Gaze Control and Visual Attention in Police Firearms Training

A Study in Progress

Joshua Olma

Institute of Traffic & Engineering Psychology, German Police University, joshua.olma@dhpol.de

German police officers find themselves - albeit rarely - in situations where they have to make use of their firearms. In order to react quickly and adequately in these extremely stressful situations, profound training is an essential precondition. The aim of this study, which is embedded in a dissertation, is to add cognitive psychological components to police firearms training. Field placements with various police authorities that are involved in police firearms training are to be conducted in order to gain valuable insights. Based on this, a modular training concept is to be developed to improve situational awareness, visual attention, tactical gaze control, decision making, and verbal communication. Video-based training scenarios will be displayed in an indoor firing range where participants will be given a USB arcade gun. Participants' eye movement patterns will be recorded using a mobile eye tracking device. The effectiveness of the individual training modules is to be tested in subsequent randomised controlled experiments.

1 INTRODUCTION

The monopoly on the use of force in the Federal Republic of Germany is the state's responsibility. It delegates this sovereign task to the German police, who are legitimised to use force in compliance with the law. While the usual area of operation for patrol officers is petty offences and road safety work, police can find themselves in situations that are potentially life-threatening all of a sudden. Fatal encounters involving police officers are fortunately the exception but police officers are expected to show situational awareness, assess threats correctly, and thus react adequately under stress at any time [Helsen & Starkes 1999; Martaindale 2021; Vickers & Lewinski 2012]. The basis for these cognitive peak performances is perceptual processes of the sensory system. Especially in police operations, visual perception proves to be the most important source of information [Heusler & Sutter 2020; Koerber 2016; Ladwig et al. 2013; Sutter & Ladwig 2012].

1.1 Visual Perception and Police Firearms Training

Optimal preparation for situations in which police officers have to use their firearms can only be ensured through professional training. Essential for the training content are the practical experiences of the police instructors, which have been established over many years of iterative evaluation. However, cognitive science can also make its contribution to refining police firearms training:

On the one hand, the limits of visual perception are well researched. New visual information cannot be processed between fixations [Carrasco 2011; Castelhano et al. 2009; Irwin 1992; Salvucci & Goldberg 2000], optical illusions, the effect of change blindness, and cognitive blind spots impair visual perception [Findlay and Gilchrist 2003; Gibson 2015; Rensink 2005; Rensink et al. 2016], and general capacity limitations within the human processing system cause neglect and loss of information.

On the other hand, research sheds light on ways to improve visual performance. There is evidence that training can facilitate performance in visual search tasks related to potential threats [Koerber et al. 2007; Martaindale 2021; Vickers & Lewinski 2012]. Heussler and Sutter [2020] showed that in video-based shooting tasks, tactical police units showed superior gaze patterns compared to patrol officers and thus achieved better results. Additionally, Koerber [2016] proved that visual priming benefits the visual search and identification of dangerous objects and weapons.

1.2 Objectives of the Study

The brief theoretical introduction demonstrates that the execution of police officers' official duties as well as their self-protection on patrol is strongly tied to visual perception processes. However, as in many other domains, the challenges for police officers are constantly evolving. This concerns all official matters and thus also the possible use of the firearm. The study in progress aims to add cognitive psychological components to the police firearms training curriculum and thereby refine it. The additional value of this training content is to be validated in an experimental setting.

2 METHOD

The exact concept of the training sessions and the associated experiments has not yet been determined. Nevertheless, an overview of current ideas and designs is given below.

2.1 Field Placements

In order to improve police firearms training, it is first necessary to gain an insight into the status quo. Therefore, field placements are carried out in various police departments to assess the structure and content of the training practised. The accessible training is conducted for the following purposes:

1. Training of new police cadets
2. Regular shooting exercises of trained police officers
3. Advanced training of selected police officers to be firearms instructors
4. Training of tactical units

The insights gained from these field placements are complemented by literature on the subject [cf. Andersen et al 2018; Hamilton et al. 2019; Heusler & Sutter 2020; Heusler & Sutter 2022; Koerner & Staller 2020; Oudejans 2008].

2.2 Modular Firearms Training

The insights gained from the field placements will be used to design a modular training concept. Modularity will allow both more flexible application of the training and easier validation. In terms of content, the following modules would be conceivable:

1. Situational awareness (raising awareness for the need to correctly assess threat levels, e.g. expected behaviour of intoxicated subjects)
2. Visual attention (enhancing vigilance towards critical visual stimuli, e.g. weapons)
3. Tactical gaze control (training of active gaze shift on tactically vital regions, e.g. suspect's hands and hip)
4. Decision making (facilitating quick and correct decisions, e.g. in shoot/don't shoot scenarios)
5. Verbal communication (coping with dual stress through visual stimuli and simultaneous verbal communication)

The modules would be similar in their structure, including a theoretical part (approx. 20 min) and a practical exercise part (approx. 40 min). In terms of content, overlapping would occur at certain points, but the purpose of this concept was to allow the modules to be conducted independently of one another and in any order. The training would be video-based. Corresponding video sequences would either be taken over [Heusler & Sutter, 2020; Heusler & Sutter, 2022] or newly created.

Visual perception would be the focus of modules 2 and 3 in particular. Similar to Heusler and Sutter [2020; 2022], the practical training would mainly be conducted in a digital indoor firing range using a pistol-shaped USB arcade gun. The core component of these modules would be the recording of the participants' eye movement patterns, their evaluation, and content-related instructions for improvement. The 'Pupil Invisible' glasses by Pupil Labs is a modern eye-tracking system for this purpose. It can capture eye movement patterns as well as video recordings of the environment and sound recordings. The significant difference to other eye-tracking systems lies in its mobility; the glasses only have to be put on, as calibration is not necessary.

Partly different visual stimuli would be used for training exercises and the measurements. For modules 2 and 3, regions of interest (ROI) would be placed over the critical visual stimuli and the tactically vital regions. The supporting software would probably be OpenSesame.

2.3 Experimental Validation

The conception of the modular training is rather theoretical; therefore, the individual modules are to be validated in subsequent experiments. With five training modules, there would be a total of six experimental groups (a group per module and a control group that receives training as usual (TAU) – meaning training already practised by police instructors). The participants would be randomly assigned to the groups. A power analysis would give information about the group sizes. In a pre-post design, the dependent variables of interest would be measured at two points in time. A follow-up measurement would be conceivable.

Dependent variables could be, for example:

1. Module “Situational awareness”: Correct decision in threat/no threat scenarios
2. Module “Visual attention”: Time to identification of a specific visual stimulus
3. Module “Tactical gaze control”: Gaze movement patterns and fixation on specified regions of interest
4. Module “Decision making”: Correct decision in shoot/don’t shoot scenarios
5. Module “Verbal communication”: Hit accuracy with simultaneous verbal task

In each of the modules, one or more shooting tasks would also be given which could be adapted from existing literature [cf. Andersen et al. 2018; Heusler & Sutter 2020; Heusler & Sutter 2022; Oudejans 2008].

3 EXPECTED RESULTS

Conventional statistical software would be used for data analysis (e.g. R or SPSS). Overall, significant group effects are to be expected. The participants' performance will improve in the post-measurement compared to the pre-measurement. Since the exact design has not yet been determined, no prediction can be drawn regarding within or between subject effects. The TAU is expected to not improve participant's performance in the control group.

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