INDIVIDUAL DIFFERENCES RELATED TO SHOOTING PERFORMANCE, IN A POLICE NIGHT-TRAINING SHOOTING EXERCISE

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Increased understanding of the stress and performance effects of gun range drills with police officers is of importance for law enforcement trainers. Seventy-one police officers participated in routine night shooting drills over a two week period as part of regular training regimen. This paper examines the effects of two shooting range tasks on police officer’s time perception, individual differences, and shooting performance. Theoretical considerations led to the hypothesis that performance changes under stress may be related to distortions in the perception of time. However, the results of this study do not provide strong evidence for nomothetic effects of time distortion. Rather, it is more likely a function of individual differences. Future studies will examine potential individual differences variables that influence the relation between time distortion under stress and task performance.

INTRODUCTION

Police officers are acutely aware of the dangers of policing, and patrol officers in particular are often at the greatest risk, since they are the first officers encountered by victims, suspects and witnesses. Patrol officers frequently operate in hostile environments, confronting variable levels of threat and danger. For instance, in 2002 55 law enforcement officers were shot to death and 58,066 were assaulted in the U.S. of the latter, 16,494 sustained serious injury (FBI, 2003). Officers are taught that a key line of defense against violent assault is their firearm, and the skill and judgment with which they use it. Therefore officers are required to complete routine firearms assessment and training programs, such as the one described in this study. There has been very little research on the factors that influence performance in these routine shooting exercises. In this study we assessed the perceived workload, shooting performance, and time perception of officers engaged in these exercises. Detailed understanding of the officers’ performance and stress level in the training exercise can lead to improved training procedures and thereby enhance shooting performance in real-world threatening situations.

The way people estimate time can possibly be manipulated by stress state. As Hancock and Warm (1989) have noted, tasks themselves are often the proximal source of stress, and individuals cope with this stress by narrowing their attention to specific cues in the environment (Easterbrook, 1959). Hancock and Weaver (2004) have shown that such narrowing occurs along the temporal domain, resulting in distortions of perceived time. At a phenomenological level, individuals who experience ‘time distortion’ under stress report one of two forms of experience, in which times appears to speed up or slow down (see Fair, 1984). Both of these patterns represent effects of ‘time in memory’ that are evident in the memory for the event. In stress conditions sufficient to induce time distortion, the increase in event registration must be substantial but to a level yet to be determined by empirical investigation. Temporal distortions may occur anywhere that insufficient attention is directed to temporal cues (Hancock & Weaver, 2004). However, evidence regarding time distortion under stress has been largely anecdotal in nature.

Field evaluations are of great importance to the study of performance under stress because they provide a realistic setting for observation. The current study examines individual differences, performance and time perception of police officers in gun training exercises. Of particular interest is the sensitivity of the Adjective Checklist as developed by Goldberg (1992) to measures of shooting performance.

METHOD

Participants

Participants were 71 police officers (10 women and 61 men) from a police department in the southeastern United States. The average age was 37 years (range 22-56 years). Police officers are required to participate in the evening night shooting exercise as part of their regular training schedule. However, they volunteered to participate in the research while performing the shooting exercise. Their decision whether to participate in the study did not influence their performance evaluation by their instructors.

Instrumentation

Officers were equipped with their personal SIG (Schweizerische Industrie Gesellschaft) Sauer p226 9mm handgun. All officers used the same standard issued duty belt with identical magazine pouches. Each officer also carried a standard department issue Streamlight Stinger flashlight 7.4 inches long and weighing 10 oz. All officers were required to wear a protective vest, hearing protection (external muffs, or internal plugs) and clear eye protection. The ammunition used for the task is a special bullet designed to shatter on contact with metal targets so as to reduce the likeliness of ricochet.

Materials

Self-reports of stress were measured using the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 2002; see also Matthews et al., 1999). The DSSQ is composed of eleven factor analytically determined scales, organized into three secondary factors, reflecting the observer’s cognitive and emotional states. These include Tense Arousal, Hedonic Tone, and Confidence and Control, reflecting the individual’s degree of Distress; Energetic Arousal, Concentration, and two kinds
of Motivation (Intrinsic and Success; see Matthews, Campbell, & Falconer, 2001), which indicate the individual’s degree of Task-Engagement; and Self-Esteem, Self-Focused Attention, and two forms of Cognitive Interference (Task-Irrelevant and Task-Related) which reflect the individual’s degree of Worry. Following the instructions for the exercise participants completed the pre-DSSQ, after which they began Task A. Upon completion of all tasks, participants were administered the post-DSSQ.

Personality differences were measured using the adjective checklist (ACL) developed by Goldberg (1992) to assess the “Big Five” factors of personality. Following the instructions for the exercise participants completed ACL.

Task Design

The night shooting exercise included four different shooting tasks (referred to as Tasks A-D). The tasks differed in complexity and in their settings however, the major difference between tasks A, B, C and Task D was that in Tasks A, B, and C officers were aiming at paper targets and therefore in the dark could not easily gauge their performance, while Task D was a feedback shooting task where the officers aimed toward metal targets where they could clearly hear whether they hit the target or not. Tasks also build up in difficulty and the two more complex tasks were tasks C and D. For the purpose of this study, the order of the last two tasks varied among participants, hence the order of the tasks was either A, B, C, and D, or A, B, D, and C. However due to the non-intervening nature of the study we did not have any control on who will be in either one of the conditions and therefore can not claim homogeneity of groups.

The order of the tasks (Task C and Task D) was counterbalanced between participants. The tasks differed in complexity and in their settings however, the major difference between the tasks was that Task C was a non-feedback shooting task where the officers aimed toward paper targets (and in the dark could not easily gauge their performance). While Task D was a feedback shooting task where the officers aimed at metal targets and could immediately receive feedback regarding their performance as a result of the sound of the bullet hitting the metal target. In both tasks the participants were running from target to target and aiming at different targets following the instructions of the shooting range instructor.

Procedure

Officers attended the training session in groups of six to twelve each, but each officer performed each task separately. The training session took place in the dark at an outdoor police shooting range, and the total session time varied from approximately 60 minutes to 120 minutes depending on the number of officers in the session. All officers were given the same instructions for procedural and safety reasons. Additionally, the officers were told that they will be asked by the experimenter to estimate of the task length in minutes and seconds upon completion of each task (Task C and Task D). There was short break between tasks.

RESULTS

Performance Measures

Shooting performance was calculated separately for each task by calculating the percentage of hits from the total shots made. This measure is the most simplified measure of performance because within each task shots were made from different ranges, so shooting accuracy and difficulty varied even within a single task. However, the hit percentage provides a global indication of how well officers performed on each task.

As expected, hit rate varied among tasks where the highest rate was found in Task A which was a stationary warm up task (74%, SD=19%), followed by Task B (65%, SD=22%), Task D (63%, SD=15%) and Task C (57%, SD=20%). There were significant differences between task A and the other tasks, and between task B and Task C, but there were no significant differences between Task C and Task D and between Task D and Task B, as shown in Table 1. We also found correlations between Task A and Task B, Task A and Task C, and Task B and Task C but no correlation with task D which was a metal shooting target while the other three were paper shooting targets. This may indicate that although the task itself has changes and became significantly more complicated (which is reflected by the degradation in hit rate) overall, the paper shooting target tasks were “more of the same” while the metal target in Task D provided “something different”. Changing the order of the tasks between Task C and Task D did not have any effect on the shooting performance.

Table 1 – Pairwise Comparisons and correlations of hit percentages among the four tasks

<table>
<thead>
<tr>
<th>Task (I) – (J)</th>
<th>Mean (SD)</th>
<th>t</th>
<th>Sig.</th>
<th>Cohen-d</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – B</td>
<td>9 (19)</td>
<td>4.1 (70)</td>
<td>.001</td>
<td>.44</td>
<td>.58*</td>
</tr>
<tr>
<td>A – C</td>
<td>16 (20)</td>
<td>6.9 (70)</td>
<td>.001</td>
<td>.87</td>
<td>.47*</td>
</tr>
<tr>
<td>A – D</td>
<td>11 (25)</td>
<td>3.5 (65)</td>
<td>.001</td>
<td>.64</td>
<td>.10</td>
</tr>
<tr>
<td>B – C</td>
<td>7 (22)</td>
<td>2.8 (70)</td>
<td>.007</td>
<td>.38</td>
<td>.45*</td>
</tr>
<tr>
<td>B – D</td>
<td>2 (24)</td>
<td>0.6 (65)</td>
<td>.574</td>
<td>.10</td>
<td>.21</td>
</tr>
<tr>
<td>C – D</td>
<td>-6(24)</td>
<td>-1.9 (65)</td>
<td>.061</td>
<td>.34</td>
<td>.15</td>
</tr>
</tbody>
</table>
**Personality and Individual differences**

We divided the shooters data into two groups where the criterion was overall performance above or below the median (median was average hit rate of 65%).

Figure 1.
The Big-Five profile for shooting performance (median split for performance).

![Big-Five profile for shooting performance](image)

Marginally significant differences in between groups were found for Agreeableness (M=140.0, SD=15.0 and M=129.9, SD=19.3, accordingly) \( t(25)=2.01, p<.055, \) Cohen’s \( d=0.59 \) and for Intellect (M=129.9, SD=17.6 and M=119.0, SD=23.9, accordingly) \( t(25)=1.95, p<.065, \) Cohen’s \( d=.51 \) as shown in Figure 1.

**Time Perception**

Time estimations were made under the prospective paradigm, where the officers knew in advance that they will be asked to judge the duration of the task. Prospective time estimations were made for Task C and Task D separately, these two tasks were also counterbalanced between group 1 (those who performed Task C before they performed Task D) and group 2 (those who performed Task D before they performed Task C).

The average actual time for Task C was 59 seconds (SD=13), and for Task D was 57 seconds (SD=19). The average estimated time for Task C was 64 seconds (SD=44), and for Task D was 66 (SD=51). Actual time and estimated time scores were used to compute two time estimation measures. These were the duration judgment ratio (DJR; Block, Zakay, & Hancock, 1999), which is the ratio between the estimated time and the actual time in minutes and seconds (in percentages), and the absolute error which represents the distance between the estimated time and the actual time (also in percentages). Descriptive statistics for both measures are given in Table 2 and Table 3. From the descriptive statistics it can be seen that approximately 60% of the officers underestimated the duration of the task (thought that the task was shorter than it actually was), however, the variability between officers was large and the absolute error measure (Table 3) indicates that on average the time estimations were quite distant form the actual time (over 40%). Underestimation of time is quite expected considering that the time estimation was not the primary task (Zakay, 1998). The correlation between the DJR of the two tasks was significant \( (r = .456, p<.001) \), and respectively, the correlation between the Absolute error of both task was also significant \( (r = .288, p<.05) \). Thus, officers were relatively consistent in the estimation of time.

<table>
<thead>
<tr>
<th>Task</th>
<th>N</th>
<th>Mean (std. dev)</th>
<th>Min</th>
<th>Max</th>
<th>Median</th>
<th>Percentage of overestimations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task C</td>
<td>71</td>
<td>109 (68)</td>
<td>21</td>
<td>450</td>
<td>93</td>
<td>43.5</td>
</tr>
<tr>
<td>Task D</td>
<td>69</td>
<td>116 (70)</td>
<td>13</td>
<td>380</td>
<td>94</td>
<td>40.8</td>
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</table>

<table>
<thead>
<tr>
<th>Task</th>
<th>N</th>
<th>Mean (std. dev)</th>
<th>Min</th>
<th>Max</th>
<th>Median</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task C</td>
<td>71</td>
<td>44 (52)</td>
<td>2.59</td>
<td>351</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Task D</td>
<td>69</td>
<td>49 (53)</td>
<td>.67</td>
<td>280.17</td>
<td>34</td>
<td></td>
</tr>
</tbody>
</table>
**Perceived Stress**

Participant’s responses on the pre- and post-DSSQ were used to calculate outcome scores (OS) on eleven scales using the formula (post-score–pre-score/SD), where the standard deviation used was from a large normative group reported by Matthews et al. (1999), except the two motivation scales, for which normative values were not available. For these scales, sample standard deviations were used (Matthews, Campbell, & Falconer, 2001). Significant effects were observed for Energetic Arousal $t(64)=3.09$, $p<.005$, $MSE=.10$, reflecting differences in Task Engagement. A significant effect was also observed for the Tense Arousal $t(64)=5.31$, $p<.001$, $MSE=.14$, Hedonic Tone $t(64)=-2.47$, $p<.05$, $MSE=.13$ and Control & Confidence $T(64)=-2.37$, $p<.05$, $MSE=.15$, reflecting differences in Distress. For Hedonic Tone and Control & Confidence we found moderate correlation with the overall performance scores (collapsed over the four shooting tasks) (0.26, 0.41, accordingly) implying that those who performed better felt less distressed. There were no significant differences for Worry or for Motivation.

**DISCUSSION**

Time estimates, especially of short durations involve cognitive processes that are sensitive to contextual conditions. The variability in time estimations, and the relative mixed literature on the topic of time estimation provided for no discernable outcome in the results for this part of the experiment. The unexpected findings for agreeableness and intellect in relationship to performing better on gun range task using the adjective checklist (Goldberg, 1992) provides an avenue for future research questions. A big 5 metaanalysis conducted by Salgado (1998) using army studies found very little information about agreeableness and intellect. Agreeableness which uses adjectives such as kindness, cooperative, considerate, pleasant. Possibly, the implications for understanding the effects of participating in a cooperative task and how that relates to the outcome of shooting performance can be predicted by agreeableness. Intellect uses adjectives such as intellectual, creative, complex, bright. Intellect may possibly be related to the nature and complexity of the task. Our future studies will attempt to explore and further reexamine these findings.

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**REFERENCES**


