Consciousness and Cognition 33 (2015) 406–413

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Spider stimuli improve response inhibition

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ARTICLE INFO

Article history:
Received 25 July 2014

Keywords:
Anxiety
Motor control
Motor decoupling
Response inhibition
SART
Speed-accuracy trade-off
Subjective state
Sustained attention
Task-related thought
Task-unrelated thought

ABSTRACT

Anxiety can have positive effects on some aspects of cognition and negative effects on others. The current study investigated whether task-relevant anxiety could improve people's ability to withhold responses in a response inhibition task. Sixty-seven university students completed a modified and an unmodified version of the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) and provided subjective measures of arousal and thoughts. Anxiety appeared to improve participants' ability to withhold responses. Further, participants' performance was consistent with a motor response inhibition perspective rather than a mind-wandering perspective of SART commission error performance. Errors of commission were associated with response times (speed-accuracy trade-off) as opposed to task-unrelated thoughts. Task-related thoughts were associated with the speed-accuracy trade-off. Conversely task-unrelated thoughts showed an association with errors of omission, suggesting this SART metric could be an indicator of sustained attention. Further investigation of the role of thoughts in the SART is warranted.

1. Introduction

Unravelling the relationship between subjective states, especially those which are consciously reportable, and performance may help resolve the role consciousness plays in human behavior. Matthews et al. write (2002, p. 316), "a subjective state may be defined as a relatively transient mental quality permeating conscious awareness whose representation is distributed across a variety of mental processes or structures, and which has the potential to generalize across activities and contexts." Matthews (2001) proposes a state-mediation model in which environmental conditions and tasks impact internal states which then influence information-processing. Research has explored the performance correlates of conscious states.

For example, anxiety and arousal states affect cognitive performance. Often anxiety has negative consequences, such as being detrimental to working memory (Matthews & Campbell, 1998) and test anxiety has been found to be detrimental to retrieval from long term memory (Kanfer & Ackerman, 1996; Kanfer & Stevenson, 1985). Energetic arousal, however, correlates with perceptual sensitivity on high-event target detection tasks and visual search tasks (Funke, Matthews, Warm, & Emo, 2007; Helton, Shaw, Warm, Matthews, & Hancock, 2008; Helton & Warm, 2008; Matthews & Davies, 1998a, 1998b; Matthews, Davies, & Lees, 1990). Humphreys and Revelle (1984) suggested arousal increases the availability of resources for sustained information-processing. There are situations where experiencing anxiety may also have positive effects on a

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http://dx.doi.org/10.1016/j.concog.2015.02.014
1053-8100/

person's cognition. In a recent study, Robinson, Krimsky, and Grillon (2013) showed that the threat of a painful electric shock increased participants' ability to withhold responses in a response inhibition task. In their experiment anxiety was induced externally to the task itself by the threat of electric shock. Whether or not task-*relevant* anxiety can similarly produce advantageous effects remains to be seen.

In the current study, participants completed a Go/No-Go response task as used by Robinson et al. (2013). This time however, the stimuli intended to induce anxiety was incorporated into the task itself, and thus task-relevant anxiety rather than task-irrelevant anxiety was examined. The Go/No-Go response task used was the Sustained Attention to Response Task (SART; Robertson et al., 1997). This is an experimental paradigm where participants respond to frequent Go stimuli and withhold responses to rare No-Go stimuli. Normally number stimuli 1–9 are used in the SART, but researchers have employed picture stimuli as well (Head & Helton, 2013). In the current experiment, we used pictures of spiders judged to be negative and arousing in nature, thus incorporating the anxiety-inducing stimuli into the task itself. The SART has been used extensively in research in a variety of contexts and populations. The primary metrics of interest are errors of commission, errors of omission, and response times to Go stimuli. A commission error describes a failure to withhold to a rare No-Go target stimulus, while an omission error is a failure to respond to a Go stimulus. Errors of commission are characteristically high in the SART; an error rate upwards of thirty to fifty percent is not uncommon (Carter, Russell, & Helton, 2013; Wilson, Head, & Helton, 2013).

The SART is characterized by a speed-accuracy trade-off, where faster response times are associated with more errors of commission (Helton, 2009; Helton, Head, & Russell, 2011; Helton, Kern, & Walker, 2009; Peebles & Bothell, 2004). While recognized as requiring response inhibition, there has been a debate regarding what the SART actually measures. One perspective is that errors of commission are primarily the result of absentmindedness caused by mind wandering (Smallwood et al., 2004). In tasks such as the SART, there is little exogenous support of attention in the time between critical targets. Smallwood and colleagues argue that this causes participants to become bored with the monotonous nature of the SART and thus their attention drifts from the task, which is manifested as an increase in task-unrelated thoughts. From this perspective SART commission errors are indicators of perceptual decoupling. Another perspective is that failures to withhold to the rarely occurring targets are actually motor response inhibition errors rather than perceptual errors per se. The repetitive nature of responding in the SART leads to the development of a prepotent ballistic motor program, which is difficult to inhibit when necessary (i.e. occurrence of a target) (Head & Helton, 2014; Helton, Weil, Middlemiss, & Sawers, 2010). Even when the participant is fully perceptually coupled, errors of commission can occur due to motor decoupling resulting from a strategic shift toward speed of response, not perceptual decoupling per se (Head & Helton, 2013). Therefore an additional research goal was to examine how the inclusion of spider picture stimuli impacted reports of task-related and task-unrelated thoughts during the SART. Thus, along with performance on the SART, we measured participants' subjective arousal levels, both energetic and tense, and both task-related and task-unrelated thoughts with four subscales from the Dundee Stress State Questionnaire (DSSQ; Matthews, Joyner, Gilliland, Huggins, & Falconer, 1999; Matthews et al., 2002).

It was expected that participants' performance would be enhanced when exposed to spider pictures in the SART, and that they would also report higher levels of anxiety, showing that task-relevant anxiety improves response inhibition. Specifically, participants would be said to show 'better' performance if their speed or accuracy was superior in a SART incorporating pictures of spiders in comparison to performance on the neutral number stimuli SART. According to the mind-wandering perspective of the SART, increased commission errors should occur when task-unrelated thoughts are more prevalent, revealed by a positive association between these metrics. From the motor perspective however, commission errors will be more frequent when response times are shorter, reflecting a speed-accuracy trade-off, rather than a relationship with task-unrelated thoughts. Indeed, from the motor perspective, self-reported task-related thoughts elicited after the SART likely reflect awareness of task performance and may even be influenced by performance itself (performance appraisal), e.g., a sportsperson following a match, stewing over a game in which they made many mistakes. McAvinue, O'Keefe, McMackin, and Robertson (2005) observed that people were aware of their SART commission errors 99.1% of the time. People are fully aware of their performance on the task. It was predicted that a speed-accuracy trade-off will be apparent, i.e. participants who overall respond faster should make more errors of commission, and vice versa.

2. Method

2.1. Participants

Sixty-seven (39 females, 28 males) undergraduate students from the University of Canterbury in Christchurch, New Zealand, participated in this study. They ranged in age between 17 and 42 years (M = 21.7 years, SD = 5.0). All participants had normal or corrected-to-normal vision.

2.2. Materials and procedure

Participants were tested in individual cubicles. They were given an information sheet and a consent form which they signed. Participants were seated approximately 50 cm in front of a computer screen (377 mm × 303 mm, 75 Hz refresh rate) that was mounted at eye level. Their head movements were not restrained. Wrist watches were removed and mobile phones