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## Individual differences in performance, workload, and stress in sustained attention: Optimism and pessimism

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### ABSTRACT

The relationship between optimism, pessimism and vigilance was investigated as a function of the degree to which different display formats facilitated performance across types of perceptual discrimination. Pessimism was associated with display and task dependent differences in workload, stress, and coping strategy. Optimism by pessimism interaction was observed for stress (Tense Arousal). Neither trait was associated with performance differences. Pessimism, but not optimism, was related to coping strategy independent of experimental condition. The results of this study were more consistent with a coping/cognitive resources perspective on optimism and pessimism than with an explanation based on learned helplessness theory. Further, the data supported the contention that optimism and pessimism are correlated but distinct constructs. The results also underscore the importance of considering both task parameters and person characteristics when evaluating the performance, workload, and stress of sustained attention.

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### 1. Introduction

Vigilance, or sustained attention, refers to the ability to monitor displays over time. Vigilance performance declines with time on watch, in part because cognitive resources available for task performance are depleted at a rate faster than they can be replenished (Parasuraman, Warm, & Dember, 1987). The resource theory explanation is supported by the finding that perceived workload and stress increase as a function of increased task demands (Warm, Matthews, & Finomore, 2008). Several studies of the workload of sustained attention have employed the NASA-Task Load Index (TLX; Hart & Staveland, 1988), a well-regarded measure that provides a global index and the relative contributions of six sources of workload (*Mental Demand*, *Physical Demand*, *Temporal Demand*, *Performance*, *Effort*, and *Frustration*). Research has shown that task characteristics that impair performance also induce high workload, and that the *Mental Demand* and *Frustration* subscales are the largest contributors to these effects (Warm et al., 2008). Stress has been measured using the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 2002), which consists of eleven factor-analytically determined scales grouped into three secondary factors of cognitive state: *Task Engagement*, reflected by scales of Energetic Arousal, Concentration, and two Motivation scales (Intrinsic and Success); *Distress*, consisting of primary factors of Tense Arousal,

Hedonic Tone, Self-Esteem, and Control and Confidence; and *Worry*, reflected by scales of Self-Focused Attention and two forms of Cognitive Interference (Task-Related and Task-Irrelevant). Several studies have shown that vigilance is associated with declines in *Task Engagement* and increased *Distress*, and that task factors that impair performance also increase the stress of vigilance (Warm et al., 2008). Further, the limited control observers typically have over the task environment may also be a significant source of stress in vigilance (Hancock, 1998).

Although the effects of vigilance on performance, workload, and stress are robust, large within-group variability is typically observed. Research on the individual differences variables driving this variability have produced mixed results (Berch & Kanter, 1984), and the interactive effects of person and task characteristics have yet to be clearly identified (Szalma, 2008). One skill that may differentiate good performers from poor ones is the capacity to cope with high workload and stress. Traits that influence vigilance may therefore include those related to stress and coping, such as optimism and pessimism. Optimism and pessimism have been defined in terms of differences in expectancies regarding the future, with the former associated with more favorable expectancies than the latter (Scheier, Carver, & Bridges, 1994). Further, optimism and pessimism have been found to be associated with differences in performance and stress response. For instance, using a double median-split approach to categorize individuals as 'optimists' or 'pessimists', Helton, Dember, Warm, and Matthews (1999) reported that although there were no significant differences between

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trait groups in overall performance, pessimists achieve a steeper vigilance decrement and higher levels of post-task stress relative to optimists. Efforts to replicate the performance results have been mixed (e.g., Helton, Matthews, Warm, & Dember, 2005; Szalma, Hancock, Dember, & Warm, 2006), but subsequent experiments confirmed that pessimism is associated with higher levels of stress in vigilance (e.g., Szalma et al., 2006).

One of the major theoretical approaches to explain differences in performance and stress response as a function of optimism and pessimism has been learned helplessness theory (Abramson, Seligman, & Teasdale, 1978), which argues that differences occur because pessimistic individuals have learned to habitually disengage or 'give up' in difficult or demanding situations or when failure occurs. Further, these outcomes are related to two expectations: Outcome (hopeless expectancies) and control (helpless expectancies). These expectancies operate by a diathesis–stress mechanism: Individuals who are pessimistic are more vulnerable to helpless and hopeless responses in stressful situations (Gillham, Shatte, Reivich, & Seligman, 2002). On the basis of learned helplessness theory, Gillham et al. (2002) argued that the positive expectations of optimistic people should facilitate motivation to maintain performance in the face of difficult situations, but that pessimistic expectancies should reduce effort and impair performance.

However, it is possible that individual differences in performance and stress may be due to the different styles of coping (Scheier et al., 1994) and differences in cognitive resources available for task performance (Szalma, 2008). Optimism has been associated with lower stress levels, and greater active or problem/task-focused coping and less avoidant coping, while pessimism has been associated with higher levels of stress, and more emotion-focused and avoidant coping (Scheier et al., 1994). As a result of more active coping, individuals high in optimism may devote more of their resources to task performance, while individuals high in pessimism may have fewer resources to allocate to the task because they are diverting some of their resources to either emotion-focused or avoidant coping efforts to deal with the stress posed by the task demands. Alternatively, it is also possible that more pessimistic individuals have learned ways of engaging in compensatory effort in order to maintain performance. If this were the case, one would expect attenuated performance differences but higher perceived workload and stress as a function of increased pessimism.

The resource theory perspective leads to the prediction that task difficulty should moderate the relation between optimism, pessimism, and performance, workload, and stress, such that individuals higher in pessimism and lower in optimism should exhibit greater performance decrements and increased workload and stress as task difficulty is increased. However, task characteristics that facilitate performance (e.g., render the perceptual discrimination easier) should have a larger positive effect on individuals higher in pessimism and lower in optimism, because such individuals presumably have fewer cognitive resources to devote to the task and will therefore benefit more from a manipulation that reduces the resources required for performance. By contrast, the helplessness theory leads to the prediction that imposition of a difficult vigilance task, in which observers have little or no control over task parameters (Hancock, 1998), should elicit helplessness appraisals across task conditions, so that individuals higher in pessimism will show similar patterns of performance, workload, and stress response regardless of task/display characteristics.

In vigilance research one of the most potent determinants of task difficulty is signal salience. High salience has been found to improve performance and relieve the workload and stress of sustained attention (Warm et al., 2008). One way in which signals can be made more salient is via the use of configural displays, which utilize easily perceived features that improve performance for tasks requiring integration of information (Bennett & Flach,

1992). Such displays work in part because the elements form an easily perceivable, integrated feature that 'pops out' and is much more salient than displays with separated elements without such feature integration. A previous study found that use of a configural display was associated with an attenuated vigilance decrement, possibly due to enhanced signal salience (Szalma et al., 2006). Hence, use of these display formats for tasks requiring integration of information may improve performance and reduce workload and stress. By contrast, cases in which display features do not support the discrimination requirements of the task should have substantially lower signal salience, and individuals higher in pessimism and lower in optimism may show greater vulnerability to performance impairment and increased workload and stress. The current study evaluated this possibility by manipulating display format and the degree to which it facilitated the perceptual demands of the task (i.e., the difficulty of the discrimination). Based on resource theory, it was expected that in the more demanding task conditions (in which the display format is not well suited for the perceptual discrimination required) pessimism should predict more emotion-focused coping and avoidant-coping, higher stress levels, and greater perceived workload. Higher levels of optimism should predict greater task-focused and less emotion-focused and avoidant coping, and lower levels of workload and stress. In the easier conditions the benefits of a display format that facilitates performance should be greater for those higher in pessimism and lower in optimism. Based on previous research (Helton et al., 1999), if there are performance differences as a function of traits it will likely manifest in changes over time, such that increased pessimism should be associated with a steeper decrement and optimism should be related to an attenuated decrement in the more demanding conditions.

## 2. Method

This study was designed to examine both group and individual differences. The group differences are summarized elsewhere (Szalma, 2002); this report focuses on investigation of individual differences. Hence, only general information regarding the experimental procedure and the tasks is reproduced here.

### 2.1. Participants

Ninety-six undergraduates (48 men and 48 women) at a north-eastern US university participated in the study in exchange for course credit. They ranged in age from 18 to 46 years old, with a mean of 20.8 years.

### 2.2. Experimental design

Two levels of task-type (dot-figure distance monitoring vs. midpoint identification) were factorially combined with three display types: Bar-graph with different baselines (BGDB), bar-graph with a common baseline (BGCB) and a polygon-graph (PG), yielding six experimental groups. The BGCB and PG displays facilitate performance on midpoint identification tasks, but do not support performance on tasks requiring discrimination of separate display elements (Bennett & Flach, 1992). The BGDB display does not facilitate performance on either task. Sixteen observers were assigned at random to each of the six conditions, with the restriction that the groups were equated for participant sex.

### 2.3. Displays and tasks

The displays employed were adapted from those used in previous research (see Bennett & Flach, 1992), and are shown in Fig. 1. In the midpoint identification task input and output values in the bar-

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