were recorded. The number of errors committed in Phase 2 were aggregated individually for each participant to create the summed error rate. Consistent with Brouwers et al. (2017), an error was defined as rerouting a train from its correct path (false alarm) or failing to reroute a train when required (a miss).

Response latency was calculated from the initial appearance of the train on the screen to the moment when participants selected the ‘change’ button. The mean response latency in each phase was calculated for each participant using correct responses only.

Docking sheet.

Performance on the docking sheet (the secondary task during Phase 2) was analysed individually for each participant. Errors in the docking sheet was defined as incomplete responses, and the errors were aggregated for each participant. Across all participants, the number of errors in the docking sheet ranged from 0 to 55 (*M* = 13.17, *SD* = 16.28).

Subjective workload.

Data for the NASA-TLX was reduced in accordance to Hart and Staveland (1988). The NASA-TLX comprises six dimensions, namely mental demand, physical demand, temporal demand, subjective performance, effort and frustration. Each dimension was scored on a 7-point Likert scale, with scores for the ‘mental demand’, ‘physical demand’, ‘temporal demand’ and ‘frustration’ dimensions ranging from 1*(low)* to 7*(high)*. Scores for the ‘effort’ dimension ranged from 1*(not very hard)* to 7*(very hard)*. Scores for the ‘subjective performance’ dimension was reverse scored, with scores ranging from 1*(not successful)* to 7*(successful)* instead. Participants were asked to complete the NASA TLX after both Phase 1 and Phase 2 of the Rail Control Task, where a mean score was calculated to form a measure of subjective workload for each phase.

State anxiety.

Ratings captured in the STAI was reduced in accordance with Spielberger et al. (1983). For the state anxiety dimension, participants responded on a 4-point Likert scale, with scores ranging from 1*(not at all)* to 4*(very much so)*. Certain items were reverse scored in accordance to Spielberger et al. (1983), so that higher scores corresponded to higher levels of state anxiety. The total score for each participant was aggregated, and scores ranged from 20 to 72 (*M* = 35.69, *SD* = 10.66). To create the state anxiety typology, a tertile split on the ranked state anxiety scores was used to separate participants into low, medium and high state anxiety typologies, similar to Harris and Cumming (2003). Those with scores of 21-30 were placed in the low state anxiety group (*N* = 9), 31-37 in the medium state anxiety group (*N* = 10), and 38 to 72 in the high state anxiety group (*N* = 10).

Prospective memory.

For the prospective memory task, accuracy and response latency was retrieved from the three prospective memory scenarios embedded within the Feature Identification Task. For accuracy, participants were scored ‘1’ if they succeeded in clicking within a specified radius of the petrol station in the driving scene and were scored ‘0’ if they did not. Accuracy was summed over all three prospective memory tasks. Mean response latency was calculated using the response latency of correct responses only. If the participant did not complete any prospective memory task accurately, they did not receive a response latency for this measure.

Preliminary data analysis indicated that response latency was unable to be used as a dependent variable, as insufficient data was collected for analysis. Of the 17 participants who successfully performed the prospective memory task, 10 participants only answer a single task correctly, and so did not provide sufficient data points to calculate a true mean.

Manipulation Check

Docking sheet.

As the data did not have a normal distribution, Spearman’s Rank-Order Correlation was used to determine the relationship between the number of incomplete responses in the secondary task and the rail control task errors in Phase 2. There was a positive relationship between both variables (Spearman's *r* = .55, *p* = .002), indicating that more incomplete responses in the docking sheets was associated with an increase in errors in the rail control task during phase 2. This suggests that the secondary task was successful in increasing the workload during the second phase of the rail control task.

Subjective workload.

A repeated measures t-test was used to determine if the secondary task was successful in increasing perceived workload in Phase 2 as captured by NASA TLX ratings. Results indicated that participants rated the workload in Phase 2 as significantly higher (*M* = 5.03, *SD* = .73) compared to Phase 1 (*M* = 2.92, *SD* = .90), *t*(28) = 13.55, *p* < .001, suggesting that the Phase 2 was rated as having a higher workload compared to Phase 1.

Cue Utilisation Typology

To identify whether participants could be categorised into clear typologies representing distinct levels of cue utilisation based on performance during the five EXPERTise 2.0 tasks, a *K*-means cluster analysis was conducted. This is consistent with the standard approach to assessing cue utilisation (Brouwers et al., 2017; Wiggins, Azar, et al., 2014). Before the cluster analysis could be performed, *z*-scores were computed for the each of the cue utilisation tasks. The cluster analysis yielded two distinct typologies that represented relatively higher and lower levels of cue utilisation. Cluster 1 contained 21 participants who recorded a relatively lower response latency in the Feature Identification Task, higher accuracy in the Feature Recognition Task, higher rating variance over response latency in the Feature Association Task, and higher rating variance in the feature discrimination task. The scores in the Feature Prioritisation task did not fall under the expected centroids, with the high cue utilisation group having higher (instead of lower) sequential selections in the Feature Prioritisation Task (Table 1). Collectively, this pattern of performance (excluding the performance in the FPT) is consistent with participants who have a higher capacity for cue utilisation while assessing and responding to domain relevant tasks. Cluster 2 comprised 21 participants who demonstrated the opposite pattern of results, performance which is consistent with a lesser level of cue utilisation. These two typologies formed the basis of subsequent analyses. Table 1 summarises the results of the cluster analysis, including the mean centroid for each cluster on each of the variables that comprise EXPERTise 2.0.

Table 1

Cluster centroids for cue utilisation typology.

	Typology	
EXPERTise 2.0 task	Lesser (n=9)	Greater (n=21)
Feature Identification Task	.88	-.38
Feature Recognition Task	-.86	.37
Feature Association Task	-.12	.05
Feature Discrimination Task	-.41	.17
Feature Prioritisation Task	-.46	.20

A series of analyses were conducted to ensure gender, age and the level of driving experience were not related to cue utilisation typology. A chi-squared test indicated that cue utilisation typology was not related to gender, X^2 (2, N = 30) = 1.63, p = .44. An independent samples t-test also did not find any significant relationship for age, t(29) = 0.039, p = .97, or driving experience, t(29) = 0.61, p = .55 with cue utilisation typology membership.

Rail Control Task Performance

Response latency (H1a, H1b, H1c).

To investigate the relationship between state anxiety and cue utilisation on response latency as specified in H1a, H1b, and H1c, a 2 x 3 analyses of variance (ANOVA) was undertaken, with the cue utilisation group (lesser, greater) and state anxiety typology (low, medium and high) as the between-groups variables, and response latency in Phase 2 (high workload) of the rail control task as the dependent variable. There was no main effect for cue utilisation, *F*(1, 27) = 0.007, *p* = .94, suggesting that there was no difference in the response latency of participants with low (*M* = 4070, *SD* = 1467) or high levels of cue utilisation (*M* = 3818, *SD* = 1269), therefore, H1a was not supported. There was also no main effect for state anxiety, *F*(2, 26) = 0.15, *p* = .94, suggesting there was no difference in the response latency of participants with low (*M* = 4148, *SD* = 1186), medium (*M* = 3947, *SD* = 1595) or high levels of state anxiety (*M* = 3645, *SD* = 1261), hence H1b was not supported. A statistically significant interaction was not present between cue utilisation and state anxiety, *F*(1, 27) = 0.93, *p* = .34 (Figure 7). This did not provide support for H1c.

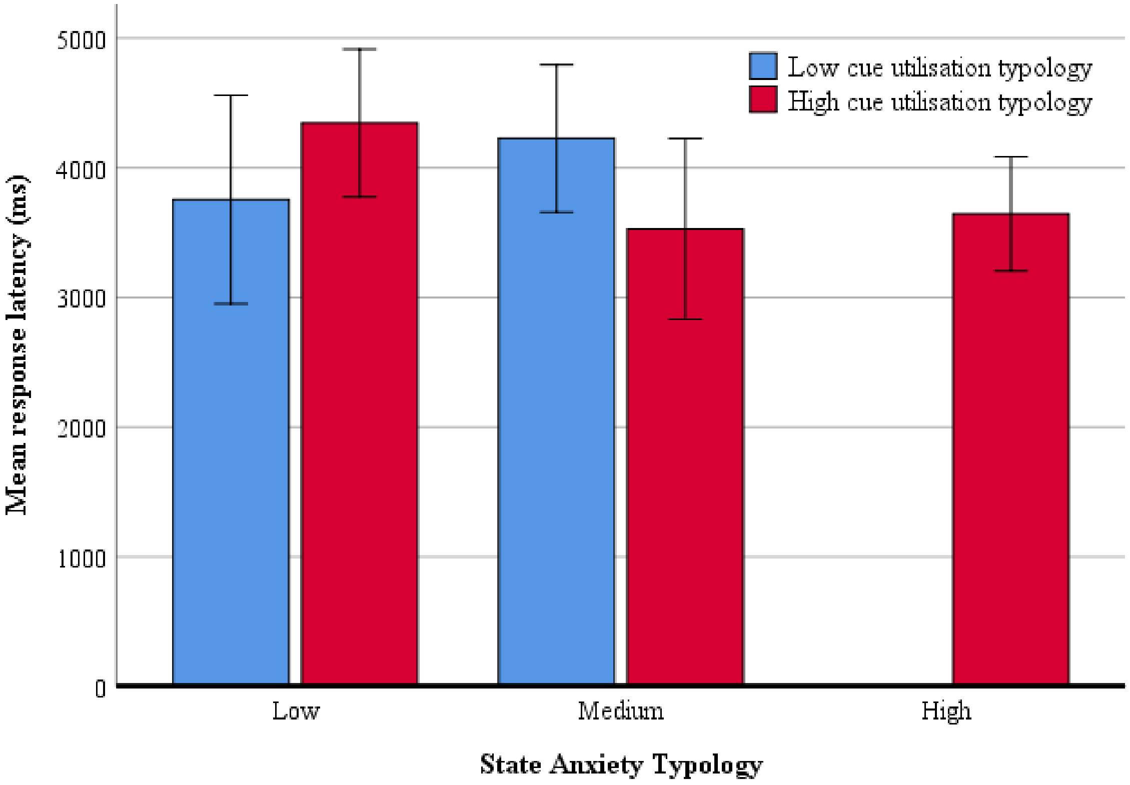


Figure 7. Mean rail control task response latencies by cue utilisation and state anxiety typologies. Error bars represent ±1 SE. There were no participants that fell into the low cue utilisation and high state anxiety typology.

Error frequency (H2a, H2b).

A 2 x 3 ANOVA was undertaken to investigate the impact of cue utilisation and state anxiety on the rail control task error frequency, as specified in H2a and H2b. The cue utilisation group (low and high) and state anxiety typology (low, medium and high) were the between-groups variables, and error frequency in Phase 2 of the rail control task was the dependent variable. There was no main effect for cue utilisation, *F*(1, 27) = 2.62, *p* = .12, suggesting that there was no difference in the error frequency between participants with low (*M* = 9.44, *SD* = 10.39) or high levels of cue utilisation (*M* = 6.33, *SD* = 4.72), therefore H2a was not supported. However, while a statistically significant interaction was evident between cue utilisation and state anxiety, *F*(1, 27) = 5.69, *p* = .03, simple main effect analysis showed that, when looking at the low cue utilisation typology, participants with low levels of state anxiety (*M* = 18.00, *SD* = 15.72) had a higher error frequency than those with medium levels of state anxiety (*M* = 5.17, *SD* = 2.86), but the difference did not reach significance (*p* = .07). There was no difference in error frequencies within the high cue utilisation typology (Figure 8). Therefore, H2c was also not supported.

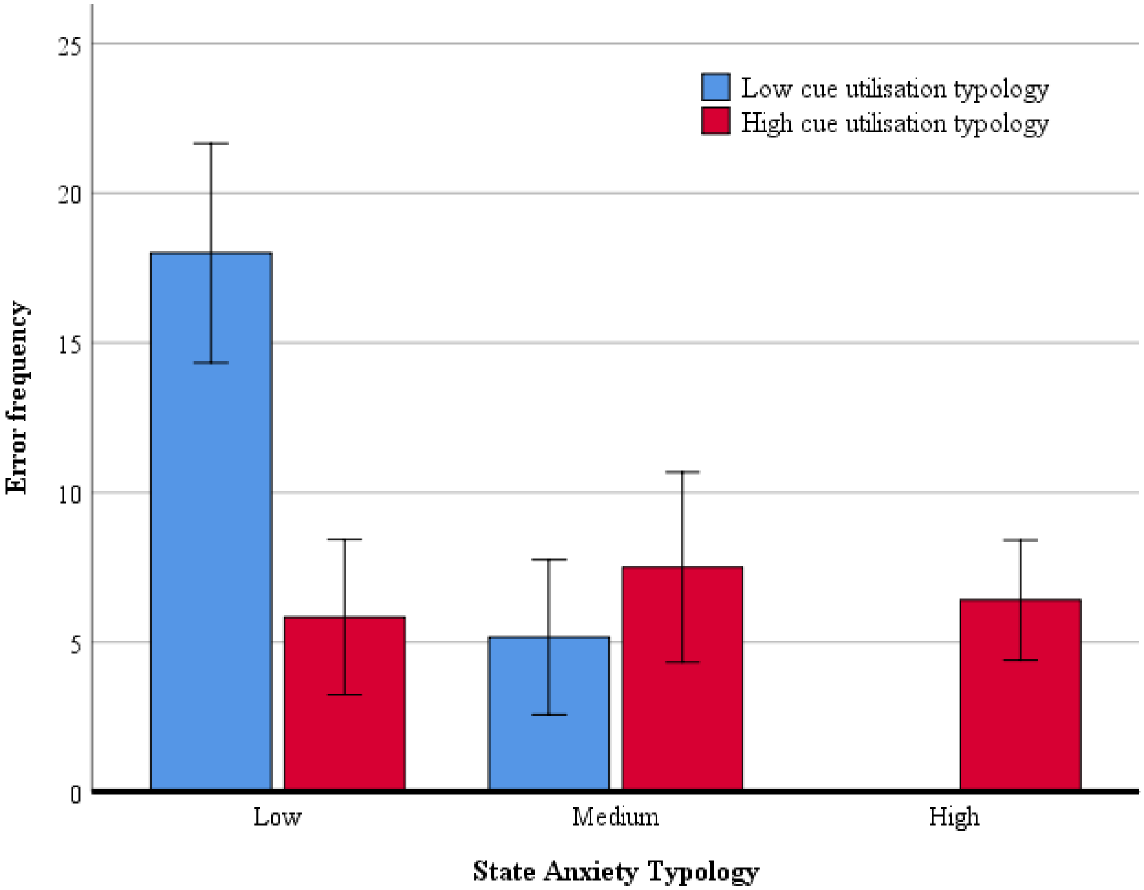


Figure 8. Error frequency by cue utilisation and state anxiety typologies. Error bars represent ±1 SE. There were no participants that fell into the low cue utilisation and high state anxiety typology.

Prospective Memory Performance

Accuracy (H3a, H3b).

A 2 x 3 ANOVA was undertaken to investigate the relationship between cue utilisation and state anxiety on accuracy in the prospective memory task, with the cue utilisation typology (low and high) and state anxiety typology (low, medium and high) as the between-groups variables, and the accuracy of the responses as the dependent variable. There was no main effect for cue utilisation, $F(1, 27) = 1.73$, $p = .20$, suggesting that there was no difference in the accuracy of participants with low ($M = 1.00$, $SD = 1.00$) or high levels of cue utilisation ($M = 0.86$, $SD = 1.01$).

Hence, H3a was not supported. No interaction was evident between cue utilisation and state anxiety, *F*(1, 27) = 2.22, *p* = .15. (Figure 9), therefore, H3b was also not supported.

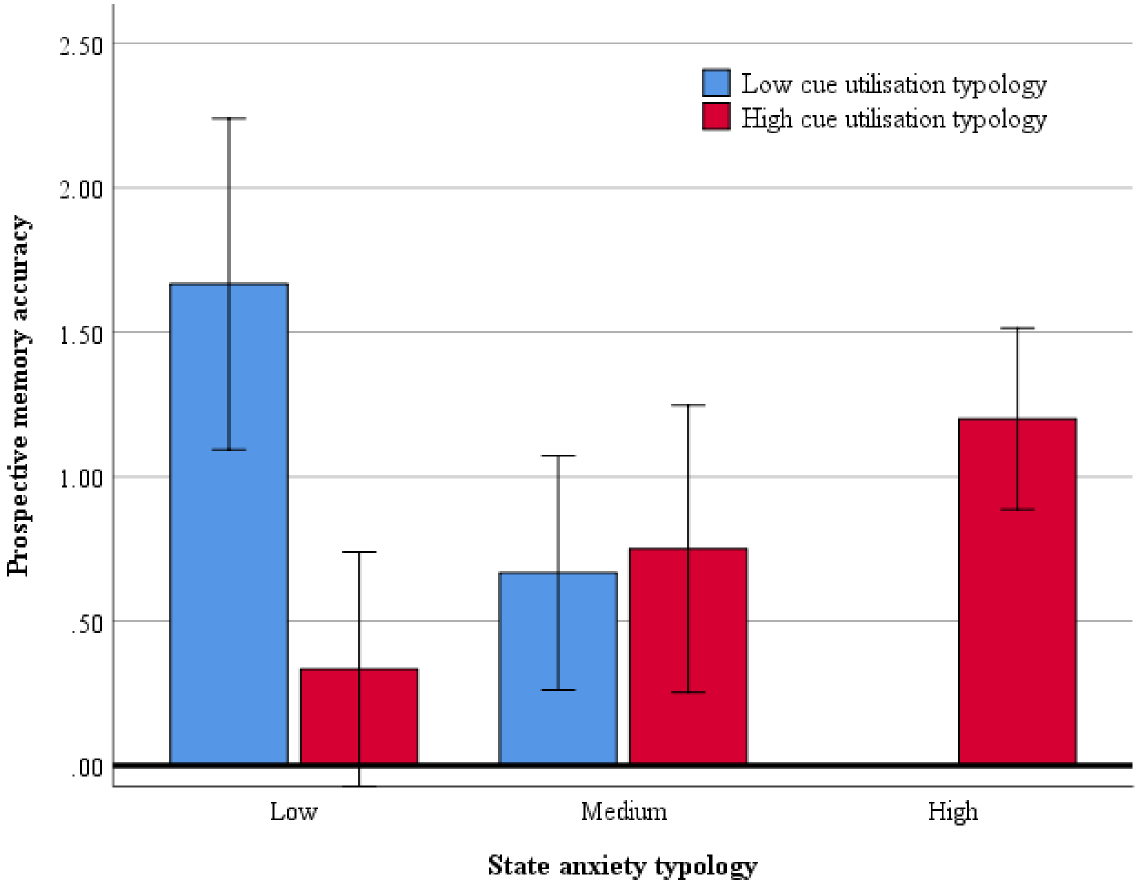


Figure 9. Accuracy in the prospective memory task by cue utilisation and state anxiety typologies. Error bars represent ±1 SE. There were no participants that fell into the low cue utilisation and high state anxiety typology.

Discussion

The current study aimed to examine the relationship between cue utilisation and state anxiety on two separate tasks: A novel rail control task and a prospective memory task. Participants completed the driving battery of EXPERTise 2.0, which assesses participants levels of cue utilisation within a driving (and hence familiar) context (Brouwers et al., 2016). Participants also completed a series of prospective memory tasks (which were embedded within EXPERTise 2.0) and the state anxiety section of the State-Trait Anxiety Inventory. Finally, participants completed a novel, rail control task, initially in the absence of any other tasks (Phase 1; low workload condition), then simultaneously with a second task (Phase 2; high workload condition). The inclusion of the secondary task, in Phase 2, was to increase the workload associated with the primary rail control task, as cue utilisation effects were only apparent in high workload conditions (Brouwers et al., 2016).

Scores on EXPERTise 2.0 clustered participants into two typologies, which reflected relatively lower and higher levels of cue utilisation (Brouwers et al., 2016; Loveday, Wiggins, Harris, et al., 2012). Similarly, participants were split into low, medium and high state anxiety typologies, based on their level of state anxiety. It was expected that performance on the rail control and prospective memory task were influenced by participants' levels of cue utilisation and state anxiety.

For the high workload scenario in the rail control task, it was hypothesised that participants with low cue utilisation would demonstrate higher *response latency* when diverting the trains, compared to those with high cue utilisation (H1a). Similarly, it was hypothesised that participants with higher state anxiety would have higher response latency as well, compared to those with lower state anxiety (H1b). An interaction between cue utilisation and anxiety was hypothesised, where mean response latency for participants with lower cue utilisation would increase as the level of state anxiety increases, to a greater degree, compared to the change in mean response latency for participants with higher cue utilisation (H1c). However, none of the hypotheses were supported, as response latency in the rail control task was not influenced by cue utilisation, state anxiety, or the interaction between cue utilisation and state anxiety.

Similarly, it was hypothesised that participants with low cue utilisation would have higher frequency of errors when diverting trains in the rail control task, compared to those with high cue utilisation (H2a). This hypothesis was not supported, as there was no difference in error rates between the two cue utilisation typologies. An interaction between cue utilisation and anxiety was also hypothesised, where the frequency of errors would not differ for participants with low state anxiety. For participants with high state anxiety, participants with low cue utilisation was proposed to have a higher frequency of errors, compared to participants with high cue utilisation (H2b). This hypothesis was not supported, as results indicated a lack of significant relationships.

This pattern of results in error frequency, for the rail control task, could have resulted from the motivational effects of anxiety, as proposed by Processing Efficiency Theory and Eysenck, Derakshan, Santos, & Calvo's (2007) Attentional Control Theory. Although anxiety consumes working memory capacity, individuals with high levels of anxiety can still compensate for this deficit, by applying more effort towards achieving task goals (Hayes, MacLeod, & Hammond, 2009). Hence, even though participants with low cue utilisation were less likely to utilise the cues, those with higher levels of state anxiety may have applied extra effort, which enabled them to reach comparable performance with the participants who had high cue utilisation. However, the previous set of hypotheses established that there were no significant differences in response latency. Hence, even with the secondary task, the overall task workload may have been insufficient in raising the cognitive load. Processing Efficiency Theory proposes that anxiety can reduce the processing capability, however, with the lack of difference in response latency, this implied that, while participants self-reported Phase 2 as having a higher workload than Phase 1, the 'high' workload condition still failed in making participants reach their cognitive capacity (Eysenck &

Calvo, 1992). Nevertheless, the results must still be interpreted cautiously due to the small sample, since the low cue utilisation typology contained only 9 participants.

The pattern of results reported for error frequency and response latency in cue utilisation was not consistent with those reported by Brouwers et al. (2017). Brouwers et al. reported that higher levels of cue utilisation were associated with lower mean response latencies and a lower error frequency in the high workload scenario of a rail control task. However, the current study did not find any significant relationship between cue utilisation and performance (response latency and error frequency) within a rail control task with a similar workload. This is most likely due to the sample size of the current study. Compared to the 61 participants recruited by Brouwers et al., the current study only recruited 30 participants, due to challenges in recruitment. Especially with the two-factor study design, the current study sample was most likely insufficient for producing significant results.

For the prospective memory task, it was hypothesised that participants with higher levels of state anxiety would have lower accuracy in the prospective memory task, compared to those with lower state anxiety (H3a). For the low cue utilisation group, participants with higher levels of state anxiety would have lower accuracy on the prospective memory task, compared to those with lower levels of state anxiety (H3b). Nevertheless, there was no significant effect for state anxiety, or the interaction between cue utilisation and state anxiety.

Processing Efficiency Theory proposes a mechanism that explains the lack of a significant interaction, as it states that the negative effects of state anxiety on performance only emerge under situations of high cognitive load (Eysenck & Calvo, 1992). When under a low cognitive load, operators are able to use compensatory mechanisms to maintain similar levels of performance. In the current study, the subjective workload of the prospective memory task was not evaluated.

Hence, it was possible that the prospective memory task did not incur a significant enough cognitive load to produce the deleterious effects of state anxiety on performance. Additionally, the study was also unable to evaluate the presence of potential compensatory mechanisms. One potential method used to maintain performance, when experience high levels of state anxiety, is through increasing the response latency. While response latency for the prospective memory task was recorded, the sample size collected was not sufficiently large to perform data analysis.

Limitations

As stated earlier, the main limitation in this study is the small study sample. The majority of analyses were conducted using a 2 (cue utilisation) x 3 (state anxiety) factorial design, and there were insufficient numbers in some of the typologies to perform data analyses. Additionally, none of the participants fell under the low cue utilisation and high state anxiety typology, making it hard to draw conclusions from the analyses.

Implications

Overall, the results of the present study did not support the results of Brouwers et al. (2017) or Cumming and Harris (2001). Contrary to their conclusions, the present study did not identify any relationship between cue utilisation, state anxiety and prospective memory.

In practice, future research into this area presents opportunities in the recruitment space, especially for high-risk, high-pressure roles. With the knowledge of how cue utilisation and state anxiety interact, recruiters might be better able to select applicants who are more suited for those roles. Additionally, the outcome might assist in identifying employees who require further training, to provide strategies for enhancing cue utilisation to minimise their cognitive load. In order to minimise potential negative impacts of anxiety on performance, training interventions could be designed to provide compensatory strategies, to reduce the impact of state anxiety on working memory.

Future Research

Due to the nature of the study design, future research should recruit a larger participants base. This would enable more reliable conclusions to be drawn from the data. In conclusion, the present study aimed to examine the relationship between cue utilisation, state anxiety and prospective memory in a novel task. However, the study sample was insufficient to conclusively determine the nature of the relationship.

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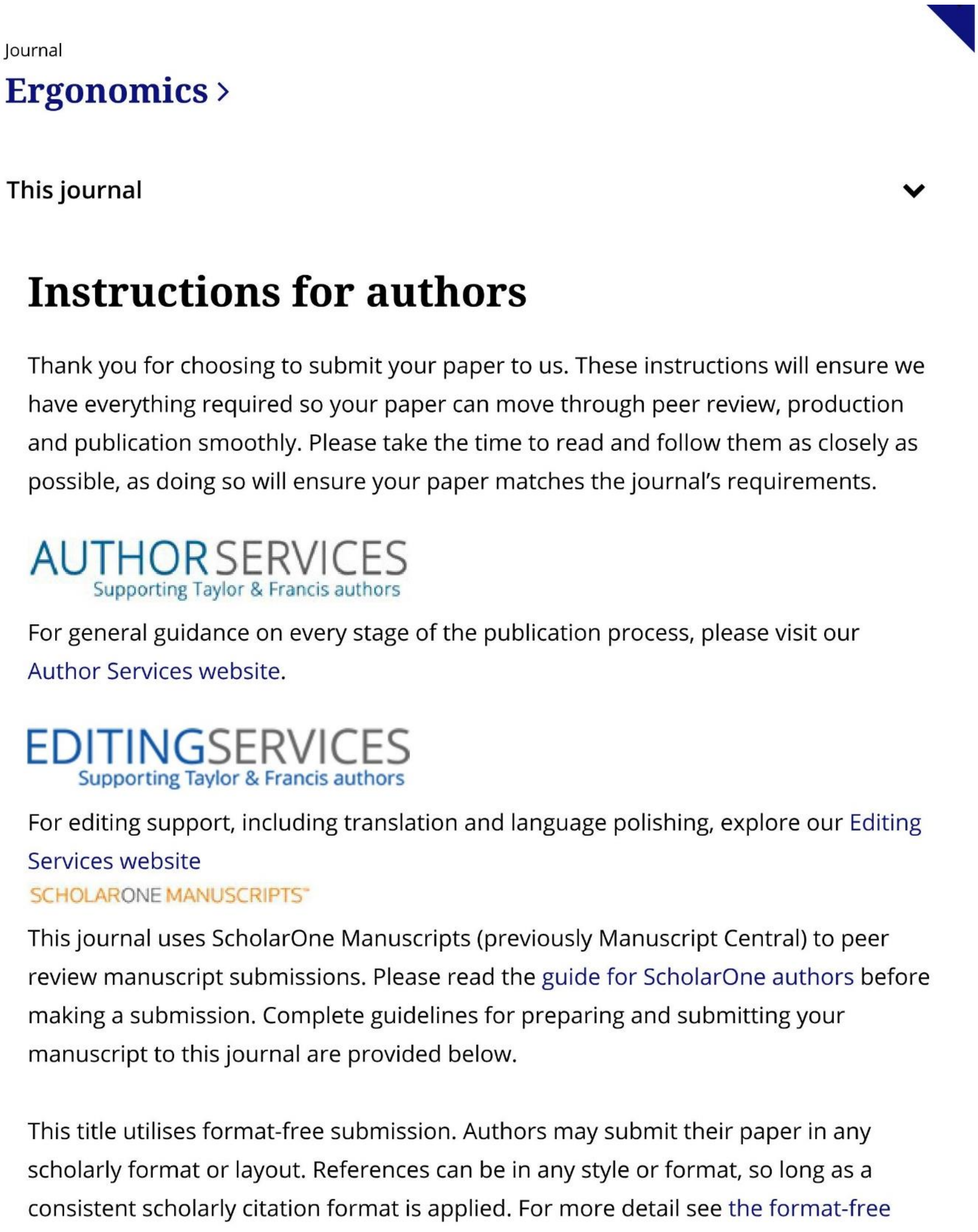
Appendices

Appendix A: Submission Specifications for Ergonomics



Journal

Ergonomics ›

This journal

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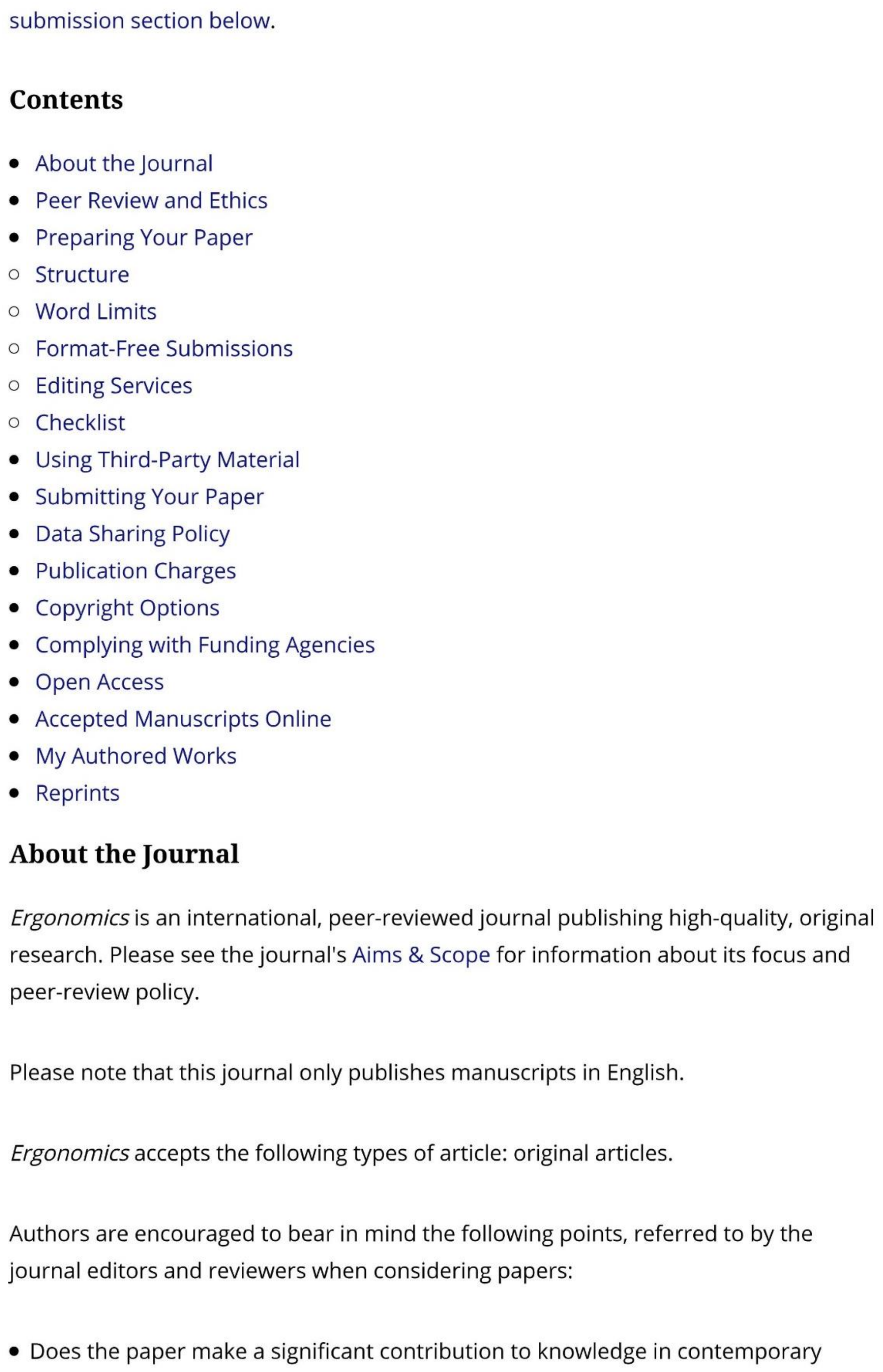

submission section below.

Contents

About the Journal

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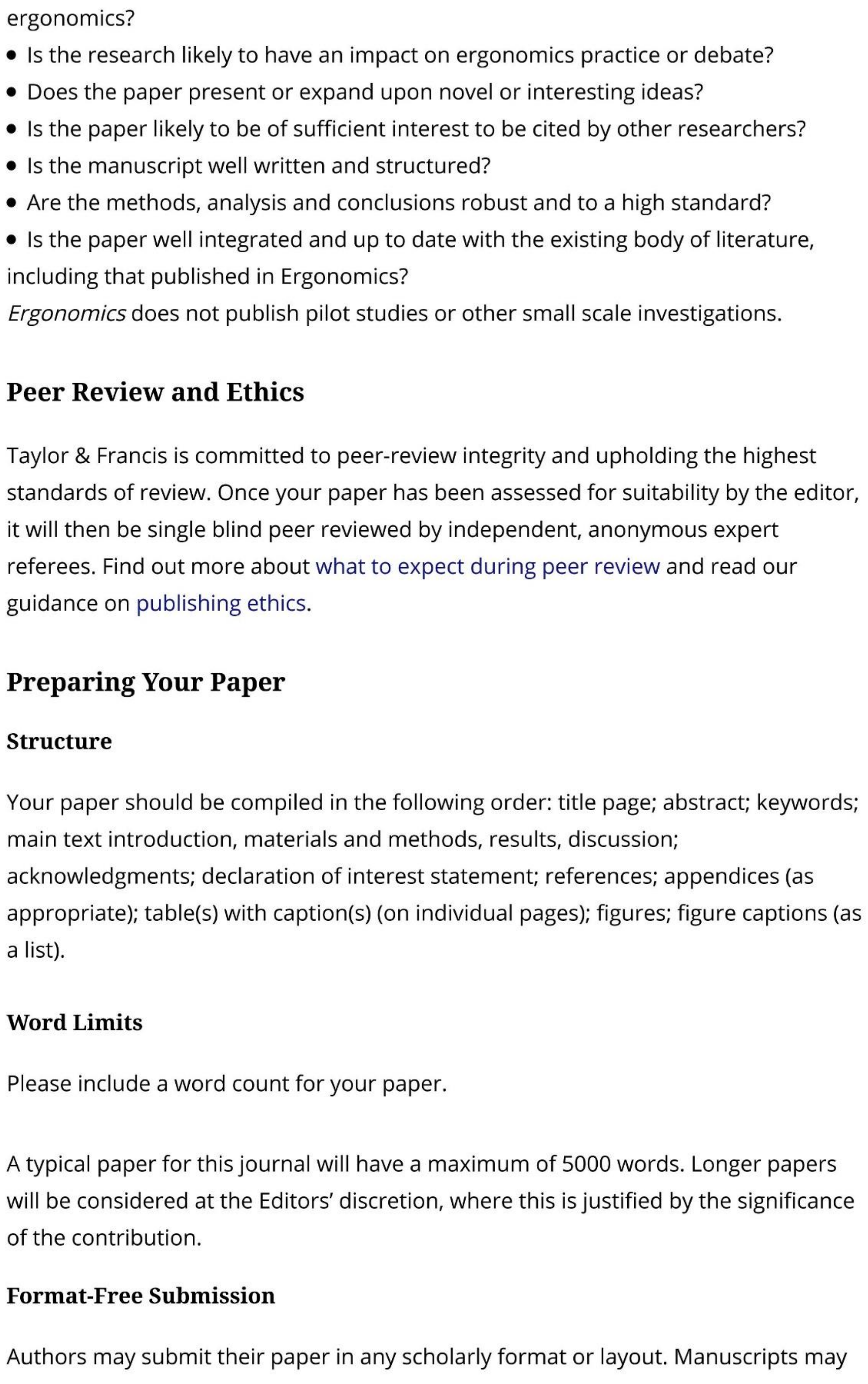

ergonomics?

- Is the research likely to have an impact on ergonomics practice or debate?
- Does the paper present or expand upon novel or interesting ideas?
- Is the paper likely to be of sufficient interest to be cited by other researchers?
- Is the manuscript well written and structured?
- Are the methods, analysis and conclusions robust and to a high standard?
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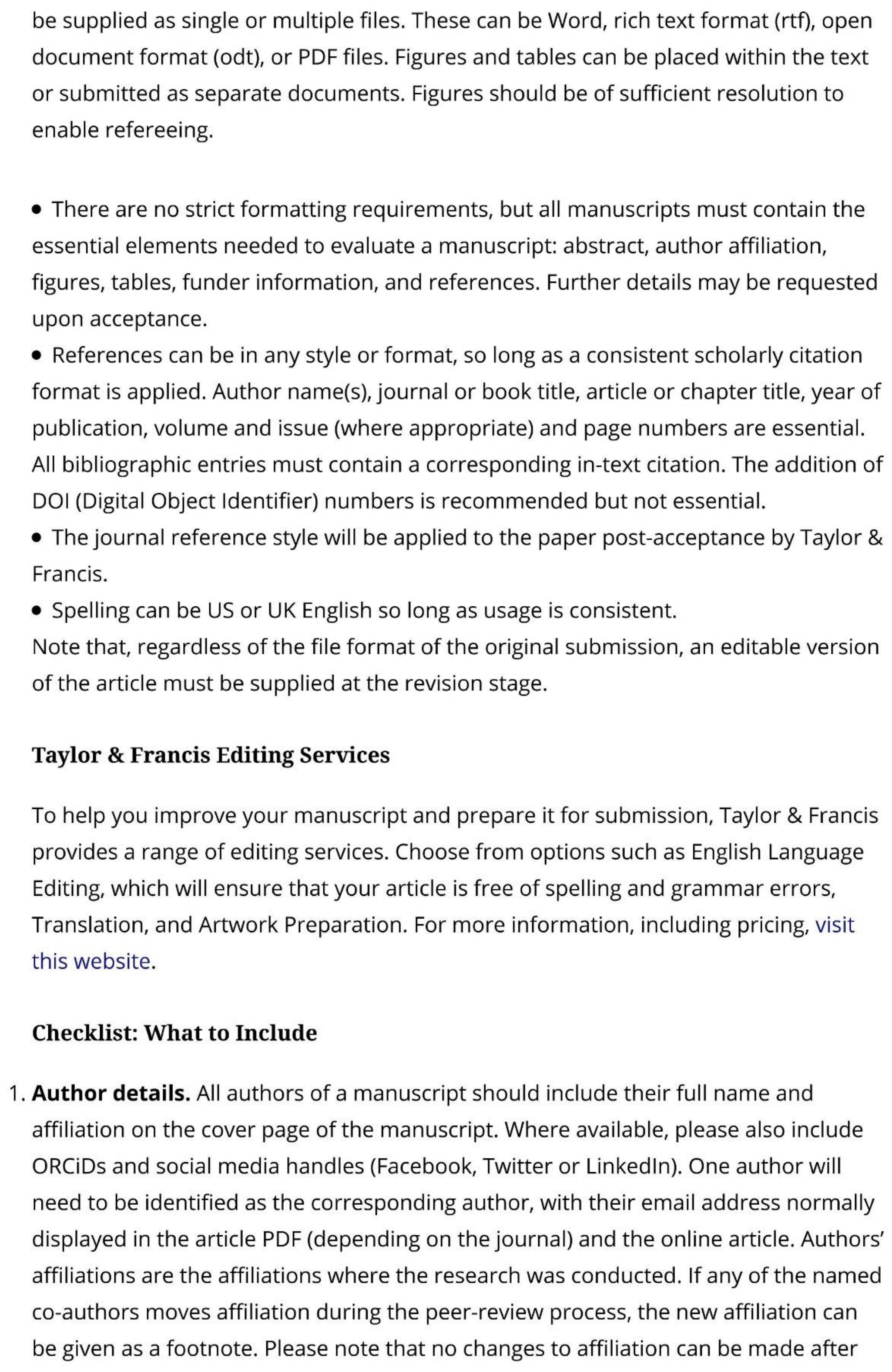

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2. Should contain an unstructured abstract of 150 words.
3. **Graphical abstract** (optional). This is an image to give readers a clear idea of the content of your article. It should be a maximum width of 525 pixels. If your image is narrower than 525 pixels, please place it on a white background 525 pixels wide to ensure the dimensions are maintained. Save the graphical abstract as a .jpg, .png, or .tiff. Please do not embed it in the manuscript file but save it as a separate file, labelled GraphicalAbstract1.
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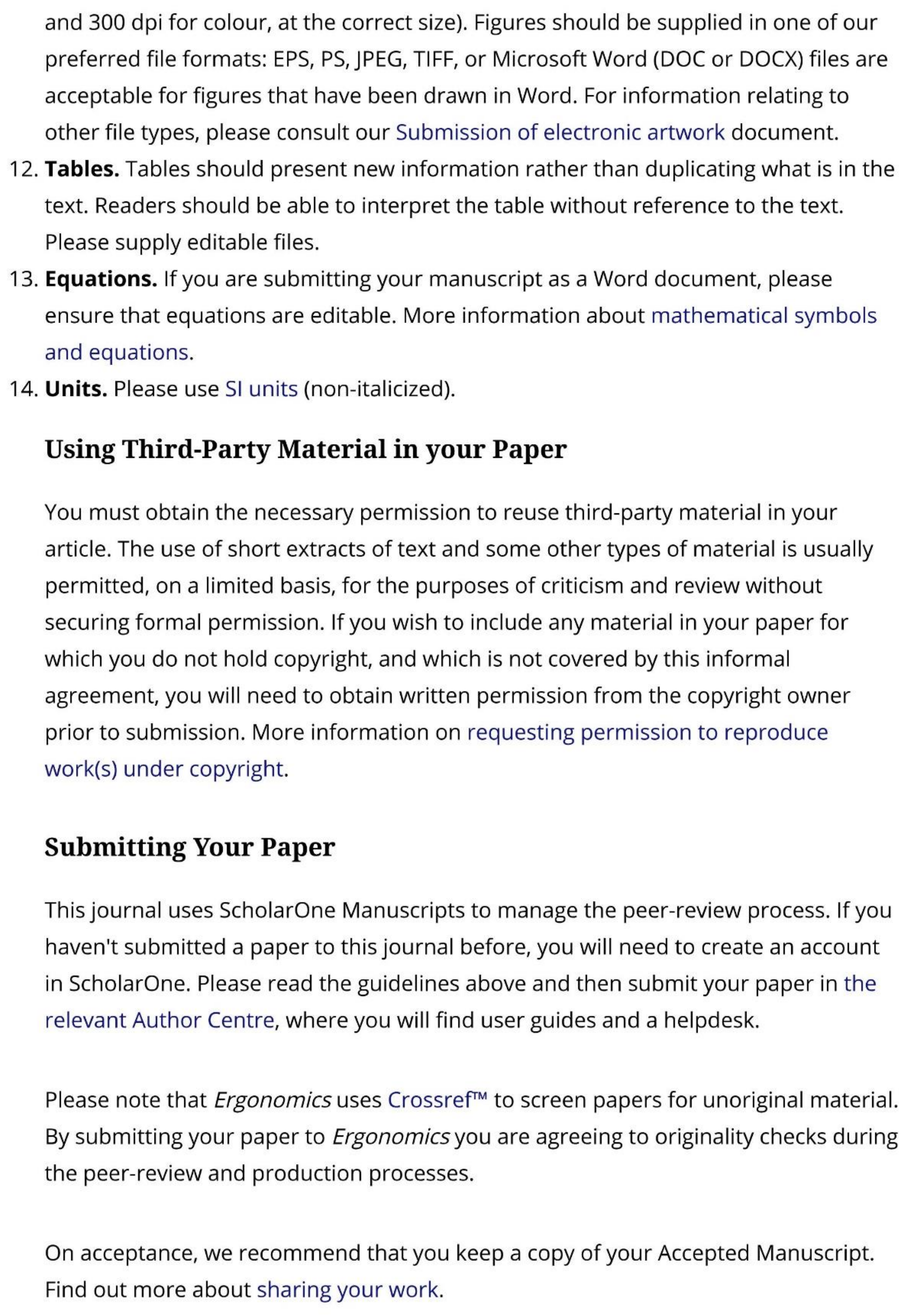

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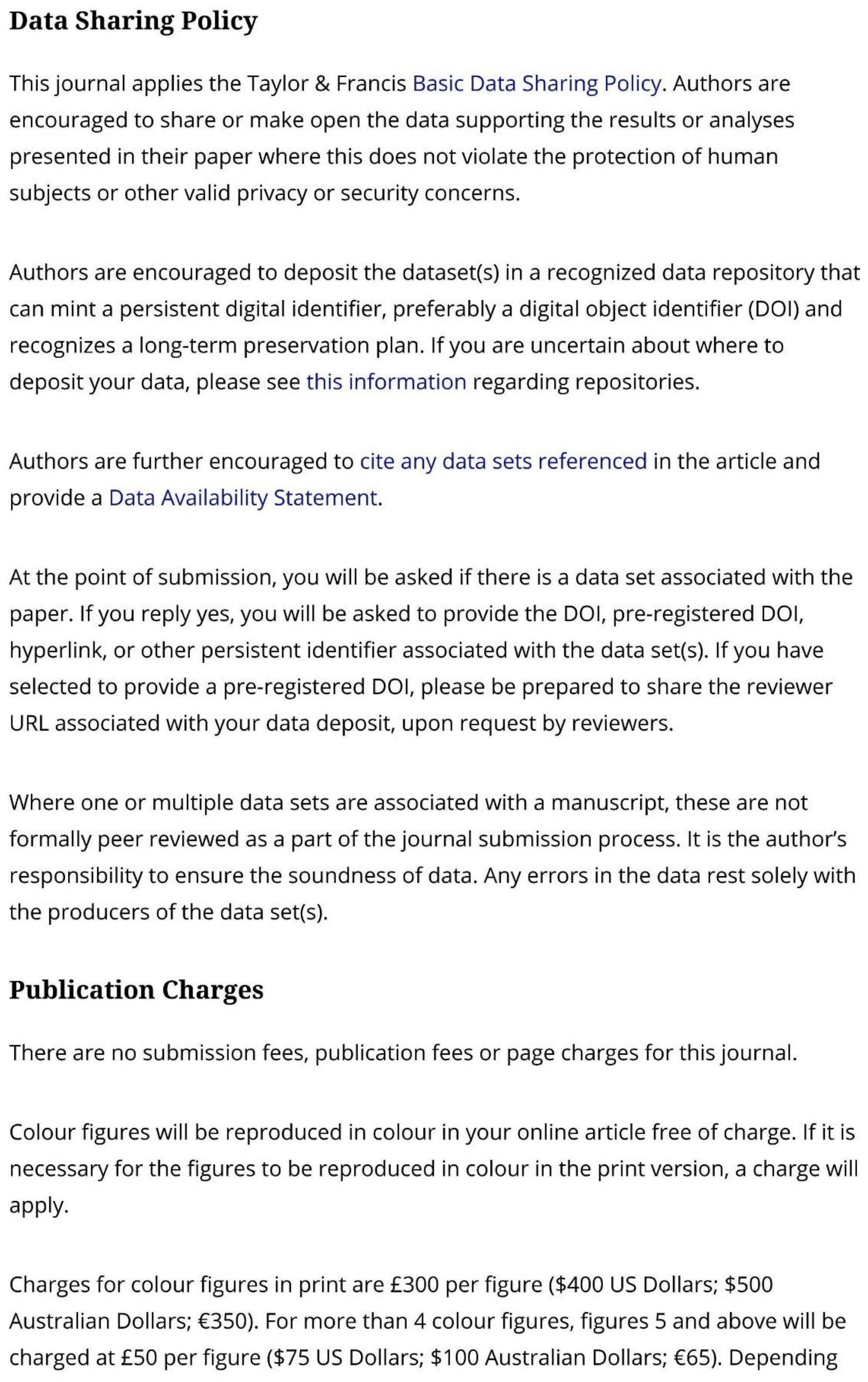

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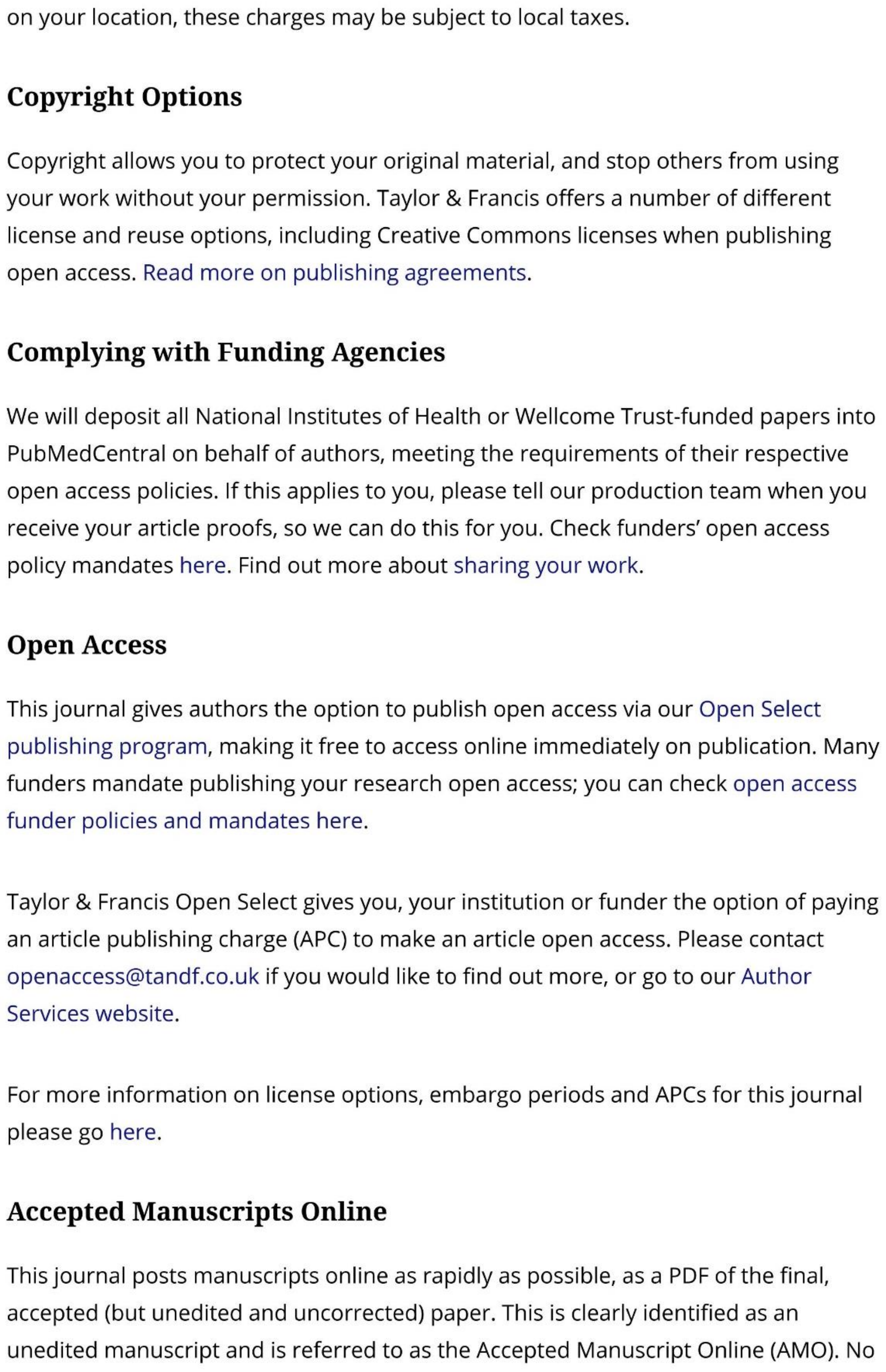

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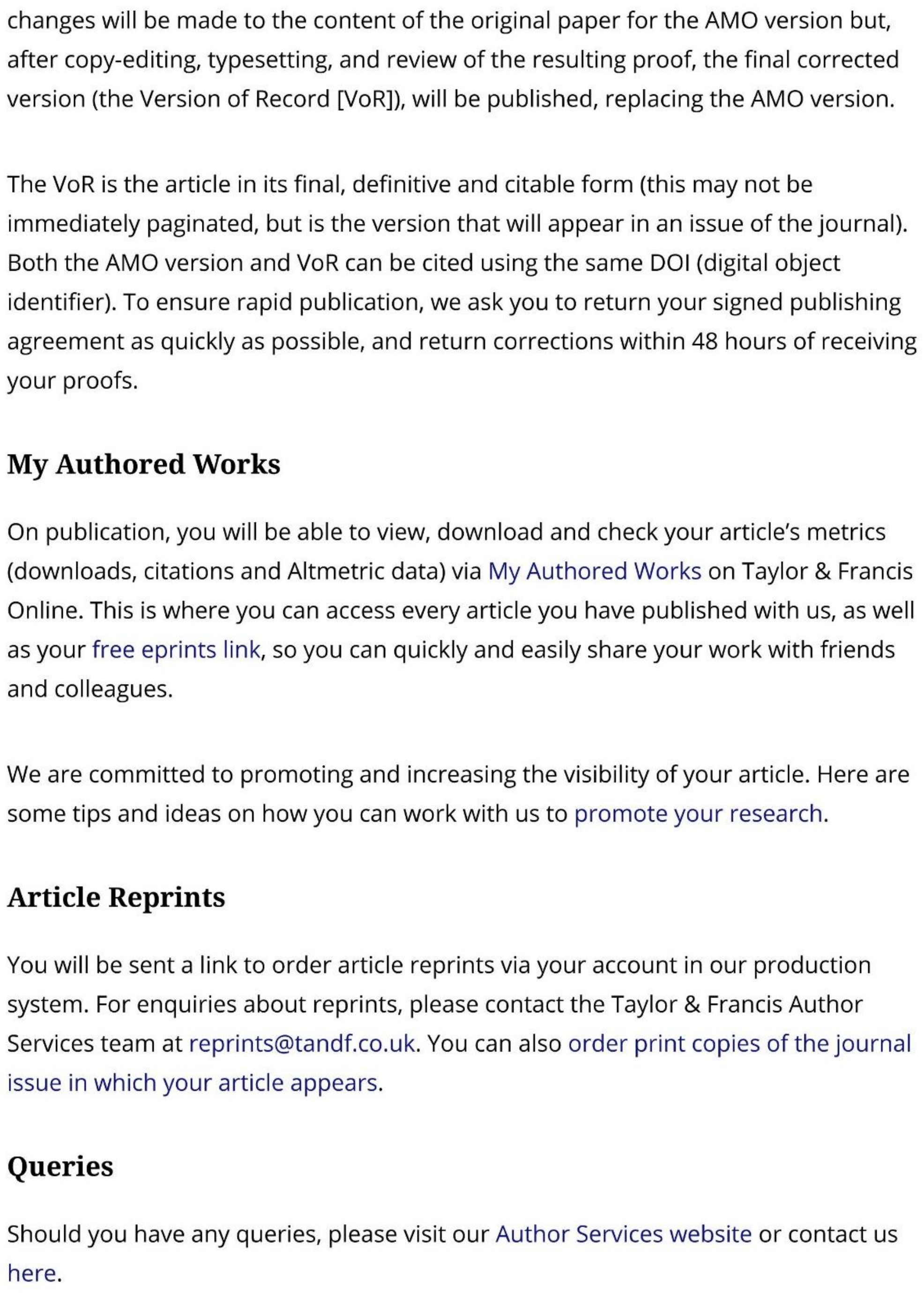

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Appendix B: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

PROJECT TITLE: THE RELATIONSHIP BETWEEN CUE UTILISATION, STATE ANXIETY AND PERFORMANCE DURING A NOVEL AND PROSPECTIVE MEMORY TASK.

HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: 19/42

PRINCIPAL INVESTIGATOR:

STUDENT RESEARCHER:

STUDENT'S DEGREE: MASTER OF PSYCHOLOGY (ORGANISATIONAL AND HUMAN FACTORS)

Brief description of the Study.
You are invited to participate in a study investigating the usage of cue utilisation and state anxiety to predict performance in a Rail Control Task. This study is conducted by XXX and XXX to fulfil the requirements of the Master of Psychology (Organisational and Human Factors), under the supervision of XXX.

Inclusion/Exclusion criteria. You must

- Be between 18 to 25 years
- Hold a valid driver's license
- Have less 7 years or less driving experience
- Be proficient in English
- Wear any required vision correction (e.g. spectacles, contact lenses) throughout the study.

Your part in the Study. You will be asked to complete a series of surveys and some interactive computer-based driving tasks, and then complete a computer-based Rail Control Task. Participation in the study is entirely voluntary; there is no obligation to take part in the study, and if you choose not to participate there will be no detriment to yourself in any form. You have the right to withdraw at any time.

Risks of participating. There are no risks to your health or wellbeing as a result of participating in this study. Any occupational health and safety issues will be identified on site and appropriate measures will be taken to control risks to participants.

Statement of Privacy. All data collected during the experiment will be treated in the strictest confidence and stored on password protected computers. The data will be used only for this project. You will also have the opportunity to receive a summary of the research findings. Results will be aggregated for reporting purposes to preserve anonymity.

Other relevant human research ethics considerations. In addition to receiving a copy of your own results, this research will be reported in the open literature in due course.

Consent. If you are willing to participate, please indicate this by clicking on the checkbox in the experimental application, as instructed by the researcher.

Contact details.
The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number 19/42). This research project will be conducted according to the NHMRC National

Statement on Ethical Conduct in Human Research 2007 (Updated 2018). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator:

Principle Investigator

If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Appendix C: Study Consent

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	**Cue utilisation, prospective memory and state anxiety in novel task performance**
Ethics Approval Number:	**19/42**

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

4. Although I understand the purpose of the research project, it has also been explained that my involvement may not be of any benefit to me.

5. I agree to participate in the activities outlined in the participant information sheet.

6. I understand that I am free to withdraw from the project at any time and that this will not affect my study at the University, now or in the future.

7. I have been informed that the information gained in the project may be published in a journal article or presented in a conference.

8. I have been informed that in the published materials I will not be identified, and my personal results will not be divulged.

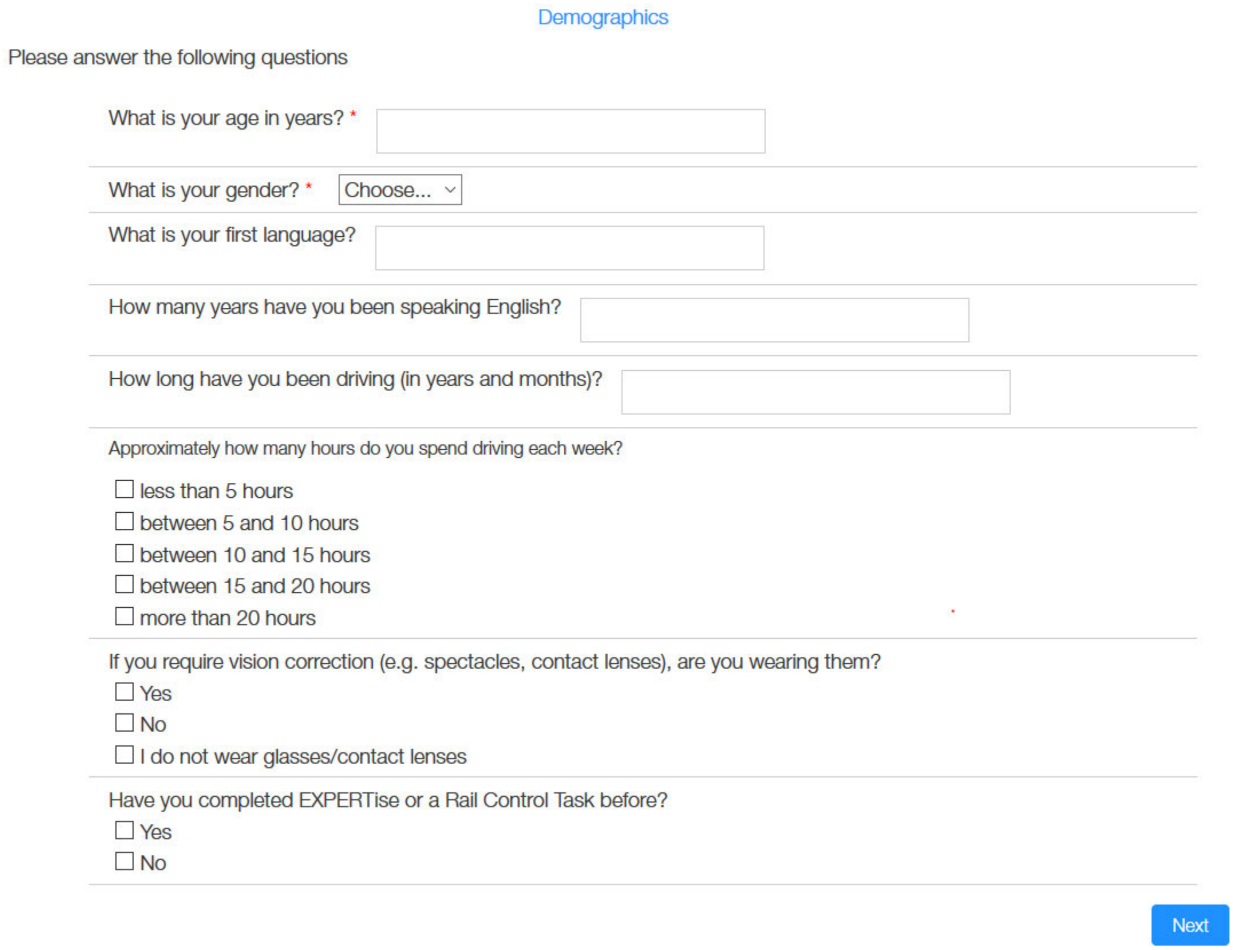
9. I agree to my information being used for future research purposes as follows:
    - Research undertaken by these same researcher(s) Yes ☐ No ☐
    - Related research undertaken by any researcher(s) Yes ☐ No ☐
    - Any research undertaken by any researcher(s) Yes ☐ No ☐

10. I understand my information will only be disclosed according to the consent provided, except where disclosure is required by law.

11. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

☐ By clicking this check box, I agree to participate in this research, knowing that I can withdraw from further participation at any time without consequence. I have been given a copy of this information to keep.

Appendix D: Demographics Questionnaire



Demographics

Please answer the following questions

What is your age in years? *

What is your gender? * Choose...

What is your first language?

How many years have you been speaking English?

How long have you been driving (in years and months)?

Approximately how many hours do you spend driving each week?

☐ less than 5 hours
☐ between 5 and 10 hours
☐ between 10 and 15 hours
☐ between 15 and 20 hours
☐ more than 20 hours

If you require vision correction (e.g. spectacles, contact lenses), are you wearing them?

☐ Yes
☐ No
☐ I do not wear glasses/contact lenses

Have you completed EXPERTise or a Rail Control Task before?

☐ Yes
☐ No

Appendix E: Docking Sheet

Rail Control Docking Sheet Instructions

During this phase of the task, you will be required to manage the re-directing of trains *as well as* completing this docking sheet. This docking sheet will require you to fill out the following pieces of information about the trains you are managing in order of their arrival:

1. The train numbers
2. The time at which the train arrived

Please use the blue clock sitting on the desk close to you when assigning the arrival time. If you miss a train or arrival time, please put an ‘X’ in the box to ensure that you maintain the correct train order. See the example below:

Train Order	Train Number	Arrival Time
1	333	3:01pm
2	444	3:01pm
3	777	3:02pm
4	X	3:02pm
5	555	3:02pm

Rail Control Docking Sheet

Train Order	Train Number	Arrival Time
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