Effects of anxiety on police officers' shooting behavior under pressure

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Abstract

The current pilot study aimed at providing an initial assessment of how anxiety influences police officers' shooting behavior. Seven police officers participated and completed an identical shooting exercise under two experimental conditions: low anxiety, against a non-threatening opponent, and high anxiety, against a threatening opponent who occasionally shot back using colored-soap cartridges. Measurements included shooting accuracy, movement times, head/body orientation and blink behavior. Results showed that under high anxiety, shooting accuracy decreased. Underlying this degradation of performance, participants acted faster and made themselves smaller to reduce the chance of being hit. Furthermore, they blinked more often, leading to increases in the amount of time participants had their eyes closed. Findings provide support for attentional control theory, hereby also pointing to possible interventions to improve police officers' shooting performance under pressure.

Keywords: anxiety, perceptual-motor performance, speed-accuracy trade-off, efficiency, attentional control theory.

Effects of anxiety on handgun shooting behavior of police officers: a pilot study

Many professions exist in which people have to perform perceptual-motor tasks within a high-pressure context. For example, police officers can experience high levels of anxiety when struggling to handcuff a suspect or when unexpectedly confronted with an armed and dangerous opponent (Anderson et al., 2002). Recently, Oudejans (2008) showed that police officers' shooting performance decreased under pressure. Given the criticality of a successful shooting performance in the line of duty, such a finding specifies a need to further our understanding of how anxiety affects performance, especially if decrements are to be prevented in the future (see also Oudejans, 2008).

A comprehensive theory accounting for the mechanisms behind the anxiety-performance relationship is attentional control theory (ACT; Eysenck et al., 2007), which has recently been developed on the basis of processing efficiency theory (PET; Eysenck & Calvo, 1992. According to ACT (and PET), anxiety may influence performance in two ways (negative and positive). First, anxiety is thought to draw attention away from task-relevant information towards more distracting stimuli such as threat-related information and internal worries, leaving less attention available to perform the task at hand. Secondly, anxiety may also serve a motivational function in that individuals can compensate for the debilitative effects of anxiety by increasing the amount of mental effort they invest in maintaining a task-relevant focus. In this way, anxiety primarily affects processing efficiency, while performance effectiveness remains the same. Although ACT and PET are originally developed to explain the effects of anxiety on cognitive performance, an increasing number of studies has provided support for their predictions within a perceptual-motor context (e.g., Hardy & Hutchinson, 2007; Oudejans & Pijpers, 2009).

Building on the results of Oudejans (2008), the current pilot study aimed to discover which underlying elements of performance are negatively affected in police officers' execution of a stressful shooting task. Regarding the predictions of ACT, assessments were made of participants' performance effectiveness (shooting accuracy) as well as several behavioral processes (movement speed, head/body orientation, blink behavior) providing possible indications of efficiency. Furthermore, the amount of mental effort invested in task execution was assessed. In line with the results of Oudejans (2008) we expected that shooting performance would decrease under high anxiety. Underlying this decrease in performance we expected to observe less efficient, more stimulus-driven shooting behavior. This would be indicated by faster movement times (less time for aiming; e.g., Behan & Wilson, 2008; Vickers & Williams, 2007), changes in head/body orientation (e.g., facing away from the opponent), and increased blinking (e.g., Mol, Baas, Grillon, Van Ooijen, & Kenemans, 2007), each of which is potentially limiting the possibility to pick-up task-relevant information.

Method

Participants

Seven police officers participated (6 men, 1 woman; mean age = 23.8 years, SD = 2.0; mean experience on the police force = 3.4 years, SD = 2.4). Participants had successfully passed their annual shooting tests and, thus, had a full license to carry their weapon. The participants' trait anxiety scores ($M = 33.29$, $SD = 5.82$; STAI A-Trait Scale) were not significantly different from the norm (i.e., 36.7; $t(6) = 1.28$, $p > .05$; Van der Ploeg, Defares, & Spielberger, 1979; 1980) implying that they had no extraordinary tendency to respond across many situations with high levels of state anxiety. All participants provided written informed consent. The study was approved by the Ethics Committee of the research institute. Given the involvement of firearms the study was executed under the responsibility of certified police firearms instructors, following their standard safety protocol.

Task and conditions

The experiment consisted of a low-anxiety and a high-anxiety condition, which were counterbalanced among participants. In both conditions, participants performed an identical shooting exercise consisting of 10 repetitive trials in which they had to fire 4 rounds (totaling 40 rounds per condition) at an opponent fitted with white target areas (one on the chest: 28 cm × 28 cm, and two on the upper legs: 12 cm × 35 cm). The distance between the participant and the opponent was set at 5 m, which is in line with average shooting distances seen in reality (e.g., Naeyé, Timmer, & Beijers, 2001).

Beginning at a starting signal (a beep) participants fired one round at the opponent's right leg target, made a step to the right, fired one round at the opponent's left leg target, reloaded their handgun, fired one round at the opponent's chest target, stepped back to the left and fired another (final) round at the chest target.

In the low anxiety (LA) condition, the opponent was a life-size mannequin, which stood straight-up facing the participants and was suited with a black protective overall, facemask, throat protector, and hand gloves. In the high anxiety (HA) condition, the opponent was an experienced police firearms instructor (wearing the same clothes and protective items, fitted with the same targets and also standing still) who occasionally fired back using colored soap cartridges (see Oudejans, 2008). Being hit with these cartridges produced a sensation of pain, the threat of which was expected to cause an increase in the participants' state anxiety. To ensure that this threat maintained realistic throughout the HA condition (and to minimize any physical inconvenience caused by the pain associated with being hit) the opponent shot back on a limited number of trials (i.e., 7 shots in total, randomly divided over half of the trials).[1]

Experimental set-up

The experiment was set-up in a large dojo at the facilities of the police academy. Participants shot with 9 mm hand-guns, identical to their duty weapon (Walther P5) and specifically prepared to fit colored soap cartridges (Simmunition, FX Marking Ammunition). In both conditions, participants' were recorded on video from the side using a digital video camera (29.97 Hz). Furthermore, shooting times were registered with a shot timer. Finally, participants also wore a mobile eye tracker (Applied Science Laboratories, Bedford, USA). The mobile eye is a monocular system that consists of two cameras, an eye camera and a scene camera (29.97 Hz), which are mounted on a pair of glasses. While the mobile eye is normally used to asses participants' direct line of gaze based on the images of both cameras combined, we used the images of each camera separately to provide measures of head/body orientation (scene camera) and blink behavior (eye camera).[2]

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[1] In order to check whether differences in shooting accuracy would be due to anxiety and not to shooting back per se, subsequent analyses were executed on participants' shooting accuracy in the HA condition, comparing the trials on which the opponent did and did not shoot back. Results showed that their was no significant difference between these trials ($M = 46.96$, $SD = 21.79$ for shooting back; $M = 48.83$, $SD = 21.75$ for not shooting back; $t(6) = 0.41$, $p = .697$, $ES = 0.09$).

[2] In this study, we also intended to record participants' gaze behavior in relation to task- and threat-related sources of information. However, due to technical problems, an analysis of gaze data was not possible.

Dependent variables

Manipulation check. To check whether our pressure manipulation was successful, participants' state anxiety, mean heart rate, and perceived mental effort, were assessed in each condition by using the anxiety thermometer (Houtman & Bakker, 1989), a heart rate recorder, and the Rating Scale Mental Effort (RSME; Zijlstra, 1993), each of which has been used successfully in earlier studies (e.g., Oudejans & Pijpers, 2009).

Shooting performance. Shooting performance was assessed by counting the number of hits on each of the designated target areas (cf. Oudejans, 2008) and computing the mean percentage of hits for each condition.

Movement speed. Based on the shooting times provided by the shot timer, response and total performance times were defined as the time between the start of each trial and the participant's first shot (response time) and the time between the start of each trial and the participant's last shot (total performance time). Reload times (defined as the time between the participant's second and third shot) were calculated based on the recordings of the digital video camera.

Head/body orientation. Based on the images of the scene camera of the mobile eye, participants' head/body orientation was measured in two ways. First, during aiming and shooting we assessed how much of the opponent was visible on a scale from 1 (not visible at all) to 5 (entirely visible; looking forward). Second, during reloading, we counted the number of trials on which the opponent was not visible because participants turned away from the opponent to reload their gun.

Blink behavior. Based on the images of the eye camera of the mobile eye, blink-rate was assessed by counting the number of times participants closed their eyes on each trial. Second, the average amount of time that participants had their eyes closed (expressed as a % of total performance time) during each trial was also calculated.

Procedure

Participants were tested individually and started with either the LA or the HA condition. Standing in front of the opponent participants received instructions about the exercise and were reminded about the specific conditions under which their performance would occur. In both conditions, participants were instructed that they were supposed to perform in a relatively quick fashion, but to make sure that they would shoot as accurately as possible. Directly following the exercise (after the 10th trial), measurements were ended and participants completed an anxiety thermometer and mental effort scale. Between conditions there was a five minute break. After participants had finished both conditions they were debriefed in a separate room to share their experiences.

Analytic strategy

Differences between experimental conditions were analyzed by using one-tailed paired t tests (anxiety, mentaleffort, heart rate, shooting accuracy, movement times, vertical orientation, blink behavior) or a chi square (X^2) analysis (horizontal orientation). For the t tests, effect sizes (ES) were calculated. Effect sizes of 0.2 or less, about 0.5, and 0.8 or more, represented small, moderate, and large effects, respectively (Cohen, 1988).

Results

Table 3.1 shows an overview of the means and standard deviations of all dependent variables in the LA and HA conditions.

Manipulation checks

Anxiety and effort scores were significantly higher in the HA than in the LA condition, t(6) = 5.04, p = .001, ES = 1.59, and t(6) = 4.58, p = .002, ES = 1.01, respectively. In addition, heart rate was also significantly higher in the HA than in the LA condition, t(5) = 5.22, p = .002, ES = 0.55. Together these results indicate that our pressure manipulation was successful.

Shooting performance and movement times

Shooting performance declined significantly under high anxiety, t(6) = 4.45, p = .002, ES = 1.12. Average response and performance times were significantly shorter in the HA than in the LA condition, t(6) = 1.97, p = .048, ES = 0.92, and t(6) = 2.36, p = .028, ES = 0.83, respectively. Reload times did not differ significantly between both conditions, t(6) = 1.04, p = .169, ES = 0.33.

Head/body orientation and blink behavior

Participants' vertical head orientation showed a strong tendency to be lower in the HA compared to the LA condition, t(4) = 2.06, p = .054, ES = 0.89, a large effect. Furthermore, participants also turned away significantly more often when anxious, $\chi^2(1) = 4.01$, p = .045. Finally, participants blinked significantly more often in the HA than in the LA condition, t(3) = 4.71, p = .009, ES = 1.30, resulting in a significant increase in the amount of time they had their eyes closed, t(3) = 3.15, p = .026, ES = 1.08.

Table 3.1: Means and standard deviations of dependent variables in the low-anxiety (LA) and high-anxiety (HA) condition

Variable	Condition	
	LA	HA
	M (SD)	*M (SD)*
Manipulation checks (*n* = 7)		
Anxiety (0-10)	3.13 (1.20)	7.09 (1.71)**
Mental effort (0-150)	53.71 (21.08)	79.14 (23.74)**
Heart rate (beats per minute; n = 6)	115.17 (12.21)	122.50 (14.57)**
Shooting performance (*n* = 7)		
Shooting accuracy (%)	70.36 (12.03)	47.63 (21.13)**
Movement times (*n* = 7)		
Response time (s)	1.79 (0.31)	1.48 (0.31)*
Total performance time (s)	11.48 (1.46)	10.25 (1.33)*
Reload time (s)	6.00 (1.01)	5.71 (0.74)
Head/Body orientation (*n* = 5)		
Vertical orientation (0-5)	3.42 (0.60)	2.43 (1.33)+
Horizontal orientation (turn/no-turn)	19 / 31	29 / 21*
Blink behavior (*n* = 4)		
Blink-rate (number of blinks per trial)	1.03 (1.06)	3.10 (1.41)*
Eyes closed (% of total performance time)	0.65 (0.87)	2.63 (2.11)*

* p < .05, ** p < .01, + p = .054
Note. Horizontal orientation refers to the number of trials on which participants did or did not turn sideways while reloading their handgun.

Discussion

The current pilot study aimed to discover which underlying elements of performance are negatively affected in police officers executing a stressful shooting task. As such, and by using a relatively small sample size, several processes were evaluated and compared between a high and a low anxiety condition. Despite the extra effort that participants invested, shooting accuracy showed a large and significant decrease under high anxiety (i.e., > 20%; Table 3.1). This finding is consistent with the results of Oudejans (2008) and, given the importance of successful police performance, specifies the need to increase our understanding of the anxiety-performance relationship in this context.

Our results on movement speed showed that one important aspect underlying the observed decrease in shooting performance may be that under high anxiety police officers acted too fast. Response as well as performance times decreased significantly under high anxiety, at the obvious cost of accuracy. This is a classical example of a speed-accuracy trade-off.

Recently, however, Beilock, Berenthal, Hoerger and Carr (2008) showed that, for expert performers, speeding up performance not always lead to decreased accuracy and may even help to improve performance. Beilock et al. analyzed expert and novice golfers' performance under speed and accuracy instructions as they used a standard putter or an unfamiliar, s-shaped, "funny putter". Against common expectations, expert performance benefitted from speed instructions when they used the highly familiar standard putter. However, when they had to use the unfamiliar funny putter their performance was negatively affected. This finding is comparable to the results of the current study, in which police officers performed well under normal conditions but became less accurate as they increased their movement speed under high anxiety. We suggest that novel constraints on action (such as increased anxiety) may alter the action capabilities of otherwise experienced performers. As a result, performance initially decreases as some form of learning process is needed in order to adapt movements to the new circumstances (Oudejans & Nieuwenhuys, 2009). Training with constraints (e.g., training under high anxiety) may allow for such a learning process and help acclimatize performance to its normal standards (Oudejans, 2008; Oudejans & Pijpers, 2009).

In the debriefing interviews, several participants stated that they tried to be quicker in the HA than the LA condition and aimed to reduce the risk of being hit, implying that the reductions in movement times were willfully strived for. This finding may explain why the extra effort that was invested did not result in the maintenance of performance under high anxiety, as predicted by ACT. Extra effort may compensate for the debilitative effects of anxiety on performance, but only when additional processes are appropriate (Hardy & Hutchinson, 2007; Oudejans & Pijpers, 2009). With regard to participants' performance effectiveness, speeding up apparently was not.

Furthermore, it was shown that participants tended to have a different head/body orientation under high anxiety, with clear attempts to make oneself smaller, and increases in the number of times they faced away from the opponent during reloading. As changes in orientation may seriously limit the possibility to pickup task-relevant information from the targets these behaviors seem to have been inspired by the threat with which participants were confronted. This is in line with ACT's prediction that, under high anxiety, attention (and consequently behavior) becomes more stimulus-driven (Eysenck et al., 2007).

Next, it also appeared that blink-rate increased significantly from the LA to the HA condition (Table 3.1). This finding might be explained by an increased startle reflex under high anxiety (e.g., Mol et al., 2007) disabling participants to inhibit their blinking. As was shown, the observed increase in blink rate led to significant increases in the amount of time that participants had their eyes closed (from about a half to over three percent of total performance time; Table 3.1). While this percentage seems rather small, note that the majority of (extra) blinks occurred at or around participants' shots. Again, given the importance of continuous visual information pickup during aiming and shooting (e.g., Behan & Wilson, 2008; Vickers & Williams, 2007), this finding indicates that efficiency decreased under high anxiety (Eysenck & Calvo, 1992; Eysenck et al., 2007). Together with the current results on movement speed and head/body orientation this suggests that under high anxiety attention was drawn away from the task and, perhaps, directed more to the sources of threat that were experienced. Preliminary gaze data (not reported here) seems to support this suggestion.

The current pilot study has limitations, the most obvious being its small sample size. While on the one hand the small sample size limits the extent to which results can be generalized, on the other hand it enabled the analysis of a broad scope of variables underlying police officers' shooting performance under pressure. Since experimental work in this direction is still scarce we believe that the present study makes a valuable contribution, both in clearing the path for future studies as well as in offering possible explanations for why police officers' shooting accuracy decreases under high anxiety. These explanations (e.g., speed at the cost of accuracy, reduced possibility to pickup task relevant information because of changes in orientation) may be useful with respect to future interventions aimed at improving police officers' shooting performance under pressure. Based on our results, future studies should investigate whether the observed losses in efficiency are indeed accompanied by changes in visual attention, as is suggested by ACT (Eysenck et al., 2007). Finally, another direction for future research would be to explore whether training under high anxiety (Oudejans, 2008; Oudejans & Pijpers, 2009) would lead to regained efficiency and a reversal of the processes that were affected by anxiety.