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Doing the unpleasant: How the emotional nature of a threat-relevant task affects task-switching

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ABSTRACT

Much recent work has investigated participants' ability to switch between simple cognitive tasks. However, little research examines how performing an emotionally relevant task affects one's ability to switch tasks. Understanding how emotion affects the task-switching process may help elucidate the role of emotion in executive control. Across two experiments, participants alternated predictably between two tasks requiring a perceptual decision about either an aversive spider image or a neutral digit. The results demonstrate that fearful participants evinced *accelerated engagement* toward, and *decelerated disengagement* away from, the threat-relevant task.

1. Introduction

The mind is capable of performing a vast number of cognitive operations. Accordingly, psychological theories often include some sort of control mechanism responsible for the coordination of these operations. This mechanism is typically referred to as the "central executive" and is held to be responsible for the control of "cognition, emotion and action" (Logan, 2000; p. 211). The purpose of the present investigation is to examine the role of negative emotion in executive control.

1.1. Emotion and executive control

Executive control is typically discussed in the context of the dividing or switching of attention between multiple tasks (e.g., Rogers & Monsell, 1995). Whereas the goal of much research has been to illuminate how the central executive functions, much less has been devoted to understanding the influence of emotion on executive control. This oversight is particularly interesting in light of the fact that emotion is a strong modulator of attention (e.g., Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; LeDoux, 1996; Öhman, Flykt, & Esteves, 2001). Thus, we can expect that emotion should influence executive control in some fashion.

There are reasons to expect that negative emotion would influence executive control processes. In a recent account of the relation between emotion and action, the human brain is held to be hard-wired in such a way that emotions rooted in survival (e.g., fear) can commandeer control over action (LeDoux, 1996). That is, our executive control can sometimes be preempted by response tendencies evoked within an emotional context (e.g., preparing for flight after mistaking a twig in the woods for a deadly snake). There are numerous empirical findings consistent with such a mechanism. For example, negative emotional stimuli attract both covert attention (Eastwood, Smilek, & Merikle, 2001; Öhman et al., 2001) and overt attention (i.e., eye movements; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005) in a stimulus-driven manner.

1.2. Indexing executive control

One popular method of studying executive control is to explore how individuals *shift between* different tasks. For example, in the "alternating runs" paradigm, participants alternate between two simple tasks on every other trial (e.g., AABBAABB), and performance on repeat trials (i.e., AA or BB) is compared to performance on switch trials (i.e., AB or BA). Results across a large number of studies have demonstrated that responses are less accurate and slower following a switch of tasks than when the task is repeated (e.g., Rogers & Monsell, 1995). This switch-cost has been taken to reflect the extra "work" needed to reconfigure the cognitive system to perform a new task.

While the present investigation focuses on task-switching in the context of the alternating runs paradigm, there exist numerous measures of task-switching (e.g., Arrington & Logan, 2004). A popular alternative is the task-cueing procedure, wherein an unpredictable "cue" indicates the task to be performed on each trial

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(e.g., Sudevan & Taylor, 1987). Our decision not to use this paradigm stems from results suggesting that "switch-costs" derived from this procedure actually reflect cue encoding (e.g., Logan & Bundesen, 2003). However, the alternating runs paradigm, while the most widely used, is not without its detractors (see Altmann, 2007). Ultimately, a converging operations approach should be undertaken where the investigation of emotion in executive control occurs across various task-switching paradigms.

1.3. Present investigation

In the present investigation, we sought to determine if the relative emotionality of two tasks influences one's ability to switch between those tasks. We investigated how the costs incurred while switching between an emotionally aversive and an emotionally neutral task depend on how relevant the aversive task was to individual participants. The *emotionally aversive* task had participants make a perceptual judgment about an aversive stimulus (i.e., a spider image). Spider images were used given that sub-clinical fear of spiders is common (American Psychiatric Association, 1994) and Öhman et al. (2001) have already demonstrated increased search efficiency for spider images relative to neutral images in a normal population. The *emotionally neutral* task had participants make an Odd/Even judgment about a digit. To provide an explicit indicator of the relation between emotional-task relevance (i.e., level of spider-fear) and task-switching processes, participants also completed the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995).

Given previous work, we expect to find that the switch-costs associated with each task are related to how emotionally relevant the aversive task is for individuals to perform. Beyond this rather straightforward prediction, cognitive accounts of anxiety make specific predictions with respect to the direction and nature of these individual-differences.

Anxious individuals are believed to be selectively biased toward processing threatening information (e.g., Mogg & Bradley, 1998). This bias is believed to reflect a *hypervigilance* to threat. The more vigilant one is to threat the more likely one is to perceive the world as a dangerous place, thereby increasing anxiety levels. This increased anxiety may then further increase vigilance toward threat, thus perpetuating anxious feelings.

Hypervigilance to threat has been hypothesized to manifest itself as either an *accelerated detection of threat* and/or a *decelerated disengagement from threat*. Empirical evidence for accelerated detection comes from visual attention tasks in which fearful individuals demonstrate a greater tendency to orient their attention toward threat (e.g., Öhman et al., 2001). Visual attention studies also provide evidence for decelerated disengagement. Specifically, Fox et al. (2001, 2002) have demonstrated that individuals high in state anxiety have a reduced ability to disengage from both angry faces and threatening words, compared to those low in state anxiety.

In the present task-switching context, accelerated engagement should lead to a faster activation of the emotionally aversive task relative to the neutral task, thus *reducing* the switch-cost to that task for individuals more fearful of spiders. Similarly, decelerated disengagement should lead to a slower deactivation of the emotionally aversive task relative to the neutral task, thus *increasing* the switch-cost to the neutral task for individuals more fearful of spiders.

Correlating the FSQ with performance will allow us to delineate the contributions of both these factors to any switch-cost difference between tasks. If the task-switching difference is a product of *accelerated engagement*, then FSQ scores should be *positively* correlated (i.e., performance improves as spider fear increases) with performance in the Spider Task after switching from the Odd/Even Task (i.e., facilitation in switching *to* the threat-relevant task). As spider fear increases, the speed/accuracy with which the participant engages the Spider Task should also *increase*. However, if the task-switching difference is a product of *decelerated disengagement*, then FSQ scores should be *negatively* correlated (i.e., performance declines as spider fear increases) with performance in the Odd/Even Task after switching from the Spider Task (i.e., difficulty in switching *away* from the threat-relevant task). As spider fear increases the speed/accuracy with which the participant disengages from the Spider Task and engages the neutral task should *decrease*.

2. Experiment 1

2.1. Methods

2.1.1. Participants

Fifty-two undergraduate students received either $5 or course credit for their participation.

2.1.2. Apparatus

E-Prime experimental software (Psychology Software Tools, 2002) controlled timing and presentation of stimuli and logged responses and response times (RTs). Stimuli were presented on a standard 17" SVGA color monitor. Vocal RTs were recorded by a microphone triggered by the participant's voice.

2.1.3. Stimuli

The experimental stimuli consisted of 32 color-images of *real* spiders with a digit appearing in the center of each image (see Fig. 1). On every trial both a spider image and a single digit were presented ("spider-digit" stimulus). Half of the spiders had a "hairy" texture and half of the spiders had a "smooth" texture. Spider images subtended 14° of visual angle vertically and 17° of visual angle horizontally. The digits 1–9 were used for the Odd/Even Task. Digits subtended 0.9° vertically and 0.6° horizontally and were presented in white in a black box that subtended 1.1° vertically and 0.8° horizontally. Each spider-digit display was created by independently selecting one spider image and one digit at random and combining the two stimuli for each trial. All images and digits appeared equally often during the experiment.

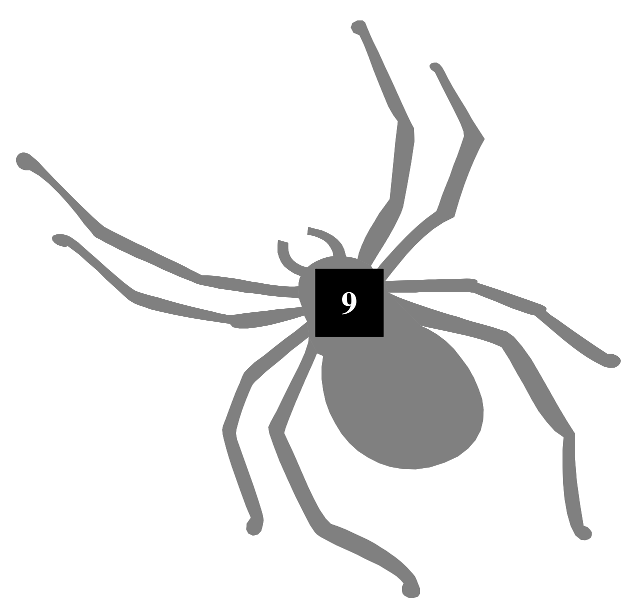

Fig. 1. Schematic example of spider-digit display. The experimental stimuli consisted of color-images (i.e., photographs) of real spiders.