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Rollercoasters and Horror Movies: The Potential Neurocognitive Effects of Acute Stress on Feature Attention

INTRODUCTION

Anecdotally speaking, everyone has experienced the following scenario: Whether it's on a high-speed rollercoaster or during an essay-writing session the night before the assignment is due, stress-inducing activities always seem to enhance one's attention to details. On the rollercoaster, quick glances at leaves on trees and other park features seem to pop out, and in the essay writing session, the same details similarly pop out. It's remarkable how real-world experiences are able to inspire research investigations, and the following research proposal will examine the potential neurocognitive effects of acute stress on feature attention.

It's no secret that stress has great influence on the brain's attentional capabilities, as behavioral research has already been conducted that looks at these effects. In a study conducted at the University of Bristol, 60 university students self-reported their levels of stress, had cortisol measured, and partook in selective attention tasks (Vedhara et al., 2000). Researchers conducted said study during an exam period and a non-exam period in order to sparse out periods of acute stress. Researchers found that in exam periods, or periods with an increase in perceived levels of stress, participants performed significantly worse on a telephone search task that measured selective attention. Ultimately, these results showed that acute stress impaired attentional processes (Vedhara et al., 2000). Although this may go against the initial anecdote, there are a few caveats that are worth addressing. Firstly, these researchers claim that their measure of stress could be considered acute, but relative to the short millisecond responses that can be recorded with an EEG, this time frame is much too long. Moreover, this study lacks any neurocognitive techniques that may seem useful in addressing the shorter time intervals. Speaking of which, neurocognitive techniques have been implemented in tackling the question. Utilizing fMRI to measure the prefrontal cortex, an area correlated with attentional control, researchers found that chronic psychosocial stress impaired attentional control (Liston et al., 2009). Once again, this kind of study looked at chronic stress, and not at acute stress. Moreover, the cognitive control of attentional shift is only one example of an attention mechanism that is affected by stress. However, this study adds to the body of literature that neurocognitive techniques may be used to examine attentional changes in the brain. Consequently, it can be posited that simpler attentional functions can also be modulated by experimental techniques that can induce stress acutely.

Acute stress is known to induce hypervigilance, which allows for better detection of threats (Henckens et al., 2012). However, sensory processing comes at the cost of unselective attention and increased distraction to irrelevant stimuli. Researchers administered 10mg doses of hydrocortisone to participants, who then completed an emotional distraction task coupled with the color naming of neutral or aversive words. Researchers found that the rapid effects of corticosteroids interfered with selective attention of aversive words. Moreover, reduced activation in the cuneus, important for attentional processing, correlated with the rapid effects of the administered corticosteroids (Henckens et al., 2012). This study adds to the body of literature that cortisol, the primary stress hormone, interferes with attentional processing. Once again it must be highlighted that there were myriad regions of interest indicated in this study, and the study struggles to find additional correlative data of attention beyond the cuneus.

A different approach that may provide more helpful evidence for feature attention is through the use of an electroencephalogram (EEG). As EEG is able to record with a temporal resolution in the milliseconds range, and because feature attention occurs at a similar temporal timescale, it's only natural that researchers resort to this method. Previous research has shown that anxiety altered goal-directing processing reduced P300 amplitude to target stimuli, but increased the C1 going to irrelevant stimuli, revealing information of the time-courses of attentional biases of stress (Rossi & Pourtois, 2015). Similarly, other researchers have concluded that acute stress impairs frontal function through cortisol release. Another group of researchers found that participants that were stressed showed reduced luminance change that would have been apparent of the N1pc going (Sänger et al., 2014). Moreover, the subsequent N2pc going, which is indicative of re-allocation of attentional resources, decreased from the induced stress. Ultimately, researchers concluded that acute stress hinders intention-based attentional allocation, but seems to prioritize stimulus-driven selection (Sänger et al., 2014).

Between anecdote and scientific, statistical evidence there tends to arise contradiction. The current study intends to clear up the confusion that tends to underlie studies concerned with the effects of stress on attention, and in this case specifically feature attention. By controlling the induced application of stress, we hope to reveal how feature attention is affected by stress, which has not been explored as in depth by other researchers. On similar lines revealed by Rossi and Pourtois (2015) and Sänger et al. (2014), we predict that an increase in self-reported levels of stress and an increase in salivary cortisol levels will correlate with a decrease not only the ability to identify certain features of stimuli, but also with decreased amplitudes in the N1 and N2 deflections found with EEG. Moreover, stimulus-driven selection will not be impaired, and P1 deflections will still occur and appear on ERPs.

METHODS

Participants, Stimuli, Conditions, and Dependent Variables

Twenty-eight undergraduates will be recruited to participate in the study from a local university. These participants will provide self-reported levels of stress twice, once before the EEG session, and another time after the EEG session. Participants will fill out the global measure of perceived stress (Cohen et al., 1983). Along with self-reported levels of stress, participants will be asked to provide saliva samples before and after the scanning phase. Participants will be told to avoid consuming any caffeinated drinks for eight hours prior to testing. In order to induce feelings of anxiety and stress, participants will be oriented towards a projector that will display clips on a screen. Participants will be randomly assigned to one of two groups, a “Stress” and “No Stress” condition. Participants in the “Stress” condition will watch horror movie clips from recently released horror movies (e.g. “A Quiet Place” and “Paranormal Activity”) in order to maintain a real-world context similar to any other anecdotal experience. The “No Stress” condition will be considered the control condition, as it did not utilize any stress-inducing stimuli.

The stimuli in this condition would consist of clips that are not fundamentally stressful (e.g. A video of a rabbit hopping in a meadow). Stimuli for the feature attention task consisted of both color and shape targets. The shape targets were either triangles or rectangles, and were counterbalanced by color, either blue or yellow (Giesbrecht et al., 2003). After each shape was presented, participants will be asked to provide a response for both shape and color. These are the behavioral dependent variables. Participants will be suited with an EEG cap that contained 128 active Ag/AgCl electrodes that are evenly distributed on the head (Rossi & Pourtois, 2015). This EEG cap is essential to measure the ERPs attributed with certain mechanisms of attention.

Procedure

As mentioned, participants will first start with their self-reported levels of stress, and will then be asked to provide a salivary sample. At this point, the EEG cap will be placed on the participant's head. After settling in a chair for a few moments, experimenters will ask if the participant is ready to begin. Participants will attend to the screen that is directly in front of them. For every block of trials, a fixation cross will be displayed for about 2000ms. A clip will then be played. This clip will either be intended to induce stress or not, and clips last around 2-3 minutes. After the clip has finished, participants will look at another fixation cross for 5000ms (variable interstimulus interval). Participants are then shown a 500ms cue that instructs them to attend to a shape (R for rectangle or T for triangle) and a color (Y for yellow and B for Blue) (Giesbracht et al., 2003). The cue is followed by another insterstimulus interval (ISI) with just a fixation cross for about 800ms. Target displays will be presented for 250ms, which are then followed by another 5000ms ISI before the next trial. During that 5000ms ISI participants will be asked to respond to what shape and color the stimulus was. 25 trials will occur before the next clip is shown. A total of five clips will be shown, for a total of 125 trials after five runs. After measuring with EEG, participants will be asked to self-report their stress and have their saliva collected.

PREDICTED RESULTS

Self-Reported Stress and Cortisol

We predict that there will be a significant difference between self-reported stress levels and salivary cortisol levels. The clips chosen for the "Stress" condition are intended to be suspenseful and terrifying, and as a result, participants should perceive changes in their stress level. Those in the “Stress” condition should report higher amounts of stress compared to participants in the “No Stress” condition, whose clips were meant to not induce stress.

Behavioral Feature Task Data

Those that were placed in the “Stress” condition should perform significantly worse at identifying both the shape and color of the target stimuli compared to participants in the “No Stress” condition. As was found in similar research studies, acute stress should impair the brain’s access to attentional resources, which would result in participants in the “Stress” condition to struggle with identifying actual features, resulting in lower scores of accuracy. This is despite the fact that participants will be paying attention to the screen as the stimuli are presented.

Neurocognitive Results

The most compelling results for the current study will arise from the use of EEG to measure participant ERPS. We predict that, because stress is associated with a state of heightened vigilance, that the P1 going component 100 ms after the stimulus should be present. Not only that, the P1 is associated with attention modulation, and due to the heightened states, participants in the “Stress” condition should have higher amplitudes of the P1 than participants in the “No Stress” condition (Sänser et al., 2014). Furthermore, we predict that the N1 and N2 ERP components will have smaller amplitudes in the “Stress” condition than in the “No Stress” condition. The N1 ERP component and the N2 ERP component are key components related to attention. However, because previous research has indicated that the N2 amplitudes had decreased due to acute stress, it should be no surprise that we should predict the same. We predict that stress modulates the amplitude of these components, and as a result, should decrease in their amplitude. Overall, these results should indicate that acute stress has a measurable effect on attention, impairing intention-based attentional direction.

DISCUSSION (all results assume to be as predicted)

Results showed a significant difference in cortisol levels and perceived stress between conditions. Participants in the “Stress” condition reported higher levels of perceived stress, and saliva samples showed higher levels of cortisol concentrations in the bod. Also as predicted, there was a significant difference in the ERP component amplitudes of the P1, N1, and N2. Participants in the “Stress” condition did have higher peaks associated with the P1, but lower peaks associated with the N1 and N2 compared to the controls in the “No Stress” condition. These results suggest that acute stress enhances stimulus-driven responses that are indicated by the P1 ERP component, but that acute stress hinders ERP components associated with attentional processes. Coupled with these results is that participants in the “Stress” condition performed more poorly and less accurately at the shape and color feature detection compared to controls, suggesting once again that feature attention is impaired due to acute stress.

This body of work adds to the literature that focuses on the time-based components of acute stress and its modulation of attentional mechanisms. This body of literature is limited, but with the addition of this work, small temporal scale work on feature attention and stress would have been conducted. One strength of this study is that, with EEG, ERP results are recorded at small temporal resolutions, which adds more evidence towards the correlative effects of stress on small timescale cognitive processes in general. One limitation of this study is that it’s limited to EEG in the first place because of the temporal resolution that’s needed to detect differences in feature attention. However, future work may look to tackle the implications of these affected attentional mechanisms by holistically observing brain activity in certain areas that focus on attention; the difference is that the temporal resolutions will have to be different. Overall, we can conclude from this work that there are measurable neurocognitive differences from how acute stress affects attention, and that ultimately acute stress impairs mechanisms of feature attention, despite enhancing irrelevant, distracting stimulus-driven reactions.

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