A META-ANALYSIS OF THE EFFECT OF TIME PRESSURE ON HUMAN PERFORMANCE
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A quantitative review of time pressure effects on human performance was conducted. One-hundred-twenty-five references were identified that met selection criteria. These studies provided 827 effect sizes. Analyses revealed an overall small but detrimental effect of time pressure on performance. However, moderator analyses indicated that the effect of time pressure varied as a function of task type and the measure of performance (accuracy vs. speed). As expected, time pressure facilitated speed but impaired accuracy for both perceptual and cognitive tasks. Although there were few studies available for motor tasks, evidence from the available studies indicated that time pressure reduced speed. Accuracy data were inconclusive. Across all analyses there was evidence of substantial variability across studies, indicating that other moderating variables may influence the performance effects of time pressure.

INTRODUCTION

One of the most proximal sources of stress in operational settings is often the task itself (Hancock & Warm, 1989). Hancock and Warm (1989) identified two fundamental task dimension that influences the level of stress and the resulting adaptation by the individual, that of information structure and information rate. In real-world settings temporal constraints often impose considerable stress and workload on operators, as anyone who is pressed to meet proposal deadlines can attest. However, to date there have been no systematic, quantitative reviews of the effects of time pressure on human performance. In the present study, we examined the effect of time pressure on human performance and the effects of two task moderators. The first moderator was the type of task performed, with tasks categorized as perceptual, cognitive, or psychomotor. The second moderator was the type of dependent measure (i.e., whether measure reflects accuracy or speed. Previous meta-analyses have indicated that these moderators influence the relationship between environmental sources of stress and performance (Conway, Szalma, & Hancock, 2007; Hancock, Ross, & Szalma, 2007; Ross et al., 2006).

METHOD

Literature Accumulation

Given the immense size of the time pressure literature, only a portion of research reports was gathered. These studies were obtained by consulting PsycINFO, MEDLINE, Dissertation Abstracts International databases, and Science Citation Index. This process resulted in identification of 281 articles, reports, dissertations, and theses. Of these, 125 papers were identified which met the selection criteria for inclusion. These 125 studies resulted in 827 effect sizes.

Identified Criteria for Study Inclusion

Each acceptable paper included in the meta-analysis possessed the following four criteria:

1) Only studies that presented empirical findings (i.e., review papers were excluded) regarding the effect of time stress (e.g., instructions to complete tasks as quickly as possible, deadlines, or stimulus presentation rate) on performance were included
2) A control condition in which no time pressure was imposed was required.
3) The dependent variable must measure performance of a healthy adult human participant.
4) Each study had to present enough information to obtain effect size statistics.

The Calculation of Effect Sizes

Pair-wise effect-sizes (Hedges’ g), is a standardized mean difference between the experimental and control conditions (Hedges & Olkin, 1985). Formulas upon which effect size was calculated are found in Lipsey and Wilson (2001)
and Hedges, Shymansky, and Woodworth (1989). In calculating the effect size, the sign of the effect size was controlled to ensure that a positive score represented improvement in performance in the experimental group relative to the control group, whereas a negative g-score indicated performance impairment. The culminated effect-size statistics were then computed and adjusted for statistical bias and methodological differences (i.e., between- vs. within-subjects design) based on formulas available in Lipsey and Wilson (2001) and Morris and DeShon (2002).

For comparison purposes, it is helpful to keep in mind Cohen’s (1988) guidelines to interpreting effect sizes as small ($g \leq 0.20$), medium ($g \approx 0.50$), or large ($g \geq 0.80$).

**Variance Estimates**

In addition to the weighted mean effect size, two variance estimates were computed: variability due to sampling error ($s_e^2$) and variability of the effect sizes ($s_g^2$). These values were used to estimate the variability due to differences in the population effect sizes, $\delta$ ($s_\delta^2$). A large $s_\delta^2$ may indicate that there is variability among the observed effect sizes that cannot be accounted for by sampling error and that there are likely to be one or more variables moderating the magnitude of the effect in question. These correspond to the random effects model described by Hunter and Schmidt (2004).

**Moderator Analyses**

It is important to note that most of the studies used in the current analysis reported multiple effect-size estimates (e.g., effect-size values for three tasks reported in one study). Thus, many of the included effect sizes were derived from common participant samples, violating the assumed independence between effect-size estimates. These violations can lead to underestimation of the variance due to sampling error. To avoid such violations effects were averaged within studies prior to estimating means and variances (see Lipsey & Wilson, 2001). In moderator analyses this averaging procedure was conducted within each level of the moderator variable (e.g., across all variables for a general effect or only within tasks for a task moderator analysis).

**RESULTS**

The weighted average effect size for the effect of time pressure on performance across all task types and performance measures was $g = -0.19$ ($k = 125$), indicating a small negative effect on performance. The confidence interval based on the sampling error associated with this effect size ($s_e^2$) indicated that mean effect was statistically reliable (-0.23 $\leq \delta \leq -0.15$). However, adopting the ‘75% rule’ recommended by Hunter and Schmidt (2004), it is clear that a substantial portion of the observed variance ($s_\delta^2$) cannot be accounted for by sampling error and is likely due to moderating factors $[(s_e^2)/(s_\delta^2) = 0.02]$. The moderator analyses for task type and measure of performance are shown in Table 1. Time pressure had small to moderate effects within each task type, although the effect on cognitive and motor tasks was impaired by time pressure while the effect associated with perceptual tasks was facilitative. As one might expect, time pressure results in faster but less accurate responding. In both cases, the effects were in the medium range (Cohen, 1988). However, inspection of Table 1 reveals that less than 8% of the observed variance in effect sizes can be accounted for by sampling error.

To investigate this heterogeneity further, a hierarchical meta-analysis of dependent measure within each task type was computed. These results are shown in Table 2. Note that for performance accuracy associated with motor tasks only two effect sizes were observed. Thus, variance data for these are not reported, although the weighted mean effect size and each individual effect size are shown in the table. It is not unusual in meta-analyses of stress and human performance to observe instances in which there are few or even no studies that provided an effect size (e.g., Conway et al., 2007).

As can be seen in Table 2, response time is facilitated and accuracy impaired for both cognitive and perceptual tasks, although the effect is stronger for cognitive as compared to perceptual tasks. For motor tasks response time is actually slower under time pressure, although these data should be
interpreted with considerable caution as there were relatively few studies employing motor tasks. Indeed, for accuracy no clear conclusion is possible with respect to motor tasks, as one effect size was strong and positive while the other was strong and negative.

DISCUSSION

The results of this meta-analysis confirmed that time pressure effects are not equivalent across tasks and that while they may induce faster responding, they do so at the expense of accuracy. However, it is noteworthy that across all analyses the proportion of variance due to sampling error was only a small proportion of the total observed variance in the effect sizes. Such ratios indicate that a substantial proportion of observed variance is due to factors other than sampling error. Future work will examine potential variables such as duration of task performance under time pressure, sex differences, and the nature of the time pressure manipulation. Nevertheless, these data confirm an important conclusion from prior meta-analyses of the effects of environmental stressors on performance (e.g., Conway et al., 2007; Hancock et al., 2007; Ross, et al., 2006): More research is needed to identify other factors (e.g., the presence of multiple stressors) that moderate the relationship between sources of stress in the environment and task performance.

REFERENCES


**Table 1: Moderator Analysis for Task Type and Measure of Performance**

<table>
<thead>
<tr>
<th>Category</th>
<th>k</th>
<th>$\bar{d}$</th>
<th>$s_e^2$</th>
<th>$s_d^2$</th>
<th>95% CI ($s_e^2$)</th>
<th>($s_e^2$)/($s_d^2$)</th>
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<tr>
<td>Perception</td>
<td>29</td>
<td>0.2</td>
<td>0.07</td>
<td>1.51</td>
<td>0.10&lt;δ&lt;0.29</td>
<td>0.05</td>
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<tr>
<td>Cognitive</td>
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<td>-0.25</td>
<td>0.06</td>
<td>3.7</td>
<td>-0.31&lt;δ&lt;-0.20</td>
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<tr>
<td>Motor</td>
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<td>-0.34</td>
<td>0.18</td>
<td>2.52</td>
<td>-0.68&lt;δ&lt;-0.00</td>
<td>0.07</td>
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<tr>
<td>Accuracy</td>
<td>92</td>
<td>-0.6</td>
<td>0.09</td>
<td>5.01</td>
<td>-0.66&lt;δ&lt;-0.54</td>
<td>0.02</td>
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<tr>
<td>RT</td>
<td>76</td>
<td>0.42</td>
<td>0.11</td>
<td>2.46</td>
<td>0.35&lt;δ&lt;0.07</td>
<td>0.04</td>
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</tbody>
</table>

**Table 2: Moderator Analysis of Dependent Measure with in Each Task Category**

<table>
<thead>
<tr>
<th>Category</th>
<th>K</th>
<th>$\bar{d}$</th>
<th>$s_e^2$</th>
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<td>2.5</td>
<td>0.14&lt;δ&lt;0.38</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>69</td>
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<td>0.09</td>
<td>5.6</td>
<td>-0.73&lt;δ&lt;-0.59</td>
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<td>0.11</td>
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<td>Motor</td>
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<tr>
<td>Accuracy</td>
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* effect sizes: g = -0.9; g = 1.01