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Effects of reflex-based self-defence training on police performance in simulated high-pressure arrest situations

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ABSTRACT

We investigated the effects of reflex-based self-defence training on police performance in simulated high-pressure arrest situations. Police officers received this training as well as a regular police arrest and self-defence skills training (control training) in a crossover design. Officers' performance was tested on several variables in six reality-based scenarios before and after each training intervention. Results showed improved performance after the reflex-based training, while there was no such effect of the regular police training. Improved performance could be attributed to better communication, situational awareness (scanning area, alertness), assertiveness, resolution, proportionality, control and converting primary responses into tactical movements. As officers trained complete violent situations (and not just physical skills), they learned to use their actions before physical contact for de-escalation but also for anticipation on possible attacks. Furthermore, they learned to respond against attacks with skills based on their primary reflexes. The results of this study seem to suggest that reflex-based self-defence training better prepares officers for performing in high-pressure arrest situations than the current form of police arrest and self-defence skills training.

Practitioner Summary: Police officers' performance in high-pressure arrest situations improved after a reflex-based self-defence training, while there was no such effect of a regular police training. As officers learned to anticipate on possible attacks and to respond with skills based on their primary reflexes, they were better able to perform effectively.

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Anxiety; flinch; resilience; stress; threat

1. Introduction

Police officers regularly have to perform arrest and self-defence skills (ASDS) during their work, for instance, when a person aggressively insults an officer, resists arrest or starts fighting. In preparation for such situations, regular police officers (basic police function) in the Netherlands train a fixed set of ASDS and they have to pass an ASDS exam each year (cf. Nieuwenhuys et al. 2009). Besides the yearly exam, officers generally receive two or three practice days (including theory, handgun shooting, ASDS training) resulting in about four to six hours of ASDS training per year (see Timmer and Pronk 2011 for comparable situations in other EU countries).

Despite the limited time for training, officers are expected to act adequately and at the same time reasonably and moderately in all violent situations. Examples of officers' actions in violent situations are controlling and arresting a non-cooperating suspect, or adequately repelling a physical attack. The concerning officers are only allowed to use proportional force and the arrest should be performed with minimal damage to officer, colleagues and/or suspect. Performing as such while having limited training possibilities is even more difficult as officers often experience anxiety during violence (Anderson, Litzenberger, and Plecas 2002). Anxiety has been demonstrated to have a negative influence on ASDS performance (cf. Renden et al. 2014, Renden, Landman et al., 2015, Renden, Nieuwenhuys et al., 2015). In short, the limited time for training and the difficulty of performing under anxiety put a strain on officers' ability to perform well in violent situations (Nieuwenhuys and Oudejans 2012; Ericsson 2014). In fact, Timmer and Visser (2014) state that when performing in violent situations, officers frequently have difficulties to act structurally as they can hardly rely on well-trained procedures. This was confirmed by a survey distributed among over 900 officers, in which the officers reported that they lack sufficient training in frequency and content (Renden, Nieuwenhuys et al., 2015).

Therefore, we aimed to investigate whether an alternative training approach can improve police officers' performance in arrest situations within the limited available training time. Recently, researchers have proposed that besides just more training, more reality-based training

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is necessary (Renden, Nieuwenhuys et al. 2015). Reality-based training concerns scenarios that are not identical to work on duty but approach reality as much as possible enforcing behaviour that is representative of actual behaviour and involves genuinely acting in a complex situation (in contrast to execution of isolated skills performed out of context). Previous research has shown that more training experience (i.e. officers practised martial arts in their leisure time) results in better performance, but also that negative effects of anxiety are difficult to prevent by more training only (Renden, Landman et al. 2015). Training in reality-based scenarios, especially with increased levels of threat and anxiety, has been shown to hold much promise in improving performance under pressure in discrete far aiming tasks such as handgun shooting (Nieuwenhuys and Oudejans 2011; Oudejans 2008; see also Oudejans and Pijpers 2009, 2010, for examples in dart throwing and basketball shooting). The questions that arise are whether and how ASDS performance under pressure can be increased with specifically designed reality-based practice.

In search for a more reality-based ASDS training approach, this paper deals with two weaknesses of the current ASDS training policy: (a) skills are almost exclusively trained in relative isolation rather than in complete reality-based scenarios, and (b) skills taught are only moderately applicable in reality-based scenarios. On duty, ASDS are never performed in isolation but mostly in complex threatening situations in a sequence of actions leading to, for instance, the arrest of a suspect (Renden et al. forthcoming). Still, current ASDS training mostly focuses on the execution of certain isolated police skills, such as punching, kicking and performing control techniques. However, Pinder, Headrick, and Oudejans (2015) argue that the isolation of specific behavioural components in training could lead to behaviour that is not representative of actual behaviour in 'real situations'. In fact, skills as 'reading' a certain situation, communicating clearly and assertively, recognising and anticipating on signals of potential aggression and possibly an imminent attack are barely addressed during police training. Still, input from police instructors made clear that officers are expected to possess these skills as these are of crucial importance on duty.

Furthermore, the current ASDS, such as punching and kicking, but also the more complex control techniques, find their origin in combat sports where they are well-learned and rehearsed over and over again. However, they may be less suitable for police officers who lack the time to sufficiently practise these skills. ASDS are often not well-learned and only acquired on the basis of limited training, making them quite vulnerable to performance breakdown under pressure and anxiety during violent situations (cf. Nibbeling, Oudejans, and Daanen 2012). Instead, it might be more effective to teach officers skills of which the movements are more compatible with human primary responses to threat and anxiety. It has been shown that anxiety increases amygdala activation (emotion centre in the brain), which at the same time decreases prefrontal control mechanisms (Bishop, Duncan, Brett and Lawrence 2004; Bishop, Duncan, and Lawrence 2004). When the amygdala detects the presence of an environmental threat, its output could lead to initiations of stress responses such as flinching (Blanchard and Blanchard 1969; Fendt and Fanselow 1999). The decrease of prefrontal control in combination with activation of primary reflexes makes it more difficult to perform skills consisting of series of actions such as the currently taught control techniques during ASDS training.

Skills that are compatible with primary reflexes are presumably controlled at lower levels of the central nervous system and therefore more robust to performance breakdown due to anxiety (see Bernstein 1996; Beek 2000 for a theoretical account supporting this suggestion). One of the primary gross motor reflexes that almost always occurs when people encounter sudden threatening events is the flinch response (Figure 1). The flinch is a highly reliable reflex-like response that could function as an effective protection mechanism (Cobb and Pincus 2003). As such, it may form a more suitable basis for performing arrest and self-defence skills on duty than the current set of ASDS.

The aim of this study was to investigate the effects of reflex-based self-defence training on police performance in simulated arrest situations. A training methodology that works with reflex-based self-defence skills is the training methodology of FIRST™ (Functional Intuitive Replication Scenario Training). The methodology of FIRST covers verbal, physical and armed aggression and focuses on training complete situations (which includes earlier mentioned competencies: 'reading' a certain situation, communicating clearly and assertively, recognising and anticipating on signals of potential aggression and possibly an imminent attack). Participants learn to analyse situations and pick up cues that may indicate danger. In that way, they learn to act goal directed at an early stage and to anticipate on

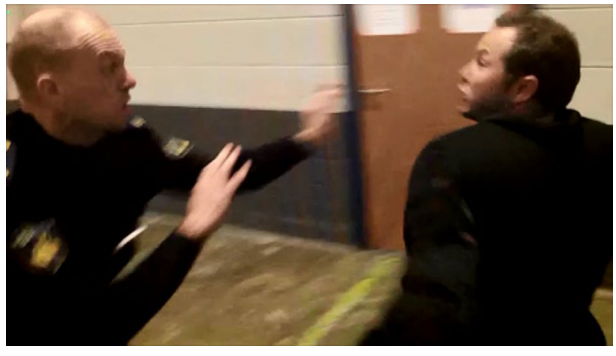

Figure 1. A flinch response.

potential danger. If an attack occurs, participants are better prepared to react. For effective reactions, they are taught to convert their primary reflexes into tactical responses (see assumptions from above-mentioned literature: e.g. Bernstein 1996; Bishop, Duncan, Brett, and Lawrence 2004; Cobb and Pincus 2003). It is important to point out that our general interest lies in the effect of reflex-based self-defence training in general, not specifically in the effect of a FIRST training.

To investigate our aim, and using a crossover design, police officers received a FIRST training as well as a control training in the form of a regular ASDS training. It is important to note that the FIRST and ASDS training differed in several regards and were experimentally not well comparable. However, the aim of this study was not to compare the two trainings, but to examine the effect of reflex-based self-defence training in comparison with the current training policy. The ASDS training was therefore used as control training. To examine the effect of both trainings, we choose to test how well officers could arrest an assailant in a series of reality-based scenarios involving different types of aggression, rather than testing ASDS skills in isolation, which normally happens during regular ASDS exams.

We expected that the FIRST training would positively influence officers' performance because (a) they trained several important aspects of arrest situations (and not isolated skills) and (b) the taught skills are more compatible with primary reflexes and therefore expected to be more robust to performance breakdown due to anxiety. We expected no effect of the ASDS training on performance because (a) of the above-mentioned weaknesses of the current training methodology, (b) the less efficient ASDS performances of officers in threatening situations in previous experiments (e.g. Renden et al. 2014; Renden, Landman et al. 2015), and (c) because officers are familiar with regular ASDS training (they do not learn anything new, this is what they normally train).

2. Method

2.1. Participants

Twelve participants participated in the experiment. Due to injury (unrelated to this study), 11 participants finished the experiment. Participants were randomly divided into two groups. Six participants (FIRST/ASDS group: 5 men, 1 woman; *M* age = 38.8, SD = 9.1; *M* years in service with police = 16.6, SD = 9.4) received the FIRST training first and later the ASDS training. Five participants (ASDS/FIRST group: 3 men, 2 women; *M* age = 38.8, SD = 9.1; *M* years in service with police = 16.6, SD = 9.4) received the ASDS training first and later the FIRST training. To rule out that participants were generally more anxious than average (personality trait) which could bias our findings, the Dutch version of the A-trait Scale of the State-Trait Anxiety Inventory was used to assess participants' trait anxiety (with Cronbach's α's around .90 and test–retest correlations between .75 and .92, Van der Ploeg, Defares, and Spielberger 1980). The A-trait Scale contains 20 questions about how participants generally feel. Participants' trait anxiety scores (FIRST/ASDS: $M = 34.0$, SD = 3.4, ASDS/FIRST: $M = 28.0$, SD = 5.0) were significantly lower than the norm (i.e. 36.7; $t = 22.4$; $p < .001$, $t = 13.7$, $p < .001$; Van der Ploeg, Defares, and Spielberger 1980) indicating that the participants had no extraordinary tendency to respond to threatening situations with an elevation in state anxiety. Participants provided written informed consent prior to participation, and the experiment was approved by the ethics committee of the research institute.

2.2. Design

We used a 2 (group) × 3 (test) crossover design. Participants first performed in the Pre-test. Subsequently, they received their first training (FIRST or ASDS), performed Post-test 1, received their second training, and performed Post-test 2. To not further increase the already large time investment by the participants, the Pre-test and the first training were sometimes performed on the same day, as were Post-test 1 and the second training. However, tests after a training were never performed on the same day as the training. The average number of days between training and the later tests was 4.8 days (SD = 2.8) and similar for both groups (FIRST/ASDS: $M = 4.8$, SD = 2.7; ASDS/FIRST: $M = 4.8$, SD = 3.0; $t(9) = 0.1$, $p = .97$.

2.3. Materials and experimental set-up

2.3.1. Test sessions

In developing the test sessions, we aimed to develop a representative research design, meaning that the test situation sufficiently replicates situations on duty (cf. Dicks, Button, and Davids 2010; Pinder et al. 2011; Pinder, Headrick, and Oudejans 2015), but also contained sufficient experimental control to compare the three test sessions (Pre-test, Post-test 1, Post-test 2). First, an important key factor in replicating work on duty was to increase the level of threat to such degree that participants had to perform while they experienced a high level of anxiety. Second, the scenarios were located in a 'practice street' (with a bar, a home, parked cars, etc.) at a police training centre to increase officers' perception of acting in 'real' situations. Third, officers did not receive specific instructions about what to do, but just a short briefing similar to what they could expect during work. Fourth, participants were

instructed to act as they would on duty (they were also dressed as usual and they had their regular police training tools with them). Different from actual work situations was that officers always acted alone, which was decided to keep sufficient experimental control. During work, officers can act alone, in pairs or in teams. However, the influence of duo or team interactions on police performance in stressful situations lies outside the scope of this study, but remains an interesting topic for future research.

In this study, participants performed in six different settings in each test session: 'passive aggressive', 'pushing', 'push and swing', 'tackle on the body', 'knife attack' (Shocknife®; length: 283 mm), 'handgun attack' (dummy handgun Walther P99Q-NL; 180 mm × 135 mm). We worked with these six different settings to make sure that participants did not know what to expect, to work with several possible attacks, and to increase statistical power for analyses afterwards. In the passive aggressive scenarios, the suspect behaved verbally aggressive and indicated that he did not want to cooperate. The participant had to physically control and handcuff the suspect. In the pushing scenarios, the suspect was also physically aggressive. He kept pushing until the participant had physical control and handcuffed him.

In the scenarios with a push and swing and with a tackle on the body, there first was a conversation between participant and suspect. Then, at a certain point, the suspect initiated the attack. The participant had to anticipate the attack and physically control the suspect. The scenarios with an armed attack (knife or handgun) were similar, but instead of a physical attack, the suspect used a weapon for the attack. The participant had to act such that the danger was undone as soon as possible.

The scenarios in the test sessions were built around the six settings. An instructor with much experience in designing reality-based scenarios during his job designed the scenarios. This instructor regularly uses these scenarios in training settings (e.g. domestic violence, shoplifter, drunken driver), as these are believed to frequently appear during police work. Briefings with participants after the experiment confirmed that. Thus, although the scenarios were different in each test session, the six settings were always the same (order was randomised). As an example, in the scenarios with a tackle on the body, the suspect sat on a chair. In the Pre-test, the suspect sat on a chair in a bar, was drunk and refused to leave, even though it was closing time. In Post-test 1, the suspect sat in his car and he was requested to come to the police station for further alcohol testing. In Post-test 2, the suspect sat on a chair in a room of a super market and was picked up by an officer for shoplifting. In all three scenarios, there was a discussion between participant and suspect. The suspect was ordered to come with the participant, but he refused. Instead, he attacked the participant with a tackle on the body.

2.3.2. Training sessions

In Training 1, participants received a FIRST training or ASDS training. This was reversed in Training 2. Both trainings lasted 90 min. The ASDS training was done in a training room and consisted of practising the skills that are tested each year in the ASDS exam, including kick and punch exercises on a foam strike field, different control exercises and handcuff exercises with different levels of resistance, transition from pepper spray to handgun and effective use of pepper spray and handgun.

The FIRST training consisted of a meeting in a classroom and physical exercises in a training room. In the classroom, the trainer explained how citizens' behaviour could be analysed. Two video fragments of real situations were used to analyse behaviour in order to make participants aware that when they address the suspect's behaviour at an early stage (e.g. raising voice, grasp an object, putting away an object, making gestures), they might de-escalate the situation. Furthermore, the trainer explained the flinch response, how the body reacts in so-called 'ambush situations' and how it can be used effectively during violent situations.

For example, the primary response to a physical attack is to protect the face with the arms up (elbows bent) and to push away the danger. Participants were taught, if they sensed that the situation could get dangerous, to move towards the suspect (to decrease his movement space) and to keep their hands between them and the suspect so that their flinch response could be used as effectively as possible in case of an attack. As a follow-up, participants were taught to keep their fingers spread (as that generates most power) and to use pushing force towards a wall, car, chair or floor, depending on the scenario. In case of a knife attack, the primary response is to move the body away from the knife and to hit the arm (holding the knife) away. Participants were taught to 'let that happen' and as a follow-up to grab the arm of the suspect, and to counter the attack by pushing the suspect towards, for instance, a wall or the floor, or to take their handgun and fire. The same principle was used for an attack with a handgun. These routines were trained during the physical exercises (more detailed information about the given FIRST training can be obtained from the authors).

Please note that this experiment focused on situations in which an officer received a call and approached a (possible) suspect. Their conversation could possibly build up towards aggression and an attack. In such situations, when an officer senses that it could get dangerous, moving forward is most of the times an effective approach. Other

situations might need another approach. For instance, as an officer receives a call with the information that a suspect walks around with a knife, it is best to keep a safe distance.

2.4. Dependent variables

2.4.1. Evaluation of training

To rule out that participants' appreciation for one training differed from the other and could therefore confound performance scores, participants rated both trainings on entertainment, usefulness and applicability on duty on a five-point Likert scale. A higher score on the scale indicates more entertainment, usefulness or applicability on duty.

2.4.2. Anxiety

To check whether participants experienced the scenarios as threatening, we assessed participants' subjective ratings of anxiety and mental effort after each scenario by using two visual-analogue scales: an anxiety scale (i.e. 'the anxiety thermometer', Houtman and Bakker 1989) and the Rating Scale for Mental Effort [RSME] (Zijlstra 1993). As state anxiety is just one variable, many studies have also used the anxiety-related variables 'mental effort' and 'average heart rate' as indications of participants' anxiety level. In this study, we also measured mental effort but heart rate was excluded because physical activity was too much a confounding factor. Both scales have good psychometric properties (anxiety thermometer: test–retest correlations between .60 and .78, RSME: test–retest correlations between .71 and .81) and were used in earlier ASDS experiments (e.g. Nieuwenhuys et al. 2009; Renden et al. 2014).

2.4.3. Performance

Nieuwenhuys et al. (2009) have developed a five-point Likert scale to assess ASDS performance. The authors reported sufficient reliability (Cohen's Kappa [K_w] of .57, which represents good test–retest agreement [minimum should be > .40]) and good ecological and concurrent validity. In this study, an experienced assessor (of reality-based scenarios) used this scale to assess performance, which he did on the basis of video recordings of the test sessions. Two experimenters had both operated a digital camera to make sure that the scenarios were well visible from different angles. The assessor was able to use the images of both cameras as often as he wanted until he was satisfied with the score. The videos were randomly presented.

For the variable 'overall performance', he received the basic instruction, 'when you assess the total situation, what grade, from 1 to 5, would you give the performance of the participant, with 1 being the lowest and 5 the highest'. Furthermore, performance was assessed on several other variables (see below). Therefore, the scenarios were divided in a pre-contact phase (before there was physical contact with the suspect) and a contact phase. In addition, a number of technique variables in the contact phase were assessed. Instructors in the Netherlands often use the here-assessed variables to assess police performance.

As a reliability check, two police instructors (unrelated to the experiment and to the FIRST methodology, but also experienced in assessing reality-based scenarios) also assessed performance on all variables for 30 scenarios. We made sure that each participant was represented and that the Pre-test, Post-test 1 and Post-test 2 as well as the six scenarios were equally distributed. Inter-rater reliability was assessed using Kendall's *W* showing a satisfactory inter-rater reliability for overall performance, $W(29) = .70$ (Van Rossum and Gagné 1994). In addition, average Kendall's *W* was .64 for the variables in the pre-contact phase (range: .52–.79), .66 for the variables in the contact-phase[1] (range: .55–.82) and .74 for the technique variables (range: .67–.82).

2.4.3.1. Pre-contact phase. Communication. The participant communicated what he or she wanted from the suspect and what the suspect was allowed and not allowed to do.

Alertness. The participant showed to be aware of potential risks (by communications and/or actions) and showed to be aware of behavioural signals of potential aggression from the suspect.

Assertiveness. The participant established boundaries in what he or she accepted from the suspect and followed up warnings with actual behaviour.

Active posture. The participant showed an active posture; he or she was ready to intervene if necessary and displayed that.

Positioning. The participant moved forward when possible and kept distance when necessary (for example to oversee the situation).

2.4.3.2. Contact phase. Communication. The participant gave clear comments (what the suspect had to do and could not do) during the physical confrontation.

Resolution. The participant showed determination in his or her actions (no hesitations).

Proportionality. The participant used force in proportion to the behaviour of the suspect.

Scan area. The participant scanned the area during the physical confrontation to remain aware of the surroundings.

Control before handcuffing. The participant had control over the suspect before he or she started handcuffing.

2.4.3.3. Technique variables. We originally aimed to assess all the used skills separately, but despite the ASDS training, most physical ASDS skills that were taught were only minimally reproduced in the reality-based scenarios, and consequently not analysed. Therefore, we choose to assess skills and technique variables that were used in the scenarios, including the more general variables such as direction of force. Also, we were particularly interested in whether participants in the reality-based scenarios were able to convert the flinch response in effective responses as was taught in the FIRST training. As this was often the case, it was included as a separate variable.

Use of flinch response. The participant effectively used the flinch response as explained earlier in the 'Training session' section (when appropriate).

Extension power. The participants used extension power (pushing).

Flexion power. The participant used flexion power (pulling).

Effectiveness verbal skills. The participant communicated clearly and assertively (as explained above).

Effectiveness physical skills. The participant repelled an attack (if necessary) and gained control over the suspect.

Effectiveness response against an armed attack. The participant repelled an attack and gained control over the suspect.

2.5. Procedure

2.5.1. Test sessions

Before the Pre-test, participants received general information about the test sessions; that they would receive a number of police alerts and that they had to follow-up on these. Before each test session, participants received practice pepper spray, practice handcuffs and a dummy handgun. Then, they performed the six scenarios. After each scenario, participants rated their perceived anxiety and mental effort.

2.5.2. Training sessions

Based on the availability of the participants, it was impossible to arrange one training session for all the participants of one group. Therefore, training sessions involved two to four participants and one instructor who also acted as a suspect when participants practised their skills. As in the test sessions, the instructor was instructed to act similarly in all training sessions. His behaviour was comparable with behaviour of instructors in regular police training; a mix of explaining and cooperating (while explaining and teaching the skills) and a little more aggressive in some of the training exercises. After each training session, participants separately assessed training on entertainment, usefulness and applicability on duty.

2.6. Data analysis

To compare how participants evaluated the FIRST and ASDS training, we performed paired sample *t*-tests. Effect sizes were calculated using Cohen's *d* with 0.2 or less, about 0.5, and 0.8 or more, representing small, moderate and large effects, respectively (Cohen 1988). To assess the effects of both trainings on anxiety and performance, we performed full crossover design 2 (Group: FIRST/ASDS, ASDS/FIRST) x 3 (Test: Pre, Post-test 1, Post-test 2) mixed design ANOVAs with repeated measures, with Group as the between-subjects factor and Test and the within subjects factor. Yet, we also performed 2 (Training: FIRST, ASDS) × 2 (Test: pre, post) repeated measures ANOVAs collapsing the data across training groups. Both types of analyses yielded the same pattern of results. Therefore, and for the sake of clarity, we only report the statistics for the latter analyses in the results section (original means and standard deviations of the groups during the three tests are presented in Appendix 1). The alpha level for significance was set at .05. Effect sizes were calculated using Cohen's *f* with 0.2 or less, about 0.3 and 0.4 or more, representing small, moderate and large effects, respectively (Cohen 1988).

3. Results

3.1. Evaluation of training

Participants rated both trainings above 4 on entertainment (*M* FIRST = 4.2, SD = 0.4; *M* ASDS = 4.1, SD = 0.5), usefulness (*M* FIRST = 4.8, SD = 0.4; *M* ASDS = 4.4, SD = 0.7) and applicability on duty (*M* FIRST = 4.5, SD = 0.7; *M* ASDS = 4.2, SD = 0.8), but the FIRST training scored significantly higher on entertainment and nearly so on usefulness, $t(10) = 3.7$, $p < .01$, $d = 1.6$, $t = 2.2$, $p = .053$. There was no significant difference on applicability on duty, $t = 1.4$, $p = .19$. These results indicate that participants considered both trainings as entertaining, useful and applicable on duty.

3.2. Anxiety

The average anxiety scores (FIRST: *M* pre = 5.2, SD = 2.2, *M* post = 4.4, SD = 1.9; ASDS: *M* pre = 5.2, SD = 2.3, *M* post = 5.1, SD = 2.4) showed that anxiety scores were relatively high (see Renden et al. 2014 for comparable scores in high anxiety scenarios), indicating that participants experienced the scenarios as threatening. Average anxiety scores ranged from 3.5 (SD = 2.0) in 'passive aggressive' to 6.3 (SD = 2.9) in 'handgun attack'.

The 2 (Training) × 2 (Test) ANOVA on anxiety scores revealed no significant main effect for training, $F(1,10) = 2.6$, $p = .14$, but it did for test, $F(1,10) = 6.2$, $p < .05$, $f = 0.8$. Anxiety scores were significantly lower in the post-test than in the pre-test, 95% CI [0.1, 0.8], although scores

remained relatively high (see previous paragraph). There was no significant interaction, $F(1,10) = 2.1$, $p = .18$.

The 2 (Training) × 2 (Test) ANOVA on RSME scores revealed no significant main effects for training or test, $F(1,10) = 1.6$, $p = .23$, $F(1,10) = 0.5$, $p = .50$. There was also no significant interaction, $F(1,10) = 2.4$, $p = .15$.

3.3. Performance

As discussed earlier, results below are obtained from 2 (Training: FIRST, ASDS) × 2 (Test: pre, post) repeated measures ANOVAs. Average scores per group and test, according to the full crossover design, are presented in Appendix 1.

3.3.1. Overall performance

The 2 (Training) × 2 (Test) ANOVA revealed no significant main effect for training, $F(1,10) = 0.1$, $p = .81$, but it did for test, $F(1,10) = 162.6$, $p < .001$, $f = 4.0$. There was also a significant interaction between training and test, $F(1,10) = 121.8$, $p < .001$, $f = 3.4$. Post-hoc pairwise comparisons showed that for the FIRST training, performance scores were significantly higher in the post-test than in the pre-test, $p < .001$, 95% CI [1.3, 1.8] (see Table 1). For the ASDS training, there were no significant differences between pre- and post-test, $p = .85$.

For reasons of readability, and because the separate variables follow the trend of overall performance, we present full statistics per variable in Table 2. Below we discuss the results and implications.

Table 1. Mean differences in anxiety score (on scale 0–10), mental effort score (on scale 0–150) and performance scores (on scale 1–5) between pre- and post-tests.

	FIRST	ASDS
Anxiety		
Anxiety score	−0.7 (1.0)*	−0.1 (0.8)
Mental effort score	−0.5 (1.1)	0.4 (0.9)
Performance		
Overall performance	1.6 (0.4)***	0.0 (0.3)
Pre-contact phase		
Communication	0.7 (0.4)***	0.0 (0.4)
Alertness	1.3 (0.5)***	0.0 (0.2)
Assertiveness	1.1 (0.7)**	0.0 (0.4)
Active posture	1.2 (0.6)***	−0.1 (0.2)
Positioning	1.3 (0.6)***	0.3 (0.3)*
Contact phase		
Communication	1.2 (0.5)***	−0.2 (0.4)
Resolution	0.8 (0.5)***	0.2 (0.3)*
Proportionality	0.3 (0.3)**	0.0 (0.3)
Scan area	0.5 (0.4)**	−0.1 (0.3)
Control before handcuffing	0.9 (0.7)**	−0.3 (0.7)
Technique variables		
Use of flinch response	2.2 (0.7)***	0.0 (0.5)
Extension power	1.0 (0.9)**	0.2 (0.5)
Flexion power	−1.0 (0.7)**	0.5 (0.8)
Effectiveness verbal skills	0.7 (0.4)***	0.0 (0.4)
Effectiveness physical skills	1.7 (0.6)***	−0.1 (0.4)
Effectiveness response against an armed attack	2.6 (1.1)***	0.1 (0.7)

*$p < .05$, **$p < .01$, ***$p < .001$.

3.3.2. Pre-contact phase

Statistical analyses on the variables in the pre-contact phase showed significant interaction effects for all variables (see Table 2). Post-hoc pairwise comparisons showed that for the FIRST training, performance scores for communication, alertness, assertiveness, active posture and positioning were significantly higher in the post-test than in the pre-test, $p < .001$, 95% CI [0.4, 1.0], $p < .001$, 95% CI [0.9, 1.6], $p < .01$, 95% CI [0.6, 1.6], $p < .001$, 95% CI [0.8, 1.5], $p < .001$, 95% CI [0.9, 1.7]. Examples of improved performance were: more goal-driven communication towards the suspect (e.g. what he or she wanted from the suspect, what the suspect was allowed and not allowed to do), visible anticipation on signals of potential danger (e.g. when an attack was imminent participants immediately moved forward [rather than backing up] to limit the suspect's movement space), immediate follow-up of warnings (instead of warning again).

For the ASDS training, there were no significant differences between pre- and post-test for communication, alertness, assertiveness and active posture, $p = .92$, $p = .85$, $p = .81$, $p = .24$. Yet, performance scores for positioning were significantly higher in the post-test than in the pre-test, $p < .05$, 95% CI [0.1, 0.4].

3.3.3. Contact phase

Statistical analyses on the variables in the contact phase showed significant interaction effects for all variables (nearly significant for proportionality: $p = .06$). Post-hoc pairwise comparisons showed that for the FIRST training, performance scores for communication, resolution, proportionality, scan area and control before handcuffing were significantly higher in the post-test than in the pre-test, $p < .001$, 95% CI [0.9, 1.5], $p < .001$, 95% CI [0.5, 1.1], $p < .01$, 95% CI [0.1, 0.5], $p < .01$, 95% CI [0.2, 0.7], $p < .01$, 95% CI [0.4, 1.3]. Examples of improved performance were: more goal-driven comments (instead of 'don't do this', 'do that'), fewer hesitations in physical actions, better adjustments of used force in proportion to the threat by the suspect (more resolute or not too much force, depending on the situation).

For the ASDS training, there were no significant differences between pre- and post-test for communication, proportionality, scan area and control before handcuffing, $p = .19$, $p = .64$, $p = .50$, $p = .30$. Yet, performance scores for resolution were significantly higher in the post-test than in the pre-test, $p < .05$, 95% CI [0.0, 0.4].

3.3.4. Technique variables

Statistical analyses on the technique variables showed significant interaction effects for all variables. Post-hoc pairwise comparisons showed that for the FIRST training,

Table 2. Statistics of the 2 (Training: FIRST, ASDS) × 2 (Test: pre, post) ANOVAs per variable.

	Training	Test	Training × Test interaction
Pre-contact phase			
Communication	$F(1,10) = 0.8, p = .40$	$F(1,10) = 25.0, p < .01, f = 1.6$	$F(1,10) = 13.1, p < .01, f = 1.2$
Alertness	$F(1,10) = 0.2, p = .66$	$F(1,10) = 57.4, p < .001, f = 2.4$	$F(1,10) = 48.0, p < .001, f = 2.2$
Assertiveness	$F(1,10) < 0.1, p = .88$	$F(1,10) = 24.5, p < .01, f = 1.6$	$F(1,10) = 13.4, p < .01, f = 1.2$
Active posture	$F(1,10) < 0.1, p = .97$	$F(1,10) = 49.0, p < .001, f = 2.2$	$F(1,10) = 37.1, p < .001, f = 1.9$
Positioning	$F(1,10) < 0.1, p = .91$	$F(1,10) = 128.3, p < .001, f = 3.6$	$F(1,10) = 16.5, p < .01, f = 1.3$
Contact phase			
Communication	$F(1,10) = 0.6, p = .45$	$F(1,10) = 31.9, p < .001, f = 1.8$	$F(1,10) = 50.7, p < .001, f = 2.3$
Resolution	$F(1,10) < 0.1, p = .98$	$F(1,10) = 46.8, p < .001, f = 2.1$	$F(1,10) = 10.6, p < .01, f = 1.0$
Proportionality	$F(1,10) = 0.3, p = .57$	$F(1,10) = 7.7, p < .05, f = 0.9$	$F(1,10) = 4.5, p = .06, f = 0.7$
Scan area	$F(1,10) = 0.9, p = .40$	$F(1,10) = 9.2, p < .01, f = 1.0$	$F(1,10) = 15.0, p < .01, f = 1.2$
Control before handcuffing	$F(1,10) = 0.2, p = .71$	$F(1,10) = 13.5, p < .01, f = 1.2$	$F(1,10) = 7.4, p < .05, f = 1.0$
Technique variables			
Use of flinch response	$F(1,10) < 0.1, p = .93$	$F(1,10) = 154.7, p < .001, f = 4.0$	$F(1,10) = 45.7, p < .001, f = 2.1$
Extension power	$F(1,10) < 0.1, p = .99$	$F(1,10) = 14.1, p < .01, f = 1.2$	$F(1,10) = 9.8, p < .05, f = 1.0$
Flexion power	$F(1,10) = 0.1, p = .74$	$F(1,10) = 2.3, p = .16$	$F(1,10) = 16.2, p < .01, f = 1.3$
Effectiveness verbal skills	$F(1,10) = 0.2, p = .66$	$F(1,10) = 19.5, p < .01, f = 1.4$	$F(1,10) = 19.4, p < .01, f = 1.4$
Effectiveness physical skills	$F(1,10) < 0.1, p = .99$	$F(1,10) = 87.5, p < .001, f = 3.0$	$F(1,10) = 59.2, p < .001, f = 2.5$
Effectiveness response against an armed attack	$F(1,10) = 0.3, p = .60$	$F(1,10) = 69.4, p < .001, f = 2.6$	$F(1,10) = 36.2, p < .001, f = 1.9$

participants were better able to effectively use the flinch response as tactical arrest and self-defence movements in the post-test than in the pre-test, $p < .001$, 95% CI [1.7, 2.7]. For the ASDS training, there were no significant differences between pre- and post-test, $p = .95$. Furthermore, the FIRST training also had an effect on directions of used force: participants made significantly more use of extension power (considered to be more effective) and less use of flexion power (considered to be less effective) in the post-test than in the pre-test, $p < .01$, 95% CI [0.4, 1.6], $p < .01$, 95% CI [−0.5, −1.4]. For the ASDS training, there were no significant differences between pre- and post-test, $p = .26$, $p = .055$. Finally, *post hoc* pairwise comparisons for the FIRST training also showed significant higher scores in the post-test than in the pre-test for effectiveness of verbal skills, physical skills and response against an armed attack, $p < .001$, 95% CI [0.5, 1.0], $p < .001$, 95% CI [1.3, 2.1], $p < .001$, 95% CI [1.9, 3.3]. The results suggest that effectiveness in verbally taking control of the situation, repelling attacks and gaining control improved after the FIRST training. For the ASDS training, there were no significant differences between pre- and post-test, $p = .76$, $p = .33$, $p = .52$.

4. Discussion

In search for a more reality-based arrest and self-defence skill training approach, we investigated the effects of reflex-based self-defence training on police performance in high-pressure arrest situations. In a crossover design, police officers received a training in which they learned to use primary reflexes as effective self-defence skills (FIRST training) and a control training (regular ASDS training). Officers' performance was tested on several variables in six reality-based scenarios before and after each training intervention. Even though participants were satisfied with both trainings, results showed improved performance after the reflex-based training, while there was no such effect after the regular police training. The FIRST training resulted in improved overall performance, which was also visible in communication, situational awareness (alertness, scanning area), assertiveness, active posture, positioning, resolution, proportionality, control and converting flinch responses into tactical movements. Moreover, though not reported in the results section, original analyses using the full crossover design revealed that the effect of the FIRST training was at least maintained from Post-test 1 to Post-test 2 for the FIRST/ASDS group (see Appendix 1). In short, it seems that reflex-based self-defence training, even one session, can already improve arrest and self-defence skills of officers in threatening arrest situations.

Improved performance seems to be caused by two main factors: (a) in the FIRST training there was also attention to signals and events before physical contact, and (b) the FIRST training focused on continuing the action after and from the inevitable occurrence of primary reflexes whereby used skills are more effective under threat and anxiety. Furthermore, these two factors were closely related as officers already positioned themselves in such a way that primary reflexes could be used effectively (if necessary). By training in this way, officers could act with a systematic approach from the start of any situation. As this is different from regular ASDS training in which officers mostly train physical skills in isolation, it is not surprising that improved performance was highly visible in the pre-contact phase, and that better performance in the pre-contact phase seemed to affect performance during the contact phase. Furthermore, as the taught skills in the FIRST training were not trained in isolation (cf. Pinder, Headrick, and Oudejans 2015) and were better adjusted to primary reflexes, officers were better able to repel an

attack and control the suspect. Therefore, it seems that police arrest and self-defence skill training could benefit from training with such an approach.

To achieve better performance in an early stage of a situation, recognising signals of a possible attack was a main topic in the FIRST training. When officers perceive such signals (e.g. an officer gives a suspect a speeding ticket and that person starts to behave aggressively), they may anticipate the attack with directive communication (telling what the suspect can and cannot do), moving forward (with the aim to decrease the suspect's moving space to perform an attack and to show assertive behaviour) and to prepare for a possible flinch in case the suspect does attack. Thus, most of that behaviour aims at de-escalation of a situation. However, by moving towards a suspect and keeping his/her hands between him/her and a suspect (for instance, by 'talking with their hands' or laying a hand on the suspect's shoulder), an officer could also anticipate on a possible flinch response in case de-escalation does not work and the suspect starts an attack. Renden et al. (2014) have recently shown that once an attack takes place, it is hard to inhibit avoidance tendencies (including the flinch response). However, when learned how to use them, avoidance tendencies such as a flinch response may provide a proper basis for subsequent arrest and self-defence actions. The results of this study show that such an approach may not only be more effective than using regular ASDS, but it also seems that it can be learned in a short period of time.

This is in line with the suggestion that mental effort can be used to enforce goal-directed behaviour under threat (cf. Eysenck and Calvo 1992; Eysenck et al. 2007; Nieuwenhuys and Oudejans 2012). Previous studies have shown that it is more difficult to move towards a threatening stimulus than to move away from that stimulus (e.g. Koch et al. 2009; Stins et al. 2011). However, the current study indicates that it is possible to teach officers to move towards a suspect in the pre-contact phase with the aim to position themselves in a dominant position. Under the acute threat in the contact phase it is harder to suppress the tendency to perform emotion-congruent responses such as the flinch. Nieuwenhuys and Oudejans (2012) argue that individuals seem to perform less effectively when goal-directed behaviour is not consistent with the emotion they experience (cf. Krieglmeyer, De Houwer, and Deutsch 2011; Renden et al. 2014). Following the FIRST training, emotion-congruent responses were implicated by converting avoidance tendencies, such as the flinch response, into tactical arrest and self-defence movements.

It is important to note that this study was performed with a small sample size and focused only on short-term effects of the training sessions. It is clear that this study needs a follow-up with a larger sample size perhaps with officers with different levels of experience with violence (in work, training or leisure time; Renden, Nieuwenhuys et al. 2015). A follow-up study also needs to determine the long-term effect of the FIRST training as well as the effects of multiple training sessions (participants in this study were trained in basic components of the FIRST programme; the training in this study did not concern the total concept). Still, that we found such positive effects of the FIRST training despite the small sample size and that participants in the FIRST/ASDS group maintained performance in the second post-test is promising, especially as officers' behaviour already improved after only one training session. Furthermore, one participant has indicated that she was able to repel a sudden attack during work using the skills she had learned in this study. When she took off the handcuffs of a suspect at a police station, the suspect immediately went for an attack. As the officer had learned to detect signals of a possible attack, she replied that she saw the attack coming in 'slow motion'. Using the flinch as a tactical response, she was able to repel the attack and control the suspect. This means that it is feasible to implement this form of training in the current training policy, ideally already at the police academy (training police recruits).

To summarise, we found that officers' performance improved after a reflex-based self-defence training while performance remained similar after a regular ASDS training. Improved performance was accompanied by better communication, situational awareness (alertness, scanning area), assertiveness, resolution, proportionality, control, and converting flinch responses into tactical movements. By using their actions before physical contact for de-escalation but also for anticipation on possible attacks, and by using skills that are compatible with primary reflexes for repelling attacks and gaining control of a suspect, officers were better able to perform effectively despite the high levels of anxiety. Therefore, our results seem to suggest that reflex-based self-defence training better prepares officers for performing in high-pressure arrest situations than the regular ASDS training.

Note

1. For proportionality, the scores for these 30 situations was mostly 5, which resulted in too many ties (26 5's per rater) to calculate a reliable Kendall's *W*.

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Appendix 1. Mean performance scores (and SDs) per group per test (on scale 1–5).

	FIRST/ASDS			ASDS/FIRST		
	Pre-test	Post-test 1	Post-test 2	Pre-test	Post-test 1	Post-test 2
Overall performance	2.6 (0.2)	4.2 (0.6)	4.2 (0.6)	2.7 (0.4)	2.7 (0.3)	4.3 (0.5)
Pre-contact phase						
Communication	3.1 (0.3)	3.7 (0.6)	4.0 (0.5)	3.4 (0.5)	3.1 (0.2)	3.9 (0.5)
Alertness	2.7 (0.5)	4.0 (0.6)	4.1 (0.7)	3.1 (0.4)	3.0 (0.1)	4.3 (0.5)
Assertiveness	3.0 (0.4)	3.8 (0.5)	4.0 (0.5)	3.1 (0.3)	2.7 (0.3)	4.1 (0.7)
Active posture	2.7 (0.3)	3.8 (0.5)	3.7 (0.3)	3.0 (0.4)	2.8 (0.2)	4.1 (0.5)
Positioning	2.8 (0.3)	3.8 (0.6)	4.1 (0.3)	2.4 (0.3)	2.5 (0.2)	4.1 (0.1)
Contact phase						
Communication	2.6 (0.2)	3.8 (0.4)	3.8 (0.6)	3.1 (0.3)	2.8 (0.3)	4.0 (0.7)
Resolution	3.1 (0.3)	3.8 (0.4)	4.0 (0.4)	2.9 (0.3)	3.2 (0.1)	4.1 (0.3)
Proportionality	4.6 (0.4)	4.8 (0.2)	4.8 (0.2)	4.4 (0.4)	4.6 (0.3)	4.9 (0.1)
Scan area	2.9 (0.3)	3.4 (0.3)	3.4 (0.4)	3.1 (0.2)	2.8 (0.4)	3.4 (0.3)
Control before handcuffing	3.0 (0.6)	3.6 (0.5)	3.6 (0.6)	3.1 (0.6)	2.5 (0.6)	3.8 (0.9)
Technique variables						
Use of flinch response	1.9 (0.3)	4.0 (0.9)	4.0 (0.8)	2.1 (0.3)	2.0 (0.3)	4.4 (0.3)
Extension power	2.3 (0.4)	3.3 (0.9)	3.4 (1.0)	1.9 (0.5)	2.1 (0.2)	3.2 (0.7)
Flexion power	2.3 (0.4)	3.3 (0.9)	3.4 (1.0)	2.5 (0.6)	2.9 (0.4)	1.9 (0.2)
Effectiveness verbal skills	2.9 (0.3)	3.5 (0.4)	3.7 (0.6)	3.0 (0.4)	2.8 (0.3)	3.6 (0.4)
Effectiveness physical skills	2.7 (0.2)	4.2 (0.5)	4.2 (0.5)	2.8 (0.5)	2.6 (0.3)	4.6 (0.3)
Effectiveness response against an armed attack	1.3 (0.4)	4.2 (0.9)	4.3 (0.8)	1.6 (0.6)	1.7 (0.8)	4.1 (1.2)