

# Detecting Critical Signals in Sustained Visual Attention Tasks Using Simulated Radar Screens

Christian Sutphin, Graham G. Lang, Giuseppe Miranda, Nnimnoabasi Essien  
 Advisors: Susan T. Davis, Ph. D. & Adam J. Barnas, B.S.  
 The University of Dayton

## Background

Vigilance, or sustained attention, requires observers to be able to recognize infrequent critical signals over extended periods of time (Warm et al., 2003). Pilots, air traffic controllers, and other technicians are required to monitor streams of visual stimuli for prolonged periods of time, often resulting in stress and perceptions of increased mental workload. The consequences of missed critical signals could be potentially catastrophic, for example misread gauges in a food processing plant could lead to widespread illnesses.

Past research has proposed that the decline in vigilance is caused by "mindlessness" or withdrawal of attention from the monitoring task. Robertson (1999) has also shown that the routinized behavior required for vigilance tasks leads to the decline in the ability to respond to infrequent signals.

Although Gulian (1970) found that overconfidence occurs in attention, perception, and decision tasks, no research exists exploring the relationship and decline of confidence and vigilance in a sustained attention task.

## Hypotheses

- 1.) Perceived mental workload will increase from the beginning to the end of the task. Specifically, the perception of stress will increase while actual task engagement will decrease.
- 2.) Accuracy in detection of critical signals will decline over time; similarly, confidence in correct detections will decrease, though less rapidly, resulting in distinct overconfidence.

## Method

Thirty undergraduate participants were presented with two types of visual stimuli (Figure 1). For neutral signals, all arrows were oriented in the same direction, either clockwise or counterclockwise. For critical signals, one of the four arrows was oriented in the direction opposite the other three. After a short practice period, participants were presented with a series of 600 total visual stimuli, including 24 critical signals spread randomly throughout the test. Participants were instructed to respond whether they thought a stimulus was critical or neutral. After each critical signal and 24 randomly selected neutral signals, participants were asked to give a percentile value for their confidence in the accuracy of their previous response. Perceived mental workload was measured following the task using a "Task Load Index" scale developed by NASA.

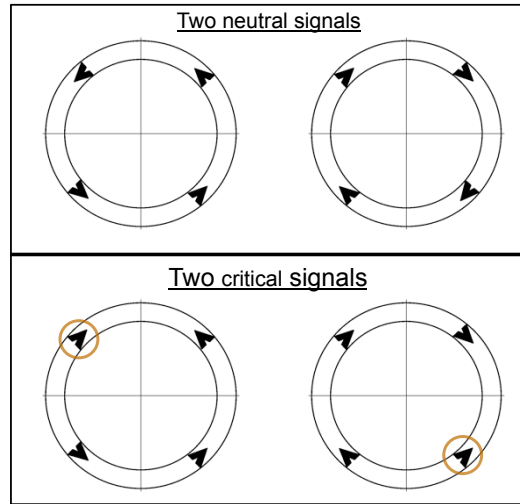


Figure 1

## Preliminary Results

Following are the relevant results from analyses of the data from 30 participants (18 women, 12 men). There was a 2 (Stimulus type: neutral vs. critical) x 2 (Direction of target rotation: clockwise vs. counterclockwise) x 2 (vigilance interval: 1<sup>st</sup> half vs. 2<sup>nd</sup> half) x 2 (gender) interaction between stimulus type, direction of target rotation, and vigilance interval,  $F(1, 28) = 5.974, p < .05, MSE = .02, \eta^2 = .211$ .

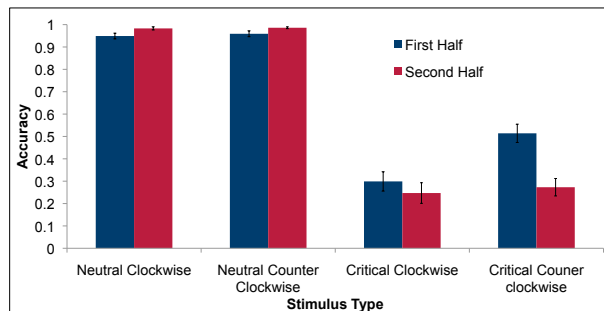


Figure 2

## Discussion

Overall there was a significant difference in performance according to type of stimulus. That is, accuracy in detecting the stimulus target type was always greatest for the neutral stimuli. This is as expected because of the much greater number of targets of this type (96%) as compared with the fewer number of critical target stimuli (4%). Additionally, the analyses also indicated a reliable difference between performance in the first half of the vigilance task and that in the second half (compare the two graphs). That is, detection was better in the first vigilance interval for targets rotated counter-clockwise, but slightly worse for both neutral and critical signals in the second vigilance interval. As also can be seen in the graph depicting the data for the first vigilance interval (top graph), however, while there was no difference in direction of rotation for neutral stimuli, there was a reliable (significant) difference in rotation for critical stimuli. There was no effect of gender differences in any of the analyses. Follow-up analyses of these data and evaluation of confidence in detection are underway.

## Implications

Future research on sustained attention tasks can be applied to many fields. Current research has been focusing on children with primary language development, narcoleptic patients, and ADHD sufferers who seek the natural ability to sustain their attention, but having difficulties doing so. Investigations into the cerebral blood flow during vigilance tasks could make way for scientists and researchers to understand the allocation of nutrients to the cortex when performing tasks that require sustained attention. Measuring individual differences within sustained attention tasks has become a new frontier for research in human factors. Further investigation into the possibility of altering or increasing an individuals' attention span while simultaneously decreasing workload is another promising avenue of future research.

## References

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