Police Practice and Research
An International Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/gppr20

Training and experience influence the consequences of anxiety during performance. A study of two groups of British firearms officers during bi-annual testing

Jolyon Faro, Caren A Frosch & Doug J. K. Barrett

To cite this article: Jolyon Faro, Caren A Frosch & Doug J. K. Barrett (2021): Training and experience influence the consequences of anxiety during performance. A study of two groups of British firearms officers during bi-annual testing, Police Practice and Research, DOI: 10.1080/15614263.2021.1927730

To link to this article: https://doi.org/10.1080/15614263.2021.1927730

Published online: 23 May 2021.

POLICE PRACTICE AND RESEARCH
https://doi.org/10.1080/15614263.2021.1927730

Routledge
Taylor & Francis Group

ARTICLE

OPEN ACCESS

Check for updates

Training and experience influence the consequences of anxiety during performance. A study of two groups of British firearms officers during bi-annual testing

Jolyon Faro, Caren A Frosch and Doug J. K. Barrett

Department of Neuroscience, Psychology and Behaviour, University of Leicester, Leicester, United Kingdom

ABSTRACT

Experience is positively related to performance, but it is less clear whether experience might also minimise the deleterious effects of anxiety and arousal in stressful situations. One hundred and twenty-seven UK firearms officers of different experience levels participated in an experiment examining the extent to which anxiety affects performance during a bi-annual qualification shoot. Performance and anxiety were compared on a low-arousal development shoot and a high-arousal qualification shoot; qualification shoot failure would result in removal from operational duties. Heart rate and responses to the State-Trait Anxiety questionnaire were examined in relation to shooting performance. Less experienced officers demonstrated significantly higher baseline corrected mean heart rates, higher anxiety levels and lower accuracy than their more experienced counterparts, who maintained accuracy, despite a significant increase in heart rate during the qualification compared to the development shoot. The results, some of the first to examine British firearms officers in their natural training environment, suggest experience reduces the physiological impact of arousal on performance in pressurised situations. We discuss options for reducing the impact on performance in less experienced officers.

ARTICLE HISTORY
Received 25 September 2020
Accepted 30 April 2021

KEYWORDS
Police; authorised firearms officer; stress; arousal; experience; accuracy

Introduction

The current threat of terrorism in the UK has required an increase in the number of Police who are Authorised Firearms Officers. The latest Home Office (2019), indicate there were 125,793 police officers in the UK. Of these, 6,653 were armed, which distinguishes the UK Police Service from those on the continent, USA and Canada where the majority of officers are armed. Police officers in the UK volunteer to undertake a rigorous selection and training program before they are authorised to deploy with firearms. Within the domain of firearms, there are several different operational roles; in this study, we have focussed on the performance of Authorised Firearms Officers (AFO) and Armed Response Vehicle (ARV) Officers. The central role of an AFO is high visibility static or mobile patrols of protected areas, airports, railway stations, military establishments and government buildings, along with a support role to ARV officers in extreme circumstances. ARV officers respond to situations involving weapons or extreme violence, such as planned arrests of armed/violent offenders. During their initial training, AFO and ARV Officers receive similar standards of handgun training. Both AFO and ARV officers then complete the National Handgun Qualification Shoot (College of Policing, 2014). The only difference is the pass mark; 70% and 80% respectively. If

CONTACT Jolyon Faro jjf13@le.ac.uk Department of Neuroscience, Psychology and Behaviour, The University of Leicester University Road, Leicester, LE1 7RH, United Kingdom

successful, officers move to a tactical phase of initial training. Following successful completion of the course, officers undertake a biannual qualification shoot as part of mandated continuation training (College of Policing, 2014). If an officer fails qualification, they are removed from operational duties and must undertake a period of development before being retested. Further failure results in withdrawal from the firearms team and a return to unarmed duties.

The training AFO and ARV officers receive is governed by the National Police Firearms Training Curriculum (NPFTC), which is overseen by the College of Policing. The majority of the curriculum focusses on physical and technical skills, as well as the tactical requirements of operating as a firearms officer. Potential effects of anxiety and stress on officers' operational effectiveness are covered only briefly and few empirical studies have sought to investigate the relationship between anxiety and performance during training. Among these, Boulton and Cole (2016) and Roberts and Cole (2018) compared AFOs with different levels of experience using a Cognitive Task Analysis methodology to identify and explain the decisions during operational and training scenarios. Cognitive Task Analysis is described by Militello et al. (2015) as an effective method to extract details of judgements and decisions during, or just after incidents of significant challenge, such as armed confrontations or situations of high threat or risk. The analysis found those with more experience were significantly more flexible in their ability to react dynamically to threats (Boulton & Cole, 2016).

The current study investigates the relationship between anxiety and performance during the bi-annual qualification for AFO and ARV officers in the UK. The qualification shoot presents the officer with a situation that is likely to induce anxiety. Anxiety is often differentiated in terms of a state or trait. State anxiety describes a transient emotional response to a situation that challenges the individual's capacity to cope (Campbell & Ehlert, 2012; Chung et al., 2005). Trait anxiety describes a stable predisposition to interpret situations as challenging (Meijer, 2001). Our use of the term focusses on anxiety as a temporary psychological response to a perceived threat (Eysenck et al., 2007). State anxiety is associated with heighten physiological arousal (Hardy & Hutchinson, 2007); influencing the autonomic nervous system and triggering a complex interaction between behavioural and cardiovascular processes (Anderson et al., 2019; Kayihan et al., 2013). These reactions, highly individual in nature (Selye, 1953), include increased heart rate, blood glucose levels, adrenalin (Baldwin et al., 2019; Hope et al., 2015) and effects on working memory (Morgan et al., 2007). The physiological symptoms associated with state anxiety are very similar to those seen in response to stress. For anxiety these responses are the result of internal challenges (Nieuwenhuys & Oudejans, 2017; Robinson et al., 2013; Vickers & Williams, 2007), whereas for stress they are the result of external factors (Roger, 2016; Selye, 1956). The qualification shoot is likely to result in both state anxiety and stress due to the internal pressures (worry about the consequences of failure) and the external pressures elicited by the environment. However, given that the officers taking part in this study are familiar with the environment and the process of the qualification, we expect the internal pressures to have a more pronounced effect than the stress elicited by being on a shooting range they are familiar with.

For firearms officers, effective and accurate performance requires the combination of cognitive and motor skills (Kantak & Winstein, 2012; Ortega & Wang, 2018; Vickers & Williams, 2007). The relationships between anxiety, physiological arousal and skilled performance have been characterised in several ways: first as an inverted U-shape (see Figure 1) and second, as an interaction between situational variables and individual factors such as cognitive resources and motivation (see Figure 2). These two classes of theory provide a framework for understanding the way psychological anxiety and physiological arousal impact an individual's performance in different situations (Giessing et al., 2019).

A number of theories describe the relationship between anxiety and performance as an inverted U-shape. These include: The Hull Spence Drive Theory (Hull, 1951); The Theory of Mental Effort (Kahneman, 1975); General Adaptation Syndrome (Selye, 1952) and; The Yerkes-Dodson Law (Yerkes & Dodson, 1908). According to these theories, maximum performance is obtained at medium levels of arousal. Both high and low levels of arousal are associated with lower levels of performance. The function describing this relationship describes a positive influence of anxiety on

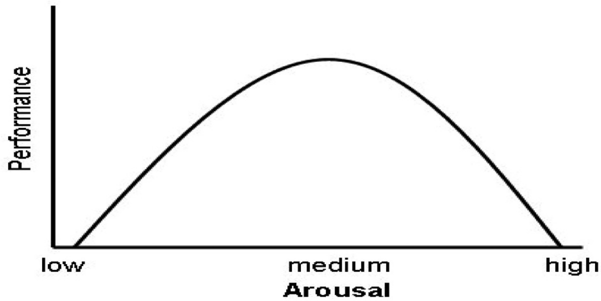

Figure 1. A typical performance curve, as suggest by Yerkes and Dodson(1908)

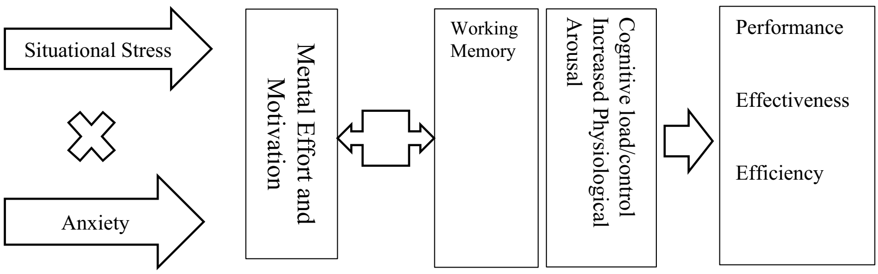

Figure 2. A diagrammatical representation demonstrating the flow and the link between stress, anxiety and physiological arousal, running through the cognitive processes behind performance based upon ACT, adapted from Anxiety and Cognitive performance: A test of Attentional Control Theory, Edwards (2015).

performance up to a certain point (Vickers et al., 2017; Vickers & Williams, 2007). Factors explaining this association include improved alertness (Nibbeling et al., 2014) and cognitive control (Andersen & Gustafsberg, 2016; Robson & Manacapilli, 2011; Staal, 2004). However, as anxiety increases, its impact on performance becomes detrimental (Ortega & Wang, 2018). Muse, Harris and Feud (2003) evaluated the predicted curvilinear association between anxiety and performance in different occupational settings. They concluded that the inverted U hypothesis captured the general form of the association across different types of skilled behaviour. Current research continues to support this relationship in both military (e.g., Nibbeling et al., 2014) and police settings (e.g., Nieuwenhuys & Oudejans, 2010).

The theories above suggest a simple curvilinear relationship between performance and arousal. However, they do not directly address the relationship between arousal, psychological stress and the cognitive processes that mediate performance in stressful situations. Attentional Control Theory (ACT: Eysenck et al., 2007) provides an explanatory model of the relationship between anxiety and performance. According to ACT, anxiety modulates an individual's ability to prioritise goal-relevant information during perceptual and post-perceptual processes, such as working memory and the planning and execution of movements (Beilock et al., 2008; Eysenck et al., 2007). As anxiety increases, the individual's ability to select and respond to task-relevant events becomes compromised by interference from threat-related information, which impacts short-term memory and executive control during decision-making and the planning and execution of action (Derakshan & Eysenck, 2009)(see Figure 2).

Anxiety-related decreases in performance are concomitant with high-levels of physiological arousal as well as changing patterns of activation in the amygdala and dorsolateral prefrontal cortex of the brain (see Bishop et al., 2004). These are thought to reflect interactions between neural regions associated with emotional processing and executive processes involved in the evaluation of sensory information and scheduling of appropriate responses. According to ACT, behaviour and action requiring high levels of cognitive control are most susceptible to interference from task-irrelevant information, particularly when the task or situation is characterised by threatening or aversive stimuli and events (Cocks et al., 2015; Eysenck & Calvo, 1992; Eysenck et al., 2007).

The theoretical models above provide a conceptual framework for understanding the relationship between levels of anxiety, arousal and performance during skilled behaviour. The emphasis on cognitive control in ACT, also suggests an important outcome of training is to minimize the susceptibility of executive processes to interference during high-anxiety situations (Beilock et al., 2002; Robinson et al., 2013). The cognitive control structures that characterise different phases of learning are explained in Fitts and Posner's Theory of Skill Acquisition Fitts and Posner (1967). They describe a three-phase model in which individuals progress from a cognitive to an associative and then automatic phase of learning. Building on Fitts and Posner's theory, Wulf et al. (2001) suggested the mental effort required to maintain cognitive control during skilled performance is higher in the cognitive, than subsequent phases of learning. During the cognitive phase, skill acquisition is slow, serial and requires a focus on the planning and execution of movements and their consequences (Furley & Wood, 2016; Schneider & Chein, 2003). Within the first two phases, concern about the individual's ability to respond to the situation is also likely to elicit anxiety (Beilock et al., 2008; Ducrocq et al., 2016). However, as coordination between cognitive control and motor responses improve, demands on working memory and executive processes decrease (Fitts & Posner, 1967). With practice and experience, the coordination of movement becomes proceduralised (Vast et al., 2011); freeing short-term memory and executive resources during decision making (Angel et al., 2012), and reducing the impact of anxiety on performance (Beilock et al., 2002). As the individual attains the final phase of learning, the impact of anxiety on cognitive control ameliorates, as automatic behaviours are less sensitive to interference from task-irrelevant internal and external stimuli (Schneider & Chein, 2003). Following extended practice and training, task performance in anxiety-provoking situations is subserved by fast, efficient control processes that place minimal requirements on attention and working memory (Boulton & Cole, 2016; Eysenck et al., 2007). Indeed, findings from a number of studies suggest high-stress training scenarios lead to improved firearms accuracy during operational situations (Morrison & Vila, 1998; Nieuwenhuys et al., 2009; Nieuwenhuys & Oudejans, 2010). Benefits in accuracy associated with this type of training are comparable to performance gains in experienced compared to inexperienced officers (Morrison & Vila, 1998; Nieuwenhuys et al., 2009; Nieuwenhuys & Oudejans, 2010).

The models above suggest experience is likely to reduce the effects of anxiety on firearms officers' performance during training and in operational situations. However, only 5.5% of serving police officers in England and Wales are authorised and trained to carry firearms (Home Office, 2019), and research in a British context is extremely limited. Recent studies in Europe and the USA support a negative association between anxiety and police officers' firearms accuracy during simulated high-threat situations. For example, Oudejans (2008) and Taverniers et al. (2011) observed a decrease in firearms accuracy in training scenarios when officers could be shot by a role player armed with paint marker rounds compared to those in which they could not. In addition, researchers examining police officers' handgun shooting have found individuals with higher anxiety devote more mental effort to sustain or improve their performance (Nieuwenhuys & Oudejans, 2017, 2011; Wood et al., 2016). High-levels of anxiety are associated with a significant decline in accuracy, with officers missing targets on up to 60% of initial shots (Artwohl & Christensen, 1997; Boulton & Cole, 2016; Nieuwenhuys & Oudejans, 2017).

Other researchers have observed a direct association between heart rate and firearms accuracy among police officers (e.g., Brisinda et al., 2015; Landman et al., 2015). These findings suggest increased heart rate indicates anxiety-induced autonomic nervous system activation during police tactical training (see also Wheat & Larkin, 2010). A further influence over performance was observed by Konttinen et al. (1998) and Ortega and Wang (2018), who found experienced individuals were able to reduce the impact of changes in heart rate on firearms accuracy during competition shooting. Whilst several of the studies above highlight the effects of anxiety on firearms accuracy, what appears to be missing is a detailed understanding of the way training and experience influence this relationship during the development of firearms skills.

The current study aimed to investigate the effect of anxiety on the accuracy of firearms officers with different levels of experience during a biannual qualification shoot. The biannual qualification is a pass-or-fail assessment. Failure results in a withdrawal from operational duties until they complete two development sessions and re-take their qualification. Continued failure results in the permanent withdrawal from firearms operations, which is generally considered a demotion in terms of career progression and professional status. As such, the biannual qualification is likely to elicit anxiety among officers, particularly those who are newly qualified and still developing and consolidating their weapons handling and shooting skills (Stöber & Pekrun, 2004). By recording officers' performance during a regular training session that included a development (low arousal) and a qualification shoot (high arousal), the study sought to assess the impact of anxiety and physiological arousal on the performance of officers with different levels of experience. We predicted higher levels of anxiety and physiological arousal during qualification among newly qualified AFO than more experienced ARV officers. The focus of the study was whether levels of experience reduce the effects of anxiety and arousal on firearms accuracy during training and qualification.

Method

Participants

One hundred and twenty-seven qualified firearms officers participated in the study. Officers were grouped according to their operational assignment and experience; AFO (n = 47) and ARV (n = 80). There were five women (all ARV officers) and 122 men and Table 1 summarises the age and experience of each group. Participation was voluntary, and the study was approved by the School of Psychology Ethics Committee at the University of Leicester.

Independent samples t-tests indicated age, $t(.83) = 125$, $p = .409$, and years of service, $t(1.27) = 125$, $p = .208$, were not significantly different in the AFO and ARV groups. As expected, the operational distinction between groups was reflected by a significant increase in firearms experience in the ARV compared to AFO officers, $t(-9.03) = 125$, $p < .001$, *Cohen's d* = 2.0, a large effect (Cohen et al., 1983).

Design

The study used a 2 × 2 mixed design with operational assignment a between-subjects variable (AFO versus ARV) and level of anxiety as a within-subjects variable (low anxiety – development vs. high anxiety – qualification session). The dependent variable was the accuracy of officers' shots across five shooting elements. Perceived anxiety levels were measured before the qualification session and officers' heart rate was recorded constantly throughout the duration of both sessions to measure physiological arousal. Heart rate and anxiety were used to measure changes in physiological arousal and anxiety in AFO and ARV groups and measure the impact of changes on firearms accuracy during training and qualification.

Table 1. Demographic information by group means (standard deviations in parenthesis).

	Descriptive Statistics		
Group	Age	Years in Police	Years as a Firearms Officer
AFO (N 47)	37 (5.9)	11.62 (5.3)	.732 (.15)
ARV (N 80)	36.1 (6.3)	12.81 (5.1)	7.29 (4.9)

Materials

The study was conducted on a small-arms range familiar to the participants. The Glock handgun and 9 mm ammunition used were the same as those officers deploy with operationally. The target is illustrated in Figure 3. Officers' accuracy was calculated by scoring rounds falling within the 'centre mass' (the inner circle). Each scoring shot was counted as one to produce a maximum score of 40. Pass marks for the AFO and ARV groups are 70% and 80% respectively.

Heart rate (HR) was measured using Polar H7 heart rate monitors with individual Bluetooth frequencies using Polar team® software. The H7 model has been found to be as accurate as an ECG (Electrocardiogram; Plews et al., 2017) and provides a reliable measure of heart rate in challenging environments (i.e., tactical training, team dynamics and athletic events; Domyancic et al., 2008; Hope et al., 2012; Pasadyn et al., 2019).

Anxiety was measured using the Spielberger Short (six item) State/Trait Anxiety Inventory (STAI; Marteau & Bekker, 1992; Tluczek et al., 2009). The original Spielberger (1983) STAI has been found to have good internal consistency and reliability in over 800 studies (see Barnes et al., 2002). Scores on the six-item scale correlate highly with those on the 20-item scale and also demonstrate high levels of internal consistency (Cronbach's α = 0.82) and validity (Tluczek et al., 2009). Responses are measured on four-point Likert type scale (1 = not at all, 2 = somewhat, 3 = moderately, 4 = very much) for a series of statements (I feel calm; I feel tense; I am upset; I feel relaxed; I feel content, and I am worried). Scores on the six-item scale are transformed to a range between 20 and 80, which is comparable to scores from the full scale (Marteau & Bekker, 1992). Normative scores for healthy adults fall between 32–36 (Julian, 2011).

Figure 3. Police Shooting Target. Officers are expected to aim for 'centre mass' indicated by the area inside the smaller circle.

Procedure

Participants completed the development and then the qualification session in a single day. Before each session, a Police Firearms instructor delivered a range-safety briefing that included a statement from officers declaring themselves fit-to-train and consenting to participate in the study. Weapons and ammunition were collected from the armoury and officers were fitted with heart rate monitors, which were checked to ensure heart rate was being recorded. Development and qualification sessions contained the same five shooting elements, which were run in the same order for all participants. Elements are designed to evaluate different aspects of officers' target acquisition, accuracy and overall firearms skill. Scores were recorded once each session was complete, with officers required to achieve a score indicating competence to pass. For example, detail one consists of six exposures and AFOs must score a minimum of four hits on the target (College of Policing, 2014). To standardise the range environment across sessions, coaching that is usually provided during development was withheld. The STAI was administered prior to the first element of the qualification session. Baseline heart-rate was recorded and measured immediately after the range safety briefing for each session. Officers' heart rates were then recorded constantly during each session finishing at the end of the final detail. To measure changes in physiological arousal, baseline heart-rates were subtracted from mean heart-rate (beats per minute) recorded during the development and qualification sessions. In contrast to baseline corrected measures of peak heart-rate (Buchheit, 2014), this quantifies a change in physiological arousal over the temporal period that firearms accuracy was assessed (Regehr et al., 2008). AFO and ARV officers attended the range on separate days and the same certified firearms instructors managed the environment for both groups.

Results

Table 2 presents mean (standard deviation in parenthesis) baseline corrected heart rate, STAI scores and accuracy in the AFO and ARV groups.

Group differences in STAI scores and heart rate by session?

Initial analyses were designed to measure group-differences in the independent variables of the study. Anxiety among AFO and ARV officers was compared using an independent samples *t*-test on STAI scores. The result revealed a statistically significant increase in anxiety among AFO compared to ARV officers ($M_{difference} = 10.4$; $t(91.29) = 7.49$, $p < .001$, *Cohen's* $d = 1.45$) (Cohen et al., 1983). To measure group-differences in physiological arousal, baseline corrected heart rates were subject to a 2 × 2 ANOVA, with group (AFO vs. ARV) and session (development vs. qualification) as between and within-subjects factors respectively. The analysis yielded significant main effects of group ($F_{1,125} = 20.38$, $p < .05$, ${\eta_p}^2 = .14$) and session ($F_{1,125} = 20.96$, $p < .05$, ${\eta_p}^2 = .14$). The Group by Session interaction did not reach statistical significance ($F_{1,125} = 1.63$, $p > .05$, ${\eta_p}^2 = .0.01$). Figure 4a illustrates higher mean baseline corrected heart-rates in the AFO than the ARV groups during both Development and Qualification sessions.

Table 2. Mean baseline corrected heart rate (BC-HR), accuracy and STAI scores for the two groups of officers during development and qualification sessions (standard deviations in parenthesis).

	BC-HR		Accuracy (Central-Mass)		STAI
Group	Development	Qualification	Development	Qualification	Qualification
AFO	18.85 (11.14)	29.47 (13.03)	30.7 (3.5)	27.5 (3.6)	46.5 (7.4)
ARV	10.20 (13.80)	16.19 (2.36)	35.7 (3.1)	35.8 (3.1)	36.1 (6.9)

Total accuracy possible = 40. STAI Healthy Adult Anxiety levels 32–36

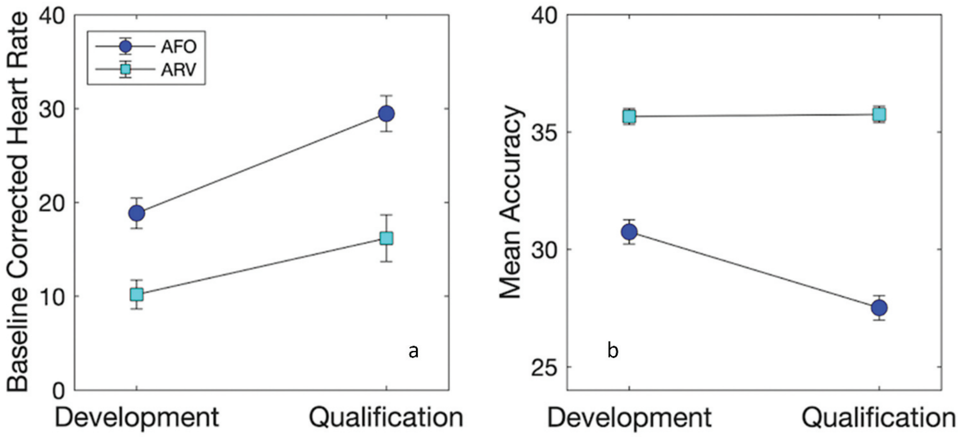

Figure 4. A) Baseline corrected mean heart rate (bpm) and B) accuracy for ARV and AFO officers on the development and qualification sessions. Error bars denote standard errors of the means.

Group differences in accuracy?

Next, we assessed differences between the two groups on the dependent variable; firearms accuracy. A 2 × 2 ANOVA with group (AFO vs. ARV) and session (Development vs. Qualification) as between and within-subjects factors respectively, yielded main effects of group ($F_{1,125}$ = 165.10, $p < .001$, $\eta_p{}^2$ = .57) and session ($F_{1,125}$ = 24.58, $p < .001$, $\eta_p{}^2$ = .16). Mean accuracy was higher for ARV than AFO officers and higher in the development than the qualification session. The effect of session on the two groups was also markedly different, producing a significant Group by Session interaction ($F_{1,125}$ = 27.39, $p < .001$, $\eta_p{}^2$ = .18). The interaction is illustrated in Figure 4b, which reveals comparable levels of accuracy across sessions in the ARV group (M = 0.09, $p > .05$: Tukey HSD) and a marked decrease in accuracy on the qualification compared to the development session in the AFO group (M = 3.23, $p < .001$: Tukey HSD).

The analyses above reveal a smaller increase in baseline corrected heart rate on the qualification than the development session and lower levels of anxiety among the more experienced ARV than AFO officers during qualification. Accuracy was also significantly higher for ARV than AFO officers, with the former able to maintain firearms accuracy despite a significant increase in physiological arousal during qualification. These data suggest ARV officers were able to negate the effects of anxiety/arousal on firearms accuracy during the qualification session. To explore the relationships between operational status and performance more closely, we computed a multiple regression on accuracy with group (ARV vs. AFO) as a categorical variable, and baseline corrected mean heart rate and STAI as continuous variables.

The regression model predicted 61% of the variance in firearms accuracy on the Qualification session (R^2 = .61; $F_{3,123}$ = 63.16, $p < .001$). Group significantly predicted accuracy ($\beta = -3.86$, $p < 0.001$) while the regression coefficient for heart rate approached statistical significance ($\beta = -.03$, $p = .07$). The regression coefficient for STAI was not statistically significant ($\beta = -.01$, $p = .73$). The additive model indicates officers' operational status had the biggest impact on firearms accuracy during the qualification shoot. Across groups, the reduction in accuracy associated with heart rate also approached significance. To investigate potential differences in the effect of physiological arousal on the accuracy of AFO and ARV officers, we computed a second regression to model the interaction between Group and baseline corrected mean heart rate. This model predicted 62% of the variance in firearms accuracy during qualification (R^2 = .62; $F_{3,123}$ = 66.79, $p < .001$). Regression coefficients for group ($\beta = -2.78$, $p < 0.001$), heart rate ($\beta = -.06$, $p = .005$) and the Group by Heart rate ($\beta = -.04$, $p < .05$) interaction all reached

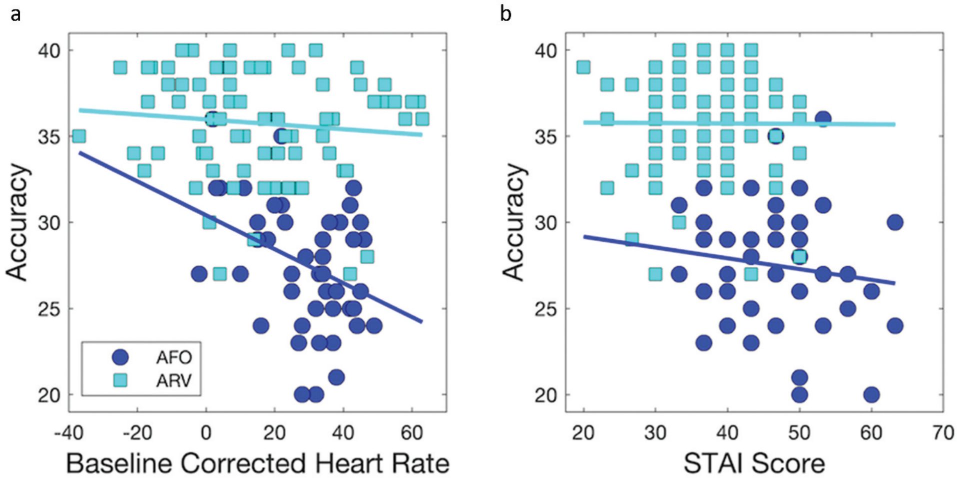

Figure 5. Best-fitting regression lines for bivariate associations between STAI score, baseline corrected heart rate and accuracy for ARV and AFO officers in the Qualification session.

statistical significance. The significant interaction is illustrated clearly in Figure 5a, with the negative slope of the best-fitting regression line for baseline corrected heart rate on accuracy much steeper for AFO than more experienced ARV officers.

The analyses above indicate variability in STAI scores was not a significant predictor of officers' accuracy. To measure the association between self-reported anxiety on the STAI and physiological arousal, we computed an additional regression, which yielded a significant equation (R^2 = .10; F (1,125) = 13.21, $p < .001$). Self-reported anxiety explained 10% of the variability in officers' heart rate on the qualification shoot, which is a small effect (Cohen et al., 1983). For every unit increase in reported anxiety, baseline corrected mean heart rates increased by 0.13 beats per minute. These findings confirm a significant association between psychological measures of arousal and physiological anxiety in our sample, while cautioning against their treatment as comparable predictors of firearms accuracy among officers with different levels of training.

Discussion

The current study investigated the way experience influences the relationships between anxiety, physiological arousal and officers' accuracy during a development (low arousal), and qualification shoot (high arousal). Participants were all UK firearms officers who had received the same standard of initial handgun training (College of Policing, 2014) but differed in terms of their operational assignment and firearms experience. Comparisons between AFO and ARV officers revealed significant differences in physiological arousal and firearms accuracy. Heart rates were significantly higher amongst AFO than more experienced ARV officers during both development and qualification. Heart rate has been identified as a key indicator of physiological arousal (Anderson et al., 2019; Buchheit, 2014) and our results support a reciprocal relationship between physiological arousal and accuracy during the qualification session. Importantly, the magnitude of the relationship was influenced by level of experience, with the decline in accuracy associated with increased heart rate significantly larger in AFO than ARV officers. In our sample, operational assignment and firearms experience was the largest predictor of accuracy during qualification. The maintenance of high-rates or accuracy in the ARV group despite an increase in heart rate, is consistent with previous evidence that experience reduces the negative impact of physiological stress on firearms accuracy (e.g., Chung et al., 2005; Ortega & Wang, 2018). In terms of the performance curve suggested by Yerkes and Dodson (1908), our findings suggest experience scales the curvilinear association between physiological arousal and performance by extending the region in which firearms accuracy is optimised (Hope et al., 2012; Tenan et al., 2017). According to this interpretation, the increase in heart rate among ARV officers during qualification falls within the region in which cognitive control and performance are maximised. In contrast, the significantly larger increase in heart rate among AFOs during qualification, indexes a level of arousal that interferes with cognitive control and reduces officers' firearms accuracy.

The preservation of accuracy despite increased heart rate in experienced firearms officers is also consistent with the predictions of ACT (Cocks et al., 2015; Eysenck & Calvo, 1992; Eysenck et al., 2007) and Skills Acquisition Theory (Fitts & Posner, 1967). As the officer becomes more experienced, cognitive demands associated with firearms competence reduce, freeing up resources to deal with anxiety and physiological stress (Suss & Ward, 2010). In terms of skills acquisition, learning in the most experienced officers should be automatic, with proceduralised firearms skills operating in the absence of direct cognitive control (Vast et al., 2011). This level of learning frees up cognitive resources to manage psychological responses to anxiety and ensure consistent performance in high-arousal conditions. A similar conclusion was reached by Landman et al. (2015), who found experienced Dutch Police officers were able to maintain firearms accuracy in situations designed to elicit low and high levels of arousal. These results offer further support for the assertion that experience establishes automaticity during skilled performance, which frees cognitive resources during the planning and execution of behaviour; increasing the individual's confidence and reducing levels of anxiety in challenging situations.

In addition to changes in heart rate, our data revealed a significant increase in the level of anxiety among AFO compared to ARV officers during the qualification session. In contrast to heart rate, our prediction that high levels of anxiety would be associated with a reduction in accuracy was only partially supported. The regression examining the relationship between self-reported anxiety on the STAI and physiological arousal revealed a small positive association. However, variability on STAI scores was not a reliable predictor of firearms accuracy in our sample. This may reflect the indirect nature of subjective reports of anxiety, which may be prone to social desirability response bias (e.g., Vine et al., 2016). Several researchers have distinguished between physiological responses to stress and subjective feelings of anxiety. For example, Sommerfeldt et al. (2019) examined differences between physiological and psychological indicators of well-being in a large sample (N = 1065) and concluded heart rate was a far stronger indicator of anxiety than psychological measures. Furthermore, Nibbeling et al. (2014), concluded heart-rate was a more direct predictor of performance in high-pressure situations, but that experience reduced its influence in a sample of Dutch soldiers. Our data support these results, and suggest changes in heart rate provide a more reliable predictor of performance than self-reported anxiety. Furthermore, a meta-analysis of physiological and psychological responses by Campbell and Ehlert (2012) observed a desynchrony between cognitive, emotional and physiological responses based upon a number of factors, including experience and confidence. They concluded that the stress response was complex in nature and involved multiple interactions. Taken together, these results caution against direct comparisons of physiological arousal and psychological anxiety and their impact on skilled performance. In contrast to heart rate, variability on self-reported measures is likely to reflect differences in the way individuals evaluate their ability to perform in stressful circumstances (Regehr et al., 2008), as well as the social consequences of failure or weakness among colleagues and superiors.

Our results indicate experience enables officers to maintain firearms accuracy across different levels of physiological arousal. The extent to which this ability transfers to operational situations is likely to require further research, as some researchers (e.g., Head et al., 2017) have argued structured range sessions are insufficiently challenging to establish generalisable levels of learning. Our data suggest changes in assessment of firearms accuracy is enough to elicit measurable changes in anxiety and physiological arousal during range sessions. As Petersson et al. (2017) highlight, it would not be until the officer becomes involved in a potentially life or death situation that their ability to perform will be tested. However, developing progressive training schedules that promote automatic levels of performance is likely to enable officers to maintain firearms accuracy in less structured training and operational scenarios.

Conclusion

The aim of this study was to investigate the effect of anxiety on the accuracy of firearms officers with different levels of experience during a biannual qualification shoot. Our results suggest training should be used to increase the confidence and skills of AFOs, given that this group of officers was impacted by the anxiety of the qualification in a way that the more experienced ARV officers were not. Furthermore, there is a need to increase our understanding of the impact of physiological stress and psychological anxiety on the performance of officers who have been trained to support more experienced colleagues. Our findings suggest experience can reduce the deleterious effects of physiological arousal on officers' firearms accuracy. However, training-related changes in firearms officers' ability to optimise firearms accuracy is likely to require environments that mimic operational situations. Some researchers have argued that firing at paper targets is not the best way to prepare officers for a real-life confrontation (e.g., Morrison & Vila, 1998; Oudejans, 2008). Contrary to that view, we believe training in a controlled environment can contribute to the development of automatic firearms proficiency, which frees cognitive resources during the evaluation and control of behaviour in stressful situations. Our findings suggest training has a pivotal role to play in the development of cognitive control, experience and automaticity. Through training and experience, officers are able to maximise the cognitive resources available to them in unpredictable and high-anxiety situations. On the basis of these findings, we recommend further investigations to evaluate the extent to which training enhances officers' performance in operational situations. Of particular interest, is whether benefits in accuracy are larger when training is designed to mimic situations experienced on operational duties, where threat, risk, judgment and decision making are likely to place a far higher demand on the physiological and psychological resources of officers than those encountered during current training in the U.K.

Acknowledgments

We would like to thank the firearms officers, training team and management of the Joint Protective Services Department of Bedfordshire, Cambridgeshire and Hertfordshire Constabularies and the College of Policing for their help and support in undertaking this research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Jolyon Faro, a Police officer for 30 years, for the last 15 years as a Police Firearms trainer. During my time as a trainer. I studied for both a PGCE and a Master's in Education. I am currently studying for my PhD with the Department of Neuroscience, Psychology and Behaviour at the University of Leicester. My research relates to performance and decision making in situations of high threat and risk. The study was undertaken prior to my retirement whilst still working operationally with the firearms team. I began a new role as a Lecturer in Policing at the University of Central Lancashire in March of 2020.

Caren A Frosch, PhD, is a lecturer in Psychology in the Department of Neuroscience, Psychology and Behaviour at the University of Leicester. She holds degrees in Psychology from the University of Sheffield, UK, and Trinity College Dublin, Ireland. Her research and publications focus on thinking, reasoning, judgment and decision making with a particular focus on counterfactual thinking, causality and fast and frugal heuristics in adults and children.

Doug J. K. Barrett, PhD, is a lecturer in Psychology in the Department of Neuroscience, Psychology and Behaviour at the University of Leicester. His research focusses on the relationships between perceptual processes, selective

attention and short-term memory and the way these mediate behaviour in different situations in clinical and non-clinical populations.

ORCID

Jolyon Faro http://orcid.org/0000-0003-4772-8982
Caren A Frosch http://orcid.org/0000-0003-4153-8571
Doug J. K. Barrett http://orcid.org/0000-0002-0351-6809

Data availability statement

The data that support the findings of this study are openly available on Figshare – University of Leicester http://doi.org/DOI10.25392/Leicester.data.12,508,592

References

Andersen, J. P., & Gustafsberg, H. (2016). A Training method to improve police use of force decision making: A randomized controlled trial. *SAGE Open*, *6*(2), 1–13. https://doi.org/10.1177/2158244016638708

Anderson, G. S., Di Nota, P. M., Metz, G. A. S., & Andersen, J. P. (2019). The impact of acute stress physiology on skilled motor performance: Implications for Policing. *Frontiers in Psychology*, *10*(November), 1664–1678. https://doi.org/10.3389/fpsyg.2019.02501

Angel, H., Adams, B., Brown, A., Flear, C., Mangan, B., Morten, A., & Ste-Croix, C. (2012). *Review of the Skills Perishability of Police " Use of Force " Skills By*. Guelph Ontario.

Artwohl, A., & Christensen, L. (1997). *Deadly force encounters*. Paladin Press.

Baldwin, S., Bennell, C., Andersen, J. P., Semple, T., & Jenkins, B. (2019). Stress-activity mapping: Physiological responses during general duty police encounters. *Frontiers in Psychology*, *10*(October), 1–17. https://doi.org/10.3389/fpsyg.2019.02216

Barnes, L. L. B., Harp, D., & Jung, W. S. (2002). Reliability generalization of scores on the Spielberger State-Trait Anxiety Inventory. *Educational and Psychological Measurement*, *62*(4), 603–618. https://doi.org/10.1177/0013164402062004005

Beilock, S. L., Bertenthal, B. I., Hoerger, M., & Carr, T. H. (2008). When does haste make waste? Speed-accuracy tradeoff, skill level, and the tools of the trade. *Journal of Experimental Psychology: Applied*, *14*(4), 340–352. https://doi.org/10.1037/a0012859

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, *8*(1), 6–16. https://doi.org/10.1037/1076-898X.8.1.6

Bishop, S. J., Duncan, J., & Lawrence, A. D. (2004). State anxiety modulation of the amygdala response to unattended threat-related stimuli. *Journal of Neuroscience*, *24*(46), 10364–10368. https://doi.org/10.1523/JNEUROSCI.2550-04.2004

Boulton, L., & Cole, J. (2016). Adaptive flexibility: Examining the role of expertise in the decision making of authorized firearms officers during armed confrontation. *Journal of Cognitive Engineering and Decision Making*, *10*(3), 291–308. https://doi.org/10.1177/1555343416646684

Brisinda, D., Venuti, A., Cataldi, C., Efremov, K., Intorno, E., & Fenici, R. (2015). Real-time imaging of stress-induced cardiac autonomic adaptation during realistic force-on-force police scenarios. *Journal of Police and Criminal Psychology*, *30*(2), 71–86. https://doi.org/10.1007/s11896-014-9142-5

Buchheit, M. (2014). Monitoring training status with HR measures: Do all roads lead to Rome? *Frontiers in Physiology*, *5*(February), 1–19. https://doi.org/10.3389/fphys.2014.00073

Campbell, J., & Ehlert, U. (2012). Acute psychosocial stress: Does the emotional stress response correspond with physiological responses? *Psychoneuroendocrinology*, *37*(8), 1111–1134. https://doi.org/10.1016/j.psyneuen.2011.12.010

Chung, G. K. W. K., O'Neil, H. F., Delacruz, G. C., & Bewley, W. L. (2005). The role of Anxiety on novices' rifle marksmanship performance. *Educational Assessment*, *10*(3), 257–275. https://doi.org/10.1207/s15326977ea1003_6

Cocks, A. J., Jackson, R. C., Bishop, D. T., & Williams, A. M. (2015). Anxiety, anticipation and contextual information: A test of attentional control theory. *Cognition and Emotion*, *30*(July), 1037–1048. https://doi.org/10.1080/02699931.2015.1044424

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A Global Measure of Perceived Stress. *Journal of Health and Social Behavior*, *24*(4), 385. https://doi.org/10.2307/2136404

College of Policing. (2014). NPFTC module B1. In *National police firearms training curriculum* (pp. 1–88). Colleg of Policing.
Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: New developments from attentional control theory. *European Psychologist*, *14*(2), 168–176. https://doi.org/10.1027/1016-9040.14.2.168
Domyancic, M., Sterland, T., & Tsac, N. (2008). Utilization of heart rate monitors during operational training. *NSCA Tactical Strength and Conditioning*, *7*(September), 1–4. http://www.polaroutdoor.eu/files/pdf/Utilization_of_Heart_Rate_Monitors_During_Operational_Training.pdf
Ducrocq, E., Wilson, M., Vine, S., & Derakshan, N. (2016). Training attentional control improves cognitive and motor task performance. *Journal of Sport and Exercise Psychology*, *38*(5), 521–533. https://doi.org/10.1123/jsep.2016-0052
Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion*, *6*(6), 409–434. https://doi.org/10.1080/02699939208409696
Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, *7*(2), 336–353. https://doi.org/10.1037/1528-3542.7.2.336
Fitts, P. M., & Posner, M. I. (1967). *Human performance*. Brooks-Cole.
Furley, P., & Wood, G. (2016). Working memory, attentional control, and expertise in sports: A review of current literature and directions for future research. *Journal of Applied Research in Memory and Cognition*, *5*(4), 415–425. https://doi.org/10.1016/j.jarmac.2016.05.001
Giessing, L., Frenkel, M. O., Zinner, C., Rummel, J., Nieuwenhuys, A., Kasperk, C., Brune, M., Engel, F. A., & Plessner, H. (2019). Effects of coping-related traits and psychophysiological stress responses on police recruits' shooting behavior in reality-based scenarios. *Frontiers in Psychology*, *10*(July), 1–16. https://doi.org/10.3389/fpsyg.2019.01523
Hardy, L., & Hutchinson, A. (2007). Effects of performance anxiety on effort and performance in rock climbing: A test of processing efficiency theory. *Anxiety, Stress and Coping*, *20*(2), 147–161. https://doi.org/10.1080/10615800701217035
Head, J., Tenan, M. S., Tweedell, A. J., LaFiandra, M. E., Morelli, F., Wilson, K. M., Ortega, S. V., & Helton, W. S. (2017). Prior mental fatigue impairs marksmanship decision performance. *Frontiers in Physiology*, *8*(SEP), 680. https://doi.org/10.3389/fphys.2017.00680
Home Office. (2019). *Police use of firearms statistics, England and Wales: April 2018 to March 2019*. Homeoffice.gov.uk. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820556/police-use-firearms-statistics-england-and-wales-april-2018-to-march-2019-hosb1319.pdf
Hope, L., Blocksidge, D., Gabbert, F., Sauer, J. D., Lewinski, W., Mirashi, A., & Atuk, E. (2015). Memory and the operational witness: Police officer recall of firearms encounters as a function of active response role. *Law and Human Behavior*, *40*(1), 23–35. https://doi.org/10.1037/lhb0000159
Hope, L., Lewinski, W., Dixon, J., Blocksidge, D., & Gabbert, F. (2012). Witnesses in action. *Psychological Science*, *23*(4), 386–390. https://doi.org/10.1177/0956797611431463
Hull, C. (1951). *Essentials of behaviour*. Yale University Press.
Julian, L. J. (2011). Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). *Arthritis Care and Research*, *63*(SUPPL. 11), 467–472. https://doi.org/10.1002/acr.20561
Kahneman, D. (1975). *Attention and effort. The American Journal of Psychology* (Vol. 88). Englewood Cliffs: Prentice-HAll Inc. https://doi.org/10.2307/1421603
Kantak, S. S., & Winstein, C. J. (2012). Learning-performance distinction and memory processes for motor skills: A focused review and perspective. *Behavioural Brain Research*, *228*(1), 219–231. https://doi.org/10.1016/j.bbr.2011.11.028
Kayihan, G., Ersöz, G., Özkan, A., & Koz, M. (2013). Relationship between efficiency of pistol shooting and selected physical-physiological parameters of police. *Policing: An International Journal of Police Strategies & Management*, *36*(4), 819–832. https://doi.org/10.1108/PIJPSM-03-2013-0034
Konttinen, N., Lyytinen, H., & Viitasalo, J. (1998). Preparatory heart rate patterns in competitive rifle shooting. *Journal of Sports Sciences*, *16*(3), 235–242. https://doi.org/10.1080/026404198366759
Landman, A., Nieuwenhuys, A., & Oudejans, R. R. D. (2015). The impact of personality traits and professional experience on police officers' shooting performance under pressure. *Ergonomics*, *0139*(December), 1–12. https://doi.org/10.1080/00140139.2015.1107625
Marteau, T. M., & Bekker, H. (1992, OCTOBER). The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *The British Journal of Clinical Psychology/the British Psychological Society*, *31*(Pt 3), 301–306. https://doi.org/10.1111/j.2044-8260.1992.tb00997.x
Meijer, J. (2001). Trait and State Anxiety - Performance Anxiety - Anxiety. *Psycbological Reports*, *88*(2001), 947–964. https://doi.org/10.2466/pr0.2001.88.3c.947

Militello, L. G., Sushereba, C. E., Branlat, M., Bean, R., & Finomore, V. (2015). Designing for military pararescue: Naturalistic decision-making perspective, methods, and frameworks. *Journal of Occupational and Organizational Psychology*, *88*(2), 251–272. https://doi.org/10.1111/joop.12114

Morgan, C. A., Hazlett, G., Baranoski, M., Doran, A., Southwick, S., & Loftus, E. (2007). Accuracy of eyewitness identification is significantly associated with performance on a standardized test of face recognition. *International Journal of Law and Psychiatry*, *30*(3), 213–223. https://doi.org/10.1016/j.ijlp.2007.03.005

Morrison, G. B., & Vila, B. J. (1998). Police handgun qualification: Practical measure or aimless activity? *Policing: An International Journal of Police Strategies & Management*, *21*(3), 510–533. https://doi.org/10.1108/13639519810228804

Muse, L. A., Harris, S. G., & Feud, H. S. (2003). Has the Inverted-U Theory of Stress and Job Performance Had a Fair Test?. *Human Performance*, *16*(4), 349–364. https://doi.org/10.1207/S15327043HUP1604_2

National SLP Qualification Shoot. (2015). *College of Policing*.

Nibbeling, N., Oudejans, R. R. D., Ubink, E. M., & Daanen, H. A. M. (2014). The effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers. *Ergonomics*, *57*(9), 1366–1379. https://doi.org/10.1080/00140139.2014.924572

Nieuwenhuys, A., Caljouw, S. R., Leijsen, M. R., Schmeits, B. A. J., & Oudejans, R. R. D. (2009). Quantifying police officers' arrest and self-defence skills: Does performance decrease under pressure? *Ergonomics*, *52*(12), 1460–1468. https://doi.org/10.1080/00140130903287981

Nieuwenhuys, A., & Oudejans, R. R. (2017). Anxiety and performance: Perceptual-motor behavior in high-pressure contexts. *Current Opinion in Psychology*, *16*(2), 28–33. https://doi.org/10.1016/j.copsyc.2017.03.019

Nieuwenhuys, A., & Oudejans, R. R. D. (2010). Effects of anxiety on handgun shooting behavior of police officers: A pilot study. *Anxiety, Stress, and Coping*, *23*(3), 225–233. https://doi.org/10.1080/10615800902977494

Nieuwenhuys, A., & Oudejans, R. R. D. (2011). Training with anxiety: Short-and long-term effects on police officers' shooting behavior under pressure. *Cognitive Processing*, *12*(3), 277–288. https://doi.org/10.1007/s10339-011-0396-x

Ortega, E., & Wang, C. J. K. (2018). Pre-performance physiological state: Heart rate variability as a predictor of shooting performance. *Applied Psychophysiology Biofeedback*, *43*(1), 75–85. https://doi.org/10.1007/s10484-017-9386-9

Oudejans, R. R. D. (2008). Reality-based practice under pressure improves handgun shooting performance of police officers. *Ergonomics*, *51*(3), 261–273. https://doi.org/10.1080/00140130701577435

Pasadyn, S. R., Soudan, M., Gillinov, M., Houghtaling, P., Phelan, D., Gillinov, N., . . . Desai, M. Y. (2019). Accuracy of commercially available heart rate monitors in athletes: A prospective study. *Cardiovascular Diagnosis and Therapy*, *9*(4), 379–385. https://doi.org/10.21037/cdt.2019.06.05

Petersson, U., Bertilsson, J., Fredriksson, P., Magnusson, M., & Fransson, P. A. (2017). Police officer involved shootings–retrospective study of situational characteristics. *Police Practice and Research*, *18*(3), 306–321. https://doi.org/10.1080/15614263.2017.1291592

Plews, D. J., Scott, B., Altini, M., Wood, M., Kilding, A. E., & Laursen, P. B. (2017). Comparison of heart-rate-variability recording with smartphone photoplethysmography, Polar H7 chest strap, and electrocardiography. *International Journal of Sports Physiology and Performance*, *12*(10), 1324–1328. https://doi.org/10.1123/ijspp.2016-0668

Regehr, C., LeBlanc, V., Jelley, R. B., & Barath, I. (2008). Acute stress and performance in police recruits. *Stress and Health*, *24*(4), 295–303. https://doi.org/10.1002/smi.1182

Roberts, A. P. J., & Cole, J. C. (2018). Naturalistic Decision Making: Taking a (cognitive) step back to take two steps forward in understanding experience-based decisions. *Journal of Applied Research in Memory and Cognition*, *7*(1), 70–81. https://doi.org/10.1016/j.jarmac.2018.01.003

Robinson, O. J., Vytal, K., Cornwell, B. R., & Grillon, C. (2013). The impact of anxiety upon cognition: Perspectives from human threat of shock studies. *Frontiers in Human Neuroscience*, *7*(May), 1–21. https://doi.org/10.3389/fnhum.2013.00203

Robson, S., & Manacapilli, T. (2011). *Enhancing performance under stress*. Rand Corporation. http://www.rand.org/content/dam/rand/pubs/monographs/2011/RAND_MG996.pdf

Roger, D. (2016). *Rumination, stress, and emotion. stress: Concepts, cognition, emotion, and behavior: Handbook of stress*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-800951-2.00031-5

Schneider, W., & Chein, J. M. (2003). Controlled & automatic processing: Behavior, theory, and biological mechanisms. *Cognitive Science*, *27*(3), 525–559. https://doi.org/10.1016/S0364-0213(03)00011-9

Selye, H. (1952). Allergy and the general adaptation syndrome. *International Archives of Allergy and Immunology*, *3*(4), 267–278. https://doi.org/10.1159/000227975

Selye, H. (1953). The Alarm Reaction, The General Adaptive Syndrome, and the role of stress and of the adaptive hormones in dental medicine. *Oral Surgery,Oral Medicine, Oral Pathology*, *7*(4), 355–367. https://doi.org/10.1016/0030-4220(54)90142-5

Selye, H. (1956). *The Stress of Life*. McGraw-Hill Paperbacks.

Sommerfeldt, S. L., Schaefer, S. M., Brauer, M., Ryff, C. D., & Davidson, R. J. (2019). Individual differences in the association between subjective stress and heart Rate are related to psychological and physical well-being. *Psychological Science*, *30*(7), 1016–1029. https://doi.org/10.1177/0956797619849555

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Staal, M. A. (2004). *Stress, cognition, and human performance: A literature review and conceptual framework*. Moffett Field California.

Stöber, J., & Pekrun, R. (2004). Advances in test anxiety research. *Anxiety, Stress and Coping*, *17*(3), 205–211. https://doi.org/10.1080/10615800412331303225

Suss, J., & Ward, P. (2010). Skill-based differences in the cognitive mechanisms underlying failure under stress. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *54*(14), 1062–1066. https://doi.org/10.1177/154193121005401403

Taverniers, J., Smeets, T., Van Ruysseveldt, J., Syroit, J., & Von Grumbkow, J. (2011). The risk of being shot at: Stress, cortisol secretion, and their impact on memory and perceived learning during reality-based practice for armed officers. *International Journal of Stress Management*, *18*(2), 113–132. https://doi.org/10.1037/a0023742

Tenan, M. S., La Fiandra, M. E., & Ortega, S. V. (2017). The effect of soldier marching, rucksack load, and heart rate on marksmanship. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *59*(2), 259–267. https://doi.org/10.1177/0018720816671604

Tluczek, A., Henriques, J. B., & Brown, R. L. (2009). Support for the reliability and validity of a six-item state anxiety scale derived from the State-Trait Anxiety Inventory. *Journal of Nursing Measurement*, *17*(1), 19–28. https://doi.org/10.1891/1061-3749.17.1.19

Vast, R., Young, R., & Thomas, P. R. (2011). Emotion and automaticity: Impact of positive and negative emotions on novice and experienced performance of a sensorimotor skill. *International Journal of Sport and Exercise Psychology*, *9*(3), 227–237. https://doi.org/10.1080/1612197X.2011.614848

Vickers, J. N., Vandervies, B., Kohut, C., & Ryley, B. (2017). Quiet eye training improves accuracy in basketball field goal shooting. In *Progress in brain research* (Vol. 234, pp. 1–12). Elsevier B.V. https://doi.org/10.1016/bs.pbr.2017.06.011 .

Vickers, J. N., & Williams, A. M. (2007). Performing under pressure: The effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. *Journal of Motor Behavior*, *39*(5), 381–394. https://doi.org/10.3200/JMBR.39.5.381-394

Vine, S. J., Moore, L. J., & Wilson, M. R. (2016). An integrative framework of stress, attention, and visuomotor performance. *Frontiers in Psychology*, *7*(NOV), 1–10. https://doi.org/10.3389/fpsyg.2016.01671

Wheat, A. L., & Larkin, K. T. (2010). Biofeedback of heart rate variability and related physiology: A critical review. *Applied Psychophysiology Biofeedback*, *35*(3), 229–242. https://doi.org/10.1007/s10484-010-9133-y

Wood, G., Hartley, G., Furley, P. A., & Wilson, M. R. (2016). Working memory capacity, visual attention and hazard perception in driving. *Journal of Applied Research in Memory and Cognition*, *5*(4), 454–462. https://doi.org/10.1016/j.jarmac.2016.04.009

Wulf, G., McNevin, N., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, *54*(4), 1143–1154. https://doi.org/10.1080/713756012

Yerkes, R. M., & Dodson, J. D. (1908). The Relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, *18*(5), 459–482. https://doi.org/10.1002/cne.920180503