



Deriving Expert Knowledge of Situational Awareness in Policing: a Mixed-Methods Study

Juha-Matti Huhta^{1,2} · Paula Maria Di Nota³ · Tony Hietanen⁴ · Eero Ropo²

Accepted: 13 January 2023
© The Author(s) 2023

Abstract

Situational awareness (SA) is the most important skill required by police to effectively assess and respond to encounters, including critical incidents. Incomplete or sub-optimal SA strategies can lead to errors in subsequent judgement, decision-making, and action, including tactics and use of force (UOF). Errors in UOF, especially lethal force, in training or operational field settings, have severe consequences for learning, occupational health, and public safety. Therefore, adequately defining and instructing SA is an important gap to fill in existing applied police literature and practice. Using a mixed-methods approach, the current study aimed to define and conceptualize SA in police-specific contexts. Participants included 23 novice trainees and 11 experienced officers and instructors in tactics and UOF. Participants were shown 13 static images of various staged encounters, ranging from non-threatening to high-threat. Following each image, participants were interviewed and asked to describe what they saw and how they would respond. Thematic analyses of the interview data revealed the following seven themes that are highly interrelated and more completely define police-specific SA: distance/time laws; partner/roles; profiling the suspect; tactical options and opportunities; ongoing assessment of own tactical activities and outcomes; surrounding environment and conditions; and dangerous objects. Expert officers provided more detailed and multidimensional descriptions of the themes and statistical analyses confirmed that experts identified more themes compared to novices. By making tacit knowledge visible, the current findings establish a professional standard for SA formation, which can inform evidence-based police training in SA, tactical decision-making, and UOF while improving operational safety.

Keywords Situational awareness · Policing · Training and education · Qualitative analysis · Tactical decision-making

Introduction

Police officers are entrusted to protect and serve the public and respond to potentially dangerous and violent encounters in addition to their routine duties (Saus et al. 2006). As they do so, officers need to rely on several different types of information, including learned tactical skills, laws and regulations and rapidly changing external cues from the

environment (Di Nota and Huhta 2019). Sometimes police work involves dynamic and complex situations that demand rapid assessment, judgement, decision-making, and actions that may require a use of force (UOF) (see Hine et al. 2018; Huhta et al. 2021; Keampf et al. 1996; Vickers and Lewinski 2012). Situational awareness (SA) (sometimes also referred to as “situation awareness”) is essential and forms the basis of all of the above functions. However, there is currently no universal definition or standardized method for training, measuring, or evaluating SA in police contexts (Di Nota and Huhta 2019). According to Endsley (1995), SA is linked to decision-making and overall performance and can be understood as three components: perception, comprehension, and projection. Making observations using our multiple senses in the first stage informs the second stage of SA, which involves developing an understanding of the current situation. In the third stage, the officer anticipates how the situation might change. Although SA has been studied in several industries (e.g., medicine, aviation,

✉ Juha-Matti Huhta
juha-matti.huhta@poliisi.fi

¹ Police University College of Finland, PL 123 Vaajakatu 2, 33721 Tampere, Finland

² Faculty of Education and Culture, Tampere University, Tampere, Finland

³ Department of Psychology, University of Toronto Mississauga, Mississauga, ON, Canada

⁴ Police of Finland, Helsinki, Finland

military command, sports), there are still only a few studies specifically evaluating SA in policing contexts (Andersen and Gustafsberg 2016; Di Nota et al. 2021a, b, c; Huhta et al. 2022; Saus et al. 2006). New studies are needed to concretely and operationally define SA and its components, and especially how SA is formed in police-specific contexts.

In a recent investigation, early-stage SA (i.e., Endsley's Stage 1—perception) has been operationalized using officers' gaze and fixation patterns (Huhta et al. 2022). While these objective visuomotor behaviors may indicate where an officer is looking, it does not guarantee that the officer will consciously perceive, encode, or recall what their eyes have seen. Therefore, the current study uses a mixed methods qualitative and quantitative approach to investigate aspects of police SA that are not readily observable from an officer's performance or behavior. Furthermore, the current set of investigations aims to determine the elements of police work used by expert officers to build SA, whose tacit knowledge can inform the development of evidence-based SA training for police.

Linking Situational Awareness to Police Tactics

SA is a critical step in deciding which tactical approach officers will use in any given situation. Tactics are the methods and techniques used by law enforcement professionals to try to work safely and effectively. Police tactics are typically not shared with the public, which is sometimes forbidden by law. For example, in Finland it is stated in Article 24 (1) (5) of the Law on the Declaration of Authorities (21.5.1999/621) that information and documents related to the technical and tactical methods of the police must be kept confidential. The release of such information could endanger public order and security. For this reason, there is no comparative peer-reviewed study of police tactics or detailed explanations of what the tactics are and how they should be applied in different situations. Accordingly, this study does not cover police tactics in detail, although we recognize the importance of different tactical options, how to manage them, and that they are critically and reciprocally linked to SA and decision-making. For instance, having less competence and relying on fewer tactical options will limit useful information gathering and SA, further limiting potential alternatives for action.

At the same time and similar to SA, the content, extent, and delivery of police tactical training are unclear across individual agencies and around the world. Partly due to the legal restrictions mentioned above, a lack of open information sharing related to SA and tactical training and operations may result in "opinion-based" practices. Without a solid understanding of SA or the use of evidence-based educational practices, training may be ineffective, or at worst,

lead to a completely wrong understanding of police tactics. Evidence-based police training is therefore informed by applied research insights from other fields including cognitive and sport psychology and exercise sciences. A growing number of research teams and articles provide definitions and standards of practice relating to police-specific SA, tactics, decision-making, and behavior (Andersen et al. 2017; Bennell et al. 2020; Bertilsson et al. 2020; Huhta et al. 2021; Koerner and Staller 2021; Koedijk et al. 2021; Martaindale and Blair 2019).

Deriving Expert Tacit Knowledge to Understand Situational Awareness in Police

While police are acting out their duties, they are also constantly taking into account tactical considerations, opportunities, and safety concerns. This is always the case, even though it may not be obvious from an outside perspective. There are therefore numerous mental and technical processes occurring that may, at least in part, be unconscious to the officer themselves. Given that mental processes are implicit and not easily detected from the outside (even to experienced police instructors), articulating or passing on such knowledge and skills can be challenging. To develop evidence-based instruction on SA for police, it is relevant to ask the following question: what are police actions, and the related mental processes preceding them, based on?

According to Michael Polanyi (1966), "we can know more than we can tell" (p. 4). Tacit knowledge is a widely used concept that broadly defined refers to experiential knowledge. In working life, tacit knowledge refers to the skills and competences generated through practical experience. It is typical of experts to intuitively make decisions and act, often quite accurately even with little time or uncertainty of circumstances, without knowing how "they know." Experts have also been described as possessing a subconscious understanding of how to act in new situations (Ropo 1991). The ability to dynamically adapt to changing situations has been well documented in the literature on expertise (Ericsson 1998). Gary Klein has investigated experts in critical decision-making for decades and has observed that tacit knowledge enables "flexecution," in which solving a problem not only seeks to achieve a specific goal, formed in advance or in the early stages of the situation but at the same time strives to clarify and redefine goals (Klein 2007). In other words, locking in on one goal without the ability to read, interpret, and update the situation in real-time and formulate new goals when needed, is not adaptive for effective performance.

Related to the definition of SA by Endsley (1995) described above, the brain organizes sensory input (i.e., Stage 1 SA) into understandable and coherent stories (i.e.,

Stage 2 SA) that can help us predict what might happen next (i.e., Stage 3 SA) (Barrett and Bar 2009). Expert knowledge is organized into multilevel and interconnected structures in the brain (i.e., areas responsible for sensory, motor, and language functions) (Di Nota 2017). Following early-stage perception, experts are highly tuned to recognize patterns in their observations that will prime previous experiences under similar circumstances. By understanding what goals are feasible, experts are able to quickly determine a suitable course of action, a strategy called “satisficing” (Klein 1993). Proficient decision-makers do not try to search for the best option (i.e., deliberate and time-consuming optimization processing) but rather intuitively select a course of action that is most likely to work, especially under time pressure (Okoli and Watt 2018). For this type of decision-making to occur, one must know what might happen by mentally simulating possible events (Moulton and Kosslyn 2009). Therefore, the later stages of SA (understanding, prediction) are dependent on the existence of expert knowledge structures. For the purpose of cultivating expert SA in police, the question remains how to develop or train these expert knowledge structures in novice or rookie officers, and under the current lack of operational definitions and evaluation standards for SA (Di Nota et al. 2021a, b, c; Di Nota and Huhta 2019; Huhta et al. 2022).

To enhance evidence-based police education of SA, we can explore experts’ tacit knowledge. As employed in constructive learning models (Honkela et al. 2000), learning can be facilitated through concrete and constructive reflections on an officers’ current options, what they are doing, and why. To understand expert UOF decision-making, Mangels et al. (2020) analyzed responses from novice and expert police while they observed body-worn camera footage of citizen encounters. Videos were paused at certain points to obtain responses to both closed- and open-ended questions regarding what the officer would do in the next few seconds, what cues the officer remembered attending to, and how they would describe what is happening. Mangels et al. (2020) found that experts considered verbal de-escalation and methods to reduce the UOF (i.e., find the distance, seek cover, ask for backup) relatively more than novices who reported more physical solutions to control or resolve the situation. The key difference between the current study and Mangels et al. (2020) is that we are interested in identifying the elements involved in creating an expert’s SA, which in turn informs subsequent decision-making, tactics, and actions. That is, we are more interested in first understanding what cues or specific situational elements an expert officer perceives and understands to form SA before decision-making even occurs. Identification of these elements can be used to develop evidence-based SA and tactical training to improve decision-making and performance outcomes.

Present Study

The aim of the current study is to provide novel insights into how expert SA is developed in police-specific encounters. Using a mixed-method study design, we qualitatively examined interview data from expert and novice police officers who were asked about what they observed and how they would act in response to several images of staged police encounters. Thematic analyses revealed an expert model of SA that can be used as a framework to develop evidence-based police training. Overall findings and between-group comparisons are summarized descriptively and quantitatively analyzed with simple statistics.

Methods

Participants

A total of 34 participants took part in the current study and were divided into groups based on their experience (see Table 1). Novices ($n=23$, 11 female, 12 male) were further subdivided based on their completed studies; the Novice 1 group included students in periods 1 to 4, and the Novice 2 group included students in periods 5 to 6 (i.e., all or most tactical training complete, just prior to beginning their practical training in the field) (Police University College of Finland 2022). Novice students were invited to participate in the study through a message distributed in the institute’s internal email system. The recruitment message indicated that eligibility in the current study required that the participant does not have previous training or work experience in the security sector. Officers in the expert police group ($n=11$, all male) had an average of 16.7 years of experience as police officers ($SD=3.9$, range: 12–25), and an average of 8.0 years of experience in special units ($SD=2.2$, range: 3.5–10) including K-9 and special response units. Experts were further subdivided based on experience as instructors

Table 1 Demographic information

Group	<i>n</i> (female)	Age <i>M</i> (<i>SD</i>)	Years of experience <i>M</i> (<i>SD</i>)
Novice 1	10 (6)	25.6 (3.4)	< 1.5 education
Novice 2	13 (5)	24.6 (4.4)	< 1.5 education + tactical training
Expert 1	5 (0)	42.0 (3.8)	17.2 (3.0) duty, 9.0 (0.7) special units
Expert 2	6 (0)	41.2 (5.0)	16.3 (4.8) duty, 7.1 (2.6) special units, 10.6 (5.8) instructor

The Novice groups are trainee officers at the Police University College of Finland

in tactics and UOF (Expert 2, range: 4.5–20 years, see Table 1). Experts from various regions and operational backgrounds were invited to participate in the study based on their availability. The study was approved on 19 February 2018 by the research ethics board of the Police University College of Finland.

Procedure

The current study was conducted at the Police University College of Finland in February 2018. Following informed consent, participants were seated at a computer and told that they will be presented with 13 static photographs of staged encounters of a confrontational nature (see Fig. 1 and Supplementary Materials in Huhta et al. 2022). Each image was shown for 15 s, after which participants were asked specific questions to probe their SA and subsequent actions:

1. “Tell us about the situation: what there is, what can happen next, and how can the situation develop?” This question was used to determine what cues (e.g., persons, objects, hallway) the participant consciously perceived, and their understanding of how these cues could affect their SA, tactical decision-making, and possible next steps and/or outcomes.
2. “How do you act: tell us about your decisions and actions. Also, tell us about possible alternative ways to act and justify your actions.”

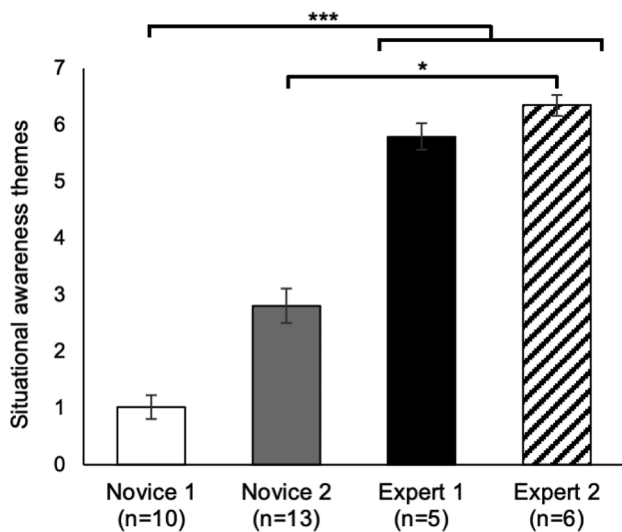


Fig. 1 Average number of situational awareness themes identified by group. Novice 1 participants identified significantly fewer themes than both Expert groups and Novice 2 participants identified significantly fewer themes than Expert 2 participants. Error bars show standard error of the mean (SEM). * $p_{Bonf} < 0.05$ *** $p_{Bonf} < 0.001$

This interview method can be described as “protocol analysis,” in which thinking aloud can be used to reveal the individual’s problem-solving process, including the search and use of information from short- and long-term memory (Anttila 2006; Ericsson and Simon 1984).

Data Analyses

Data from the eye tracking portion of the experiment has been reported in a separate study (Huhta et al. 2022). The current study will analyze the qualitative interview data to expose the elements of SA and tactical decision-making among expert and novice police.

Qualitative Analyses

All participant responses were recorded on a voice recorder and later transcribed verbatim. Two of the study authors (J-MH & TH) independently read the transcripts thoroughly to become familiarized with the data. Next, the authors systematically and iteratively read and manually identified categories and codes (i.e., meaningful sentences and words) that were used to classify discrete themes. According to Eskola and Suoranta (2014), there are many ways to qualitatively analyze verbal material in addition to coding. Coding units can include words, phrases, lines, paragraphs, or longer sections of text depending on starting points and goals. Manual coding can be done, for example, by underlining or overlining statements that are often repeated or abnormal from the material, or using characters (i.e., letters, numbers) and/or different colors and their shades. The current study coded transcribed material by hand on printed papers using different colored highlighters. The researchers chose not to use coding software (e.g., NVivo) because they did not want to miss any information because of a possibly inadequate code word list. For instance, it can be assumed that participants in the novice groups may not have the vocabulary to describe specific police tactics or situational elements, so the code word list would not be meaningful to use in these cases. In addition, the terminology associated with police tactics may differ by geographic location and regional dialects.

Overall, our qualitative analyses and the codes used to identify themes were conceptually driven (i.e., as opposed to word-specific codes), meaning that sometimes whole sentences were used as a code to fulfill the criteria of one or more specific themes. For example, “distance” is both a theme and a code word for the same theme. The word code “distance” was found many times, although there were also other word codes (e.g., “close,” “cut the distance,” “steps,” “stay,” “fast”) or sentences that referred to the overall theme of “distance” (e.g., describing the situation as “being too close to the subject,” “just a few steps away,” or “I’m way too close”). In these examples, participants were estimating

distance without using the word “distance,” which satisfied the theme.

It was also possible for participants to identify two themes at the same time in a single statement. For example:

(Expert 2—Participant 5): “...target person physically seemed to be in good condition, quickly cut that distance, so I’d prefer to stay there in the previous doorway to give the command and speak...”

The theme distance is to be found (“quickly cut that distance,” “I’d prefer to stay there in the previous doorway”), as well as Profiling the Suspect (“target person,” “physically in good condition,” “quickly”).

Once all of the themes were identified and saturated (i.e., no more themes or codes were identified), both authors independently and manually analyzed the blinded data (i.e., without consideration of who or from which group the respondent was) several times. As a final step, both authors cross-checked all responses to extract quantitative data (see below) and ensure that nothing was missed. During the entire coding process, only two discrepancies were identified and these were carefully discussed and reconciled.

Quantitative Analyses

In addition to qualitative analyses, the interview data was also analyzed quantitatively by comparing the number of themes identified by each group. For each participant, image, and theme, a spreadsheet was marked with a 1 = yes if a participant mentioned the theme, and 0 = no if the theme was not mentioned. This binary classification was intentionally chosen for simplicity of summarizing the results, even though it does not reflect the extent to which participants may have briefly or extensively discussed a given theme. For instance, responses from the experts were generally found to be more diverse and descriptive, so a theme could have been described by several different code words and meaningful sentences, while responses from the novices could be one-worded. Nonetheless, if there was a meaningful code or codes for a given theme, a value of 1 was given. Quantitative data were imported into SPSS (Version 24, IBM Corp.) and analyzed descriptively for means and standard deviations. Between-group analyses were conducted using a non-parametric Kruskal-Wallis test and pairwise comparisons were conducted using the Mann–Whitney *U* test, which also accounts for differences in sample sizes between $k=4$ groups. Statistical significance was set at $p < 0.05$ and Bonferroni corrections for multiple comparisons are reported where relevant. Therefore, this study combines complementary qualitative and quantitative methods to answer the research questions.

Results

The interview data raised seven specific themes that define the elements from which SA is derived in police-specific situations (Table 2):

- Distance/time law
- Partner/roles
- Profiling the suspect
- Surrounding environment and conditions
- Tactical options and opportunities
- Ongoing assessment of own tactical activities and outcomes
- Dangerous objects

The themes have not been listed in any particular order, are not intended to be listed from most to least important, or occurring in a discrete or chronological order. That is, depending on the situation the assessment of current tactical options can occur after a dangerous object has been identified.

Distance/Time Law

In their verbal responses, participants assessed the distance between the police (i.e., the perspective of the image) and the target person(s), as well as the distance between themselves and targets relative to bystanders in situations where bystanders were present. Participants’ estimations of distance were directly related to their judgements of how much time they had to respond, and also informed what behavioral response they could use (e.g., verbal instruction, command, means, and UOF). For instance, the estimated distance informed whether an officer could cut the distance for quick and surprising apprehension or be able to get between a target and bystanders to protect them. The distance was also directly related to the evaluation of the speed with which the target person could attack and whether there would be opportunities to react if the distance was not actively increased by the officer. In this regard, the evaluation of available time was closely linked to profiling of the target person. In the initial responses to most of the presented situations, experts noted that there was too little distance for safe activities and therefore their very first maneuver would be to increase their distance from target persons.

Partner/Roles

Participants assessed the situation according to roles related to patrol activities (i.e., taking a primary lead or secondary support role). Participants identified various specific tasks

Table 2 Themes defining situational awareness in police-specific contexts

Theme	Novice participant statement	Expert participant statement
Distance/time law	<p>N2-1-1: "...need to be prepared for going farther." (Picture 5)</p> <p>N1-9: "...ask the man to go back a little bit, to get into the apartment." (Picture 1)</p> <p>N1-6: "...then I would ask for a little distance, that [the target person] goes a little farther away." (Picture 4)</p>	<p>E2-6: "Well, first taking distance." (Picture 5)</p> <p>E2-2: "He has the opportunity to target us, target the police with something of a violent attack if he wants to, he has a chance ... to do so. The distance is so short." (Picture 1)</p> <p>E2-5: "... distance I took a little more and my partner kept the door still in control. That is, I took a couple of steps back..." (Picture 1)</p> <p>E1-3: "Being pretty close to the target person, getting out of the car can be a nasty situation. You should take a little distance to the person by car, withdrawing 15-20 m." (Picture 4)</p>
Partner/roles	<p>N2-1: "Also be prepared for having to go with partner to capture that fist-wielding guy." (Picture 2)</p> <p>N2-9: "I would feel like this so I would go with my partner to catch the target." (Picture 3)</p> <p>N2-6: "Possibly a patrol buddy would move the wounded to the side of the corridor a bit from the situation to shelter." (Picture 10)</p>	<p>E1-4: "Another acts as a shelter officer or observes the environment. Efforts to be in such a way as to maintain observation of all persons in the room." (Picture 2)</p> <p>E2-5: "... either one speaks so the other observes three-sixty environments." (Picture 2)</p> <p>E2-6: "...that [officer] clearly takes this target person and the other [officer] is trying the best possible way then to save the child from in between them." (Picture 3)</p> <p>E1-1: "... and partner can be prepared for example the use of a taser." (Picture 10)</p> <p>E2-3: "I'd say that drop the ax on the floor, again that my partner knows that I see a person with an ax in his hand." (Picture 11)</p>
Profiling the suspect	<p>N1-4: "A big-sized bald man, in a military-patterned fleece jacket like that, stands in the apartment, looks a bit angry." (Picture 6)</p> <p>N1-5: "...a little like that threatening." (Picture 4)</p> <p>N1-3: "It looked pretty gentle, not at all aggressive ... he didn't look like aggressive." (Picture 12)</p>	<p>E2-3: "... heavy-duty shoes, so his kicks would be risky." (Picture 6)</p> <p>E2-5: "... this guy seems to be physically in very strong condition." (Picture 4)</p> <p>E2-3: "There was a man with a short sleeve shirt. The other hand was left hand, it was hidden and it was not visible. There was some fist shape in my opinion in that other hand. That little look is not just curious, somewhat defiant but not aggressive ... jeans were wearing, belt, wristwatch, long hair, a little beard, slim, ... athletic guy and the watch was obviously something of [trademark brand]. The person could be judged based on the watch, and he may be [capable] in a way I would take [the situation] a little differently... [with] that kind of wristwatch... he's probably doing some sport or doing some kind of shooting or fighting, ... there is a reason for that watch... Clear place, left the impression that pretty neat... apartment where no heaps of rocks were visible which is often the case in normal "police customers" places, but that this could be such a precise, careful guy." (Picture 1)</p>
Tactical options and opportunities	<p>N1-9: "I ask that man, I tell him to move further away from that table and other instruments he can throw at us." (Picture 6)</p> <p>N2-13: "I'd tell the guy to calm down and lower the kid out of his hands on that bed." (Picture 3)</p>	<p>E1-2: "The best way would be to order him to put him in a more appropriate place for us. And, so to speak, to a safer state... The second option is that... we charge the target person, catch [them] and [achieve the] goal, ... gain control and calm him down." (Picture 6)</p> <p>E1-5: "...if he does not obey the order, let's pull him out because he is within plucking distance of the doorway, or charge towards the man, if the other hand is empty..." (Picture 1)</p> <p>E1-4: "...Let's talk, let's keep controlling the door." (Picture 1)</p>
Ongoing assessment of own tactical activities and outcomes	<p>N2-5: "If you can't 'talk' the baby out of his arms, you can't use the means of force in [the situation], because there's a risk of hitting the baby." (Picture 3)</p>	<p>E2-5: "No means of force, if you think about a situation like that, then you can't use. The baton may be the only sensible one besides the handcuffs, but even that there is a risk that he will use the child as a shield, which means we will have to use physical force..." (Picture 3)</p> <p>E1-3: "... You should take a little distance to the person by car, withdrawing 15-20 m. In this case, doing so you would receive 'playing time' if the person does not obey and the hand remains in the pocket. It is easier to use force in this case. At the same time, we can tell bystanders to stay put..." (Picture 4)</p> <p>E2-1: "First to actually be informed that we [the police] are on the scene ... substantially influences what that person does immediately thereafter." (Picture 7)</p> <p>E2-3: "...I would cut through the left ... block [the suspect's] access to possible blades and... see in his lap." (Picture 12)</p>

Table 2 (continued)

Theme	Novice participant statement	Expert participant statement
Surrounding environment and conditions	<p>N2-7: "The corridor would be safer, good space and it is known that there are no surprises as inside the apartment could be." (Picture 1)</p> <p>N2-4: "...the front room, behind which there was a balcony both right and left in that room, the viewing angle did not open so there may be additional persons or something else." (Picture 10)</p>	<p>E2-2: "Seems that the space would continue to that direction... The visibility of the apartment was good that if you had to go there, it wasn't so dim but very bright." (Picture 1)</p> <p>E2-5: "Big man who would go on a rampage in a small space." (Picture 10)</p> <p>E2-4: "...an apartment, from which a rather narrow sector of the doorway can be seen..." (Picture 13)</p>
Dangerous objects	<p>N1-1: "It seemed that there might have been something on the left side under the shirt, maybe even a knife, a gun, or something else." (Picture 8)</p>	<p>E2-2: "...left hand a little bit like it would be close to the mouth of the pocket and... the left helm of the t-shirt... was elevated, [so] there is probably something there in the trousers of the target person... He might start to dig a possible weapon, firearm, or knife, or something." (Picture 8)</p> <p>E2-5: "[The left hand is] pretty surprisingly high, which means you can imagine that either he's leaning against that doorway or wall, or he's got something there in hand. It is not likely to be his phone, because the phone is already in his pocket. But mainly you can imagine that it is something else. And as the worst-case scenario, there could be a blade, striking weapon, or possibly a handgun." (Picture 1)</p>

Participant group (N1 = Novice 1, N2 = Novice 2, E1 = Expert 1, E2 = Expert 2) and number (following the “-” each statement) have been identified before each statement. For example, E2-5 is Participant #5 from the Expert 2 group. To facilitate direct comparison of responses between novices and experts, the picture each statement is referring to has also been provided in parentheses following each quotation. Some of the pictures described above have been previously published as supplementary materials in Huhtia et al. (2022): Picture 3 = Fig. S3, Picture 4 = Fig. S1, Picture 7 = Fig. S2, Picture 8 = Fig. S4, Picture 9 = Fig. S5. Additional pictures can be requested from the first author

or goals that they or their partners could execute at the same time (see Table 2). Specifically, experts stressed the importance of primary and secondary roles and tasks, which may change during the situation. Thus, both patrol members act as enablers of different functions—one provides support while the other can work. Officers can facilitate the overall patrol's common understanding of the situation through their verbal orders to the target person (e.g., “drop the knife and stand still”) so that even if another patrol member does not see the situation, they would be able to form their own situational assessment through the content of the order (in policing often referred to as “communication through the target”). Therefore, roles were aimed at better assessment and control of the situation, making so-called 360-degree perception and action more efficient. Roles were tightly tied to tactics as well and were used to ensure the most safe and effective UOF (if necessary).

Profiling the Suspect

Participants assessed the situation by profiling the target person. At the very least, participants tried to judge the target person's mood (e.g., angry, aggressive). Experts mostly evaluated the functional capacity of the target person, in particular assessing how strong, fast, or possibly skilled and therefore dangerous they might be. While novices described the clothes of the target person, experts evaluated how their dress might influence the officer's own UOF and what they should be especially careful about; for example, a target person's heavy shoes may pose a danger by possibly kicking the officer or bystanders. Experts also used their evaluation of the surrounding environment to inform their suspect profile. For example, the way an individual maintained their apartment (e.g., messy or tidy) could suggest their functional capacity.

Tactical Options and Opportunities

Part of evaluating SA through tactics is identifying options as dictated by the situation. The specific tactics used by the police are, in principle, confidential information, so this study does not distinguish what these tactics might have been. At a general level, tactical options included verbal instructions, orders, or having a conversational interaction to de-escalate or resolve the situation. Another part of tactics was the evaluation of opportunities and possibilities for very detailed motor functions (e.g., cross hold) and other various UOF techniques or equipment. For instance, if a target person was seated it would dictate which tactical options were possible for the officer to take control of the situation. Therefore, tactical options and opportunities were directly related to other themes, especially partner/roles, profiling the

suspect, estimation of distance and time, and the surrounding Environment (including the presence of bystanders).

Ongoing Assessment of Own Tactical Activities and Outcomes

Participants' assessments included trying to predict how their own actions will affect the situation as it unfolds. In particular, experts assessed how their own tactical decision-making could affect the behavior of the target person and how the officer's own actions could affect the safety of bystanders. This theme of self-evaluation also included consideration of the selection and effectiveness of various UOF tools including physical force techniques. In other words, experts seek to predict the effects of their own action alternatives on the overall development of the situation. Self-assessment of the consequences of one's own actions was also partly based on confidence in one's own abilities and competencies. This, in turn, can affect the tactics and techniques chosen by the officer, either increasing or limiting potential options.

Surrounding Environment and Conditions

The reality created by the surrounding environment also informed participants' situational assessments; for instance, whether there were "dark" (i.e., unseen or occluded) corners hidden from the officer's sight, the size of a room/place, the placement of furniture relative to possible activity. Officers also evaluated other physical structures, such as hallways or doors that could be seen as either supporting or impairing safe operation. Ambient environmental conditions such as lighting or weather also impact SA and subsequent tactical decision-making, such that an officer might not use OC spray in windy conditions or in a housing unit with many apartments. The perspective of one officer alone may not be sufficient such that assessing the environment requires active engagement and shared knowledge between members of the patrol. In this way, information related to the environment is continuously updated during the operation and forms a more complete picture of the situation. This includes assessing the + 1 rule (Huhta et al. 2021), a common concept in police tactics that refers to the possibility of an unknown or additional threat including target persons or items.

Dangerous Objects

Participants evaluated the situation through the real or potential presence of dangerous objects, which can include weapons (e.g., knives, firearms) or objects that could be used to cause harm to the officer or bystanders (e.g., chair,

bottles). Dangerous objects were either directly visible and thus immediately impacted the situation and tactical options, or their possible presence and impact on the situation were assessed on the basis of assumptions (e.g., there are always knives in the kitchen; there may be something in the target's other hand that is out of sight) including the + 1 rule (i.e., if one weapon is visible, another may be hidden somewhere close by). Experts also noted that their evaluation of dangerous objects would consider previous experience or knowledge generated by computer systems related to the target person or address, such as previous calls for service.

Quantitative Results: Expert Versus Novice Situational Awareness

Overall, significant differences were observed in the number of themes identified between groups ($H(3) = 27.74$, $p < 0.001$). On average, Novice 1 participants identified 1 ($SD = 0.65$) out of the 7 identified themes per image, Novice 2 identified 2.8 ($SD = 1.12$) themes, Expert 1 identified 5.8 ($SD = 0.52$) per image, and Expert 2 identified 6.4 ($SD = 0.45$) themes per image (Fig. 1). Pairwise comparisons reveal that Novice 1 participants reported significantly fewer themes than both Expert groups ($p_{Bonf} < 0.001$) and that the Novice 2 group reported fewer themes than the Expert 2 group ($p_{Bonf} = 0.030$).

The frequency of responses for each theme was converted to a percentage for each group (e.g., for the theme of distance in the Novice 1 group = the frequency of responses for distance/[10 Novice 1 participants \times 13 images = 130 total possible response opportunities]) and are shown in Fig. 2. Statistical analyses reveal significant differences between all of the groups for all themes ($H(3) > 16.25$, $ps < 0.001$). Pairwise comparisons are summarized in Table 3.

Both expert groups were able to identify almost every theme in each image presented, especially distance/time law, profiling the suspect, tactical options and opportunities, and surrounding environment and conditions. The Expert 2 group, which comprised police instructors, were particularly effective at identifying partner/roles and ongoing assessment of their own tactical activities and outcomes.

The Novice 1 group identified a relatively low frequency of the themes overall and were identified inconsistently and superficially (i.e., only one word with no elaboration). Out of a total of 130 possible response opportunities (10 participants \times 13 images), only one Novice 1 participant indicated ongoing assessment of their own tactical activities and outcomes once in the entire study. Novice 1 participants were often able to identify dangerous objects, as these are quite obvious visual cues that were directly visible in several of the presented images. However, in cases where the dangerous object was not directly visible or in a possible location such as a knife in a kitchen scene, Novice 1 participants

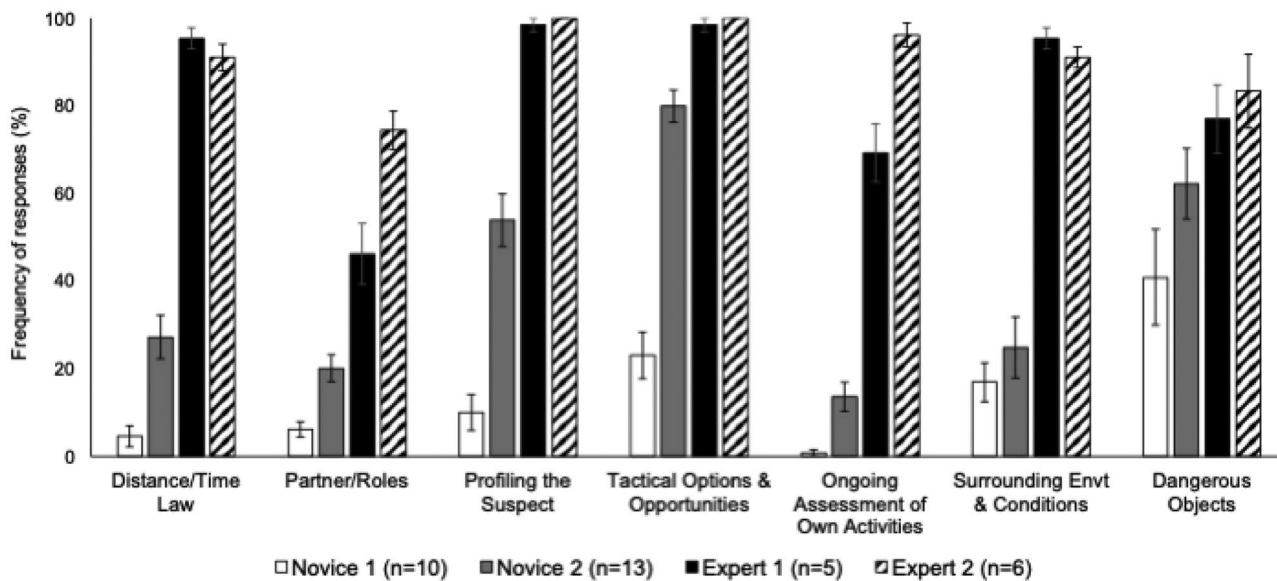


Fig. 2 Average frequency of situational awareness themes by group. Pairwise comparisons reveal that Novice 1 participants identified all themes significantly less than both Expert groups. Novice 1 and 2 only differed significantly for the theme of tactical options and opportunities. Novice 2 participants identified distance/time law significantly less than Expert 1 participants, and partner/roles, profiling the suspect, and ongoing assessment of own tactical activities and

outcomes significantly less than Expert 2 participants, and surrounding conditions and environment significantly less than both Expert groups. Frequency of identified themes did not significantly differ between Expert groups. See Table 3 for full reporting of pairwise comparisons. Error bars show standard error of the mean (SEM). * $p_{Bonf} < 0.05$ ** $p_{Bonf} < 0.01$ *** $p_{Bonf} < 0.001$

did not identify this theme nor were they able to infer its presence (i.e., making an inference using the + 1 rule). In addition, Novice 1 participants did not identify possible next steps for their own actions, their partner’s actions, or those of the target person based on the possible presence of a dangerous object. Instead, both Expert groups emphasized these other themes in relation to the consideration of a dangerous object even when it was not explicitly visible.

Relative to the Novice 1 group, Novice 2 participants were able to identify tactical options and opportunities quite well. This finding is understandable as this group had

completed all or most of their tactical training with specialized UOF instructors and were about to begin their practical field work. However, Novice 2 participants did not identify the themes of Ongoing Assessment of their own tactical activities and outcomes, distance/time law, partner/roles, and surrounding environment and conditions more than 30% of the time. Novice 2 participants’ profiling of the suspect was quite varied, ranging from simple descriptions of subjects’ perceived mood to more analytical assessment of their functional capacity in 53% of total response opportunities (Fig. 2).

Table 3 Mann–Whitney *U* pairwise comparisons for between-group differences in identified themes

Pair	Distance/time law	Partner/roles	Profiling the suspect	Tactical options and opportunities	Ongoing assessment of own activities	Surrounding conditions and environment	Dangerous objects
Novice1-Novice2	0.199	0.444	0.113	0.020*	1.000	1.000	0.137
Novice1-Expert1	0.000***	0.010*	0.000***	0.001**	0.008**	0.001**	0.015*
Novice1-Expert2	0.000***	0.000***	0.000***	0.000***	0.000***	0.001**	0.002**
Novice2-Expert1	0.043*	0.398	0.116	0.591	0.104	0.015*	1.000
Novice2-Expert2	0.062	0.015*	0.037*	0.216	0.001**	0.019*	0.444
Expert1-Expert2	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Significance values have been adjusted by the Bonferroni correction for multiple tests

* $p_{Bonf} < 0.05$; ** $p_{Bonf} < 0.01$; *** $p_{Bonf} < 0.001$

Discussion

The current mixed-methods study evaluated interview data from novice and expert police officers in response to images of various staged encounters using qualitative and quantitative approaches. The most novel and important finding based on the responses from all participants, and especially the tacit knowledge derived from experts, is the identification of seven themes that are foundational to forming SA in police-specific contexts: distance/time law, partner/roles, profiling the suspect, surrounding environment and conditions, tactical options and opportunities, ongoing assessment of own tactical activities and outcomes, and dangerous objects. These themes are highly connected to one another and can inform each other. Importantly, the themes are not ordered chronologically or by importance to cultivating overall SA. Rather, the identified themes are all essential aspects of individual and collective SA and come into play as situational demands dictate. For instance, a dark corner (i.e., surrounding environment and conditions) can dictate an officer's current Tactical Options and also inform their ongoing assessment of how their own actions can influence situational outcomes. At the same time, missing the dark corner can lead to the selection of a less ideal tactical option, or compromise the patrol's overall situational assessment. At worst, this can lead to errors in SA and subsequent decision-making. These negative outcomes are what the current study aims to reduce by defining and building optimal police SA through evidence-based approaches. This allows for the creation of effective teaching methods, where SA formation is one critically important learning objective for police, which can now be operationally defined and segmented into individual entities or "chunks" based on the themes identified above to promote learning.

Development of SA from Novice to Expert Through Training and Experience

Both expert groups identified more themes for each image (Fig. 1) and there were also qualitative differences in the amount of detail described for each theme. The following example illustrates the multidimensionality of expert responses that identify several themes in a single statement, each of which will be discussed in turn below:

Expert 1-Participant 1: "That is, one can take a distance [distance] to the man,... one can be prepared for the use of a firearm [Tactical Option], the other to carry out the apprehension [partner/role]... An alternative model would be [ongoing assessment], [officers] should take distance [distance and tactical option], go, for example, seek shelter, structural protection [surrounding environment], and from there give the verbal

command that we will use a firearm [tactical option] [if the target person does not comply]." (Picture 9, or Fig. S5 in Huhta et al. 2022)

As exemplified in the quote above, the theme of distance is a prominent and well-known concept among police UOF instructors and researchers alike. Nieuwenhuys et al. (2012) argue that distance is an important factor in deciding how to act/respond in a situation such that large distances usually provide more options and time for action. In a reaction time study, Blair et al. (2011) found that officers in a shooting position aiming at an armed suspect were unable to shoot before they were shot at. Based on fundamental physical laws and experience, action is always faster than reaction, highlighting the necessity for police officers' ability to recognize and assess every situation as fast and as accurately as possible (Huhta et al. 2022). These findings align with the current study, whereby both expert groups estimated distance and time laws in almost every encounter (Fig. 2). Most often, expert participants noted that they were too close to target persons and that their first course of action would have been to try to create more distance to gain more time.

The lowest reported theme among all participants was related to identifying roles for the officer themselves or their partners (Fig. 2). At least in Nordic countries, the specific tasks and goals assigned to each role (e.g., primary lead, secondary support) are well understood. Nonetheless, the actions mediated by specific roles (e.g., secondary officer switching to a lower force option) are often communicated in operational contexts, training scenarios, and were identified in the current study most often by experts (Fig. 2, Table 3). When novices identified this theme, they referred to what "we" would do as a collective, while experts articulated individual roles and tasks.

With respect to profiling the target person, novices primarily conducted this assessment according to the suspect's mood (e.g., "looks angry") while experts assessed their ability to function and potential action competencies (e.g., "... the guy is in good physical shape..."; "... the posture seemed to be a little bit ... offensive and suited to martial arts."). As shown in Table 2, experts (and especially Expert 2 participants) provided ample detail on target persons' physical features (e.g., "jeans were wearing, belt, wristwatch, long hair, a little beard, slim") and in some cases even inferred their physical capabilities from very detailed features, including a wristwatch that is commonly worn by high-level athletes or martial artists. Experts also informed their suspect profile by considering the theme of the surrounding environment and conditions, and how these features might indicate something about the suspect (e.g., a very neat apartment indicated that the suspect was a "precise, careful guy"). This example further demonstrates that the seven identified themes are highly interrelated and work together to form more complete SA.

Relating to the development of SA, Novice 1 participants did not possess the fundamental skills of identifying themes individually or discretely, nor had they yet developed the higher-level ability to connect the themes to one another (Fig. 2). This is likely because the Novice 1 group had not yet started their tactical training with specialized UOF instructors, even though they had started the basic tactics curriculum (Police University College of Finland 2022). The Novice 2 group had completed all or part of the tactical training block and were able to identify tactical options and opportunities in 80% of cases (Fig. 2). However, Novice 2 participants were still relatively poor at conducting ongoing assessment of their own tactical activities and outcomes and identifying distance/time laws, partner/roles, and surrounding environment and conditions (Fig. 2). This may be because the Novice 2 group had not yet had the opportunity to apply their tactical skills and knowledge in real-world field settings. This finding also highlights the differences in skills developed through deliberate training exercises versus operational experience in the field. By providing a better understanding of the specific elements that comprise SA, the current study can also inform the development of improved evidence-based training, including an understanding of how SA connects to ongoing assessment of tactical options, opportunities, and actions.

Deriving tacit knowledge from expert practitioners is an important method for developing police training and education, especially for skills and mental processes that are not readily observable. Using quantitative psychophysical methods, the eye-tracking data collected as part of this study have already revealed expert and novice patterns of early-stage SA (Huhta et al. 2022). Interestingly, what the participants saw (i.e., where their gaze was fixated) did not always correspond with what they perceived, understood, or predicted according to their qualitative responses, especially among novices. Despite spending more time scanning the environment relative to experts, novices were unable to identify or understand the importance of themes like the surrounding environment and conditions, the relative distance between themselves, target persons, or bystanders, or the potential presence of dangerous objects (Fig. 2). Similarly, novice participants' eye movement patterns beginning with target person's faces, hands, and bodies did not result in profiling the suspect as expressed in their interviews. These findings are consistent with Mangels et al. (2020), who also identified quantitative and qualitative differences in novice and expert officers' UOF decision-making strategies. The authors found that novices were also less likely to identify or recognize the importance of distance, time, backup, and cover provided by the surrounding environment. Mangels et al. (2020) concluded that an inability to perceive the situational aspects as found in their qualitative analyses led to the selection of more physical tactical and UOF options among novices

compared to experts who were more likely to engage in verbal de-escalation.

All of the SA themes identified can be effectively learned in training exercises. However, profiling the target person may require additional consideration. In police training exercises, the target person is often portrayed by a certified UOF instructor or an actor. While other themes like tactical options and opportunities and distance/time laws may be effectively trained with a known actor, trainees' ability to authentically profile the target person can often be artificial in these cases (i.e., the high-level functional capacity of UOF instructors is well known and assumed; variability in instructors' ability to act out a variety of emotional or mental states). As a result, improved suspect profiling skills observed among expert participants may be a result of refinement through specialized training and applied field-work experience. That is, experienced officers not only develop a larger repertoire of past experiences (i.e., training and operational) but also develop higher-level SA skills that integrate multiple themes to supplement their profiling abilities (i.e., assessing the target based on the condition of their apartment). At the same time, suspect profiling may be superficial among novice participants due to a lack of explicit and directed training on suspects' functional capacities in existing UOF and tactical training curriculums.

A possible explanation for the Expert 2 participants' ability to identify the greatest number of SA themes, especially partner/roles and ongoing assessment of own tactical activities and outcomes (Fig. 2), could be expert instructors' experience with verbalizing tactical considerations for the purposes of teaching and providing feedback to trainees. Specialized UOF instructor training offered at the Police University College of Finland, which was completed by all Expert 2 participants, requires that the instructors have relevant field experience and complete a "train the trainers" course that includes pedagogical theory, practice, and application of tactical techniques (see Di Nota et al. 2021a). Therefore, the police instructors included in the current study are specifically trained to speak aloud about perceptual, thinking, reasoning, and decision-making processes for the purpose of training others. This results in more detailed and multidimensional responses that reflect "linguaging"—a pedagogical concept that describes the development of one's own understanding by expressing their thinking to others using natural language. This method has been observed particularly in mathematical and linguistic learning contexts whereby students express and critically reflect on the key features of a concept to others, in turn structuring their own knowledge and thought processes. At the same time, students can compare their conceptual understandings with the content expressed by others, enabling learning through conversation and shared thoughts (Joutsenlahti and Kulju 2015).

Relevant to all police training and field experiences, learning may not occur unless the officer engages in purposeful reflection whereby the individual recognizes and critically evaluates the underlying assumptions and truisms of their own thinking, emotions, and actions. Reflection is itself a competency without which action becomes routine-based and is a skill that is developed through training with the guidance of instructors and constructive feedback (Mezirow 1998; Di Nota et al. 2021a). Therefore, training serves an important function for both initial skill development, as well as novel skill learning and “refresher” exercises for experienced professionals. Other research teams have provided resources and insights on how to develop effective police training exercises to meet learning objectives (see Jenkins et al. 2021; Koedijk et al. 2021).

Updating SA and Goals Through Self-Awareness

Considered together with previous literature, the current findings provide further insight into how early-stage perceptual processes are intimately linked to higher-level cognitive processes such as understanding and prediction in accordance with Endsley’s (1995) model of SA, as well as subsequent decision-making and motor planning. The themes identified in the current study reflect all stages of Endsley’s SA, such that an officer’s understanding of the low-level perceptual aspects of a room (e.g., placement of furniture, doors, windows) will dictate what higher-level Tactical Options and Opportunities are available to them. Using mental models and established knowledge structures, more experienced officers are better able to put smaller perceptual pieces or “chunks” together and predict how their own actions might influence situational outcomes (Di Nota and Huhta 2019). The current findings highlight a knowledge gap in, or at least an inability to verbalize, self-awareness of the officer’s own impact on situational outcomes, which should be explicitly addressed in SA training at all levels.

Police are trained (at least in theory) to continuously repeat the SA process and update their situational assessment as the encounter unfolds and new information is revealed. This practice is also reflected in visual models of police UOF decision-making (see Di Nota et al. 2021b). However, similar to the operational definitions of SA and UOF, training of situational re-assessment is inconsistent and not standardized. Researchers have found that proficient decision-makers in incident command contexts update their current understanding as well as situational tasks and goals based on changing demands or features (Alison et al. 2022). Relevant to police, Klein’s (2007) investigations on experts reveals “flexexecution.” Rather than focusing on achieving goals made during early assessment or planning phases, flexexecution refers to the capacity to flexibly change goals based on discoveries made during execution. Therefore, it is

essential that officers are able to quickly identify new goals, and if needed abandon previous ones, and to be able to act towards new goals. In this way, police decision-making can be based on SA, and not focus simply on the final outcome.

Practical Implications for Police Training and Evaluation of SA

As mentioned earlier and elsewhere, there is a current lack of standard definitions and evidence-based methods for police training concerning SA (Di Nota and Huhta 2019). We hope that the current findings will provide police educators with an opportunity to have officers reflect on all of the identified themes to develop a more complete skillset for achieving optimal SA. We do not suggest that police officers are not already implementing the themes identified here, but they may not realize when they are engaging self-reflective processes or when they are not. Without such conscientious reflection, officers are not learning, and it may lead to haphazard SA and action that is based on reflexive routines or implicit non-analytical strategies (Hine et al. 2018), especially under stressful conditions that compromise mental and physical performance (for reviews see Anderson et al. 2019; Di Nota and Huhta 2019). Instead, officers should consider their own thought patterns as an important part of SA and the required competencies that they bring to any encounter.

Following previous pedagogical models for developing police competencies (Di Nota et al. 2021a; Jenkins et al. 2021; Koedijk et al. 2021), we propose that revised SA training begin with foundational knowledge of the themes identified in the current study. Instructors can now describe individual situations that can be broken down around these seven themes, allowing officers to conceptualize SA in more manageable and concrete “chunks” that facilitate learning through reflective discussions (Kurby and Zacks 2008). Based on recent eye-tracking studies in police, instructors can also develop observation-based training exercises (Huhta et al. 2022). Various images can be viewed and analyzed as “saliency maps” to guide effective and efficient visual search patterns that promote more complete SA by connecting them to the current themes (Fig. 2). For example, instructors can direct officers’ gaze to observe target person’s hands earlier and develop their understanding of how this physical feature could be relevant for profiling the suspect, including detecting real or possible dangerous objects. Visuomotor behaviors can also be trained to search the surrounding environment more efficiently to derive relevant information, such that identifying “dark” corners or Dangerous Objects should be linked to Tactical Options and Opportunities (i.e., know where these elements are so that you can prevent the target person’s access to them later in the situation).

Once foundational knowledge of SA is established, training exercises should increase in complexity (including the

level of induced physiological stress) to promote encoding and performance in similar stressful situations (Di Nota et al. 2021a; Koerner and Staller 2021). Virtual or live simulations should be designed to elicit consideration of each theme and how it affects SA and later tactical decision-making and motor behaviors. For example, scenarios can manipulate the Distance between officers and the target person to develop a better understanding of whether officers can operate within the time span that their chosen means provides for “safe” apprehension. Specifically, time span can refer to the time it takes to use a given option (e.g., is the target person close enough for a Taser to be effective or should officers “cut the distance” to use one), or it can also refer to the time created by a given option to perform other actions (e.g., considering whether using a flash bang gives time to apprehend the suspect). At the same time, officers must be mindful about whether the surrounding environment and conditions impact the effectiveness of their tactical options and opportunities by conducting an ongoing assessment of their own tactical activities and outcomes. For instance, selecting OC spray would require additional consideration for what effects this option may have on bystanders or the officer themselves in an enclosed space or in windy conditions. In this way, officers can prepare more appropriate and effective motor plans that reduce the likelihood of, and reliance on, higher force options while promoting operational safety.

Instructors should also observe behavioral competencies, such as withdrawal and target-oriented behavior, and evaluate whether the officer is taking initiative to create distance, for example, based on SA-informed decision-making or acting out of fear (Huhta et al. 2021). Instructors need to be able to see, question and understand what officers base their actions on in order to promote correct training and feedback. In this way, instructors can make tacit knowledge visible (or explicit) in training situations where SA-related mental processes may not be readily observable. Guided by the seven SA themes, “*languageing*” can also increase training efficiency by facilitating observation-based learning among officers watching their colleagues act out simulations. Importantly, the themes identified in the current study also broaden the scope of teaching and learning from considering only the “end result” of the performance and emphasizing continuous thinking and action. This kind of “end result” evaluation (e.g., shoot/no-shoot decision-making, apprehending the suspect) can be problematic because according to Endsley (1995), good performance can be achieved even if SA is defective. The most dangerous implication in police training contexts is if a good result is achieved by luck and serious errors that could endanger safety are overlooked by the trainer and the performer. Failing to consider the SA process may give both the trainer and trainee a false sense of capability, which may result in serious harm in real-life

encounters if opportunities to identify and correct SA and tactical skills are missed.

Errors in police decision-making and behavior result in considerable distress and investment into understanding precisely where, when, why, and how things went wrong. Previous studies identify many factors that influence officer decision-making in critical situations, including those related to the environment, target person, and individual officer including physical and psychological stress (Chan et al. 2022; Giessing et al. 2019; James et al. 2019). The themes identified in the current study provide seven specific criteria that can be utilized at the processes level to understand and identify where things went wrong. In this way, these findings can also contribute meaningfully to the training, operations, and investigations surrounding individual police tasks during critical incident management.

Limitations and Future Directions

The current findings do not necessarily represent an exhaustive set of elements that inform police SA. Indeed, various policing roles or contexts (e.g., responding alone, in pairs, or part of a tactical team) may limit or introduce other aspects of SA that were or were not revealed by the current study. However, we are confident that no additional themes were missed, and that full saturation of participant responses was achieved. Particularly among Experts, some participants expressed concern to the researchers that their responses were becoming too repetitive, but were nonetheless encouraged to provide as much detail and information as possible for each image. We also acknowledge that possible differences in legislation, for instance, whether officers carry a duty weapon or not, may also influence training and operational standards as well as SA formation for officers in those jurisdictions. All officers included in the current study are legislated under the same sole centralized police organization, but the Experts are stationed and have operational experience in different regions. While the current elements are applicable to forming SA at the individual officer level in frontline positions (i.e., responding to calls), future studies can investigate the critical aspects of SA in other positions including leadership and management, whose awareness would have to consider the “*bigger picture*” and involvement of other personnel, agencies, and resources (e.g., paramedics, fire and rescue).

An additional limitation of the current study is the use of static images and a non-stressful experimental paradigm. Building on existing literature (Huhta et al. 2021, 2022; Mangels et al. 2020), future research can evaluate observable aspects of SA (i.e., visuomotor behaviors, tacit knowledge) while viewing dynamic footage (e.g., body-worn cameras, surveillance) or engaging in virtual or live training scenarios that activate physiological stress responses. In this way,

we can begin to understand more naturalistic SA processes in critical contexts, including the order that each theme is addressed and how different elements of SA are impacted by stress physiology.

The current study samples were also relatively small, especially expert groups, which also had no female participants. There are no current or previous female officers serving in Finnish special force units, and females are significantly underrepresented (or completely absent) from these roles in other countries. Therefore, potential sex differences in the themes identified (i.e., the frequency of individual themes, qualitative differences in theme descriptions) could not be analyzed. All study participants and persons included in the images were White European/Caucasian. Previous investigations in European and North American police have shown racial disparities in UOF and lethal force errors in both experimental and field settings (Andersen et al. 2021; Edwards et al. 2019; Essien et al. 2017; Wortley et al. 2020). While these sociocultural factors may influence decision-making by way of modulating threat perception and stress physiology, they still relate to the elements of SA defined in the current study and specifically profiling the suspect. Therefore, future SA training can direct officers' suspect profiles to be based primarily on functional capacity and not suspect race, sex, or gender. Through the current study, we hope to minimize any differences—between sexes, cultures, or individual officers—in how SA is conceptualized, operationalized, and utilized in police-specific contexts.

Conclusion

Police officers require expertise in situational awareness in order to effectively and dynamically apply their knowledge and skills to resolving the task at hand. Therefore, identifying the basic elements of SA is a means to enhance the current understanding of what and how we should teach and train. Through rigorous research methods that tested both novice and expert officers, the current study identified seven unique but interrelated themes that inform SA. Given that all of the themes were identified across all encounters that represented typical frontline tasks with varying levels of threat, the current study reveals universal elements that define SA in police-specific contexts. The present findings will be used to enhance evidence-based frameworks for training SA, tactics, and UOF, and establish a professional standard for SA in policing.

Acknowledgements The authors would like to thank the police forces for their support of this study. We would also like to thank the individual officers and students who participated in this study.

Author Contribution Conceptualization, J.-M.H.; methodology, J.-M.H. and E.R.; qualitative analysis, J.-M.H. and T.H.; quantitative

analysis and data curation, J.-M.H. and P.M.D.; writing—original draft preparation, J.-M.H.; writing—review and editing, J.-M.H., P.M.D., T.H. and E.R.; visualization, J.-M.H. and P.M.D.; supervision, E.R.; project administration, J.-M.H. All authors have read and agreed to the published version of the manuscript.

Funding Statement Open access funding provided by Tampere University including Tampere University Hospital, Tampere University of Applied Sciences (TUNI). No funds, grants, or other support was received.

Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Approval was obtained from the research ethics board of the Police University College of Finland. The procedures used in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

Previous Publication The quantitative eye-tracking data obtained from the current sample has been previously published elsewhere (Huhta et al. 2022). However, the qualitative analyses presented in the current study have not been previously published, and all text is original (i.e., not self-plagiarized).

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Alison L, Shortland N, Palasinski M, Humann M (2022) Imagining grim stories to reduce redundant deliberation in critical incident decision-making. *Public Money & Management* 42(1):14–21. <https://doi.org/10.1080/09540962.2021.1969085>
- Andersen JP, Di Nota PM, Boychuk EC, Schimmack U, Collins PI (2021) Racial bias and lethal force errors among Canadian police officers. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*. Advance online publication. <https://doi.org/10.1037/cbs0000296>
- Andersen JP, Di Nota PM, Poplawski S, Pitel M, Zurowski J, Azmi P (2017) *The science behind de-escalation and use of force decision-making: policy recommendations for police training*. Government of Ontario, Ministry of Community Safety and Correctional Services, June

2017. Available online: <https://hartlab.net/policy-recommendations-for-police-training/> (Retrieved 4 October 2022)
- Andersen JP, Gustafsberg H (2016) A training method to improve police use of force decision making: a randomized controlled trial. *SAGE Open* 6(2):2158244016638708. <https://doi.org/10.1177/2158244016638708>
- Anderson GS, Di Nota PM, Metz GAS, Andersen JP (2019) The impact of acute stress physiology on skilled motor performance: implications for policing. *Front Psychol* 10(2501):1–11. <https://doi.org/10.3389/fpsyg.2019.02501>
- Anttila P (2006) *Tutkiva toiminta ja ilmaisu, teos, tekeminen*. [Exploratory activities and expressions, work, doing.] Akatiimi Oy
- Barrett LF, Bar M (2009) See it with feeling: affective predictions during object perception. *Philosophical Transactions of the Royal Society B: Biological Sciences* 364(1521):1325–1334. <https://doi.org/10.1098/rstb.2008.0312>
- Bennell C, Blaskovits B, Jenkins B, Semple T, Khanizadeh AJ, Brown AS, Jones NJ (2020) Promising practices for de-escalation and use-of-force training in the police setting: a narrative review. *Police Intern J* 44(3):377–404. <https://doi.org/10.1108/PIJPSM-06-2020-0092>
- Bertilsson J, Niehorster DC, Fredriksson PJ, Dahl M, Granér S, Fredriksson O, Nyström M (2020) Towards systematic and objective evaluation of police officer performance in stressful situations. *Police Pract Res* 21(6):655–669. <https://doi.org/10.1080/15614263.2019.1666006>
- Blair JP, Pollock J, Montague D, Nichols T, Curnutt J, Burns D (2011) Reasonableness and reaction time. *Police Q* 14(4):323–343. <https://doi.org/10.1177/1098611111423737>
- Chan J, Di Nota PM, Planche K, Borthakur D, Andersen JP (2022) Associations between police lethal force errors, measures of diurnal and reactive cortisol, and mental health. *Psychoneuroendocrinology* 142:105789. <https://doi.org/10.1016/j.psyneuen.2022.105789>
- Di Nota PM (2017) Short- and long-term changes in behaviour and brain activity following exercise, motor learning and expertise. [Doctoral dissertation, York University]. York Space Institutional Repository. <http://hdl.handle.net/10315/33618>
- Di Nota PM, Andersen JP, Huhta JM, Gustafsberg H (2021a) Evidence-based instruction of police use of force: practical methods and pedagogical principles. In Arble, E. & Arnetz, B. (Eds.), *Interventions, training, and technologies for improved police well-being and performance* (pp. 72–101). IGI Global. <https://doi.org/10.4018/978-1-7998-6820-0.ch005>
- Di Nota PM, Chan J, Huhta J-M, Andersen JP (2021b) Considering objective and subjective measures for police use of force evaluation. *Int J Environ Res Public Health* 18(10):5351. <https://doi.org/10.3390/ijerph18105351>
- Di Nota PM, Huhta J-M (2019) Complex motor learning and police training: applied, cognitive, and clinical perspectives. *Front Psychol* 10(1797):1–20. <https://doi.org/10.3389/fpsyg.2019.01797>
- Di Nota PM, Stoyko P, Jenkinson J, Boychuk EC, Andersen JP (2021c) Critical review of visual models for police use of force decision-making. *Vision* 5(6):1–20. <https://doi.org/10.3390/vision5010006>
- Edwards F, Lee H, Esposito M (2019) Risk of being killed by police use of force in the United States by age, race-ethnicity, and sex. *Proc Natl Acad Sci USA* 116(34):16793–16798. <https://doi.org/10.1073/pnas.1821204116>
- Endsley MR (1995) Measurement of situation awareness in dynamic systems. *Hum Factors* 37(1):65–84. <https://doi.org/10.1518/001872095779049499>
- Ericsson KA (1998) The scientific study of expert levels of performance: general implications for optimal learning and creativity. *High Ability Stud* 9:75–100. <https://doi.org/10.1080/1359813980090106>
- Ericsson KA, Simon HA (1984) *Protocol analysis: verbal reports as data*. The MIT Press
- Eskola J, Suoranta J (2014) Johdatus laadulliseen tutkimukseen [Introduction to qualitative research]. Vastapaino
- Essien I, Stelter M, Kalbe F, Koehler A, Mangels J, Meli S (2017) The shooter bias: replicating the classic effect and introducing a novel paradigm. *J Exp Soc Psychol* 70:41–47. <https://doi.org/10.1016/j.jesp.2016.12.009>
- Giessing L, Frenkel MO, Zinner C, Rummel J, Nieuwenhuys A, Kasperk C, Plessner H (2019) Effects of coping-related traits and psychophysiological stress responses on police recruits' shooting behavior in reality-based scenarios. *Front Psychol* 10:1523. <https://doi.org/10.3389/fpsyg.2019.01523>
- Hine KA, Porter LE, Westera NJ, Alpert GP, Allen A (2018) What were they thinking? Factors influencing police recruits' decisions about force. *Police Soc* 29(6):673–691. <https://doi.org/10.1080/10439463.2018.1432612>
- Honkela T, Leinonen T, Lonka K, Raike A (2000, August 21–25) *Self-organizing maps and constructive learning*. [Conference paper]. Proceedings of the International Conference on Educational Uses of Communication and Information Technologies (ICEUT), Beijing, China (pp. 339–343). <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.117.2706&rep=rep1&type=pdf>
- Huhta JM, Di Nota PM, Nyman M, Pietil E, Ropo E (2021) Universal police behaviours during critical incidents and their connection to personality: a preliminary study. *Nord J Stud Polic* 8:1–18. <https://doi.org/10.18261/issn.2703-7045-2021-01-04>
- Huhta J-M, Di Nota PM, Ropo E, Surakka V (2022) Experience-dependent effects to situational awareness in police officers: an eye tracking study. *Int J Environ Res Public Health* 19:1547. <https://doi.org/10.3390/ijerph19095047>
- James L, James S, Davis R, Dotson E (2019) Using interval-level metrics to investigate situational-, suspect-, and officer-level predictors of police performance during encounters with the public. *Police Q* 22(4):452–480. <https://doi.org/10.1177/1098611119857559>
- Jenkins B, Semple T, Bennell C (2021) An evidence-based approach to critical incident scenario development. *Policing: an International Journal* 44(3):437–454. <https://doi.org/10.1108/PIJPSM-02-2020-0017>
- Joutsenlahti Jorma J, Kulju P (2015) Kielentminen matematiikan ja idinkielen opetuksen kehittmisess [using languaging to enhance mathematics and native language education]. In: Kaartinen T (ed) *Monilukutaito kaikki kaikessa [Multi-literacy is everything]*. Tampereen yliopiston normaalikoulu, pp 57–76
- Keampf GL, Klein G, Thordsen ML, Wolf S (1996) Decision making in complex naval command-and-control environments. *Hum Factors* 38:220–231. <https://doi.org/10.1177/001872089606380204>
- Klein GA (1993) A recognition-primed decision (RPD) model of rapid decision making. In Klein, G.A., Orasanu, J., Calderwood, R. & Zsombok, C.E. (Eds.), *decision making in action: models and methods* (pp.138–147)
- Klein G (2007) Flexecution as a paradigm for replanning, part 1. *IEEE Intell Syst* 22(5):79–83. <https://doi.org/10.1109/MIS.2007.4338498>
- Koedijk M, Renden PG, Oudejans RR, Kleygrewe L, Hutter RI (2021) Observational behavior assessment for psychological competencies in police officers: a proposed methodology for instrument development. *Front Psychol* 12:552. <https://doi.org/10.3389/fpsyg.2021.589258>
- Koerner S, Staller MS (2021) Police training revisited—meeting the demands of conflict training in police with an alternative pedagogical approach. *Policing: a Journal of Policy and Practice* 15(2):927–938. <https://doi.org/10.1093/police/paaa080>
- Kurby CA, Zacks JM (2008) Segmentation in the perception and memory of events. *Trends Cogn Sci* 12(2):72–79. <https://doi.org/10.1016/j.tics.2007.11.004>
- Mangels L, Suss J, Lande B (2020) Police expertise and use of force: using a mixed-methods approach to model expert and novice use-of-force decision-making. *J Police Crim Psychol* 35(3):294–303. <https://doi.org/10.1007/s11896-020-09364-4>

- Martaindale MH, Blair JP (2019) The evolution of active shooter response training protocols since Columbine: lessons from the Advanced Law Enforcement Rapid Response Training Center. *J Contemp Crim Justice* 35(3):342–356. <https://doi.org/10.1177/1043986219840237>
- Mezirow J (1998) On Critical Reflection *Adult Education Quarterly* 48(3):185–198. <https://doi.org/10.1177/074171369804800305>
- Moulton ST, Kosslyn SM (2009) Imagining predictions: mental imagery as mental emulation. *Philosophical Transactions of the Royal Society B: Biological Sciences* 364(1521):1273–1280. <https://doi.org/10.1098/rstb.2008.0314>
- Nieuwenhuys A, Cañal-Bruland R, Oudejans RR (2012) Effects of threat on police officers' shooting behavior: anxiety, action specificity, and affective influences on perception. *Appl Cogn Psychol* 26(4):608–615. <https://doi.org/10.1002/acp.2838>
- Okoli J, Watt J (2018) Crisis decision-making: the overlap between intuitive and analytical strategies. *Manag Decis* 56(5):1122–1134. <https://doi.org/10.1108/MD-04-2017-0333>
- Polanyi M (1966) *The tacit dimension*. Doubleday & Company
- Police University College of Finland. The structure of the degree. Available online: <https://polamk.fi/en/the-structure-of-the-degree> (accessed on 4 October 2022)
- Ropo E (1991) Opettajaeksperttiyden kehittyminen: tutkimustuloksia ja näkökulmia. [The development of teacher expertise: research results and perspectives.] *Aikuiskasvatus [Adult Education]* 11(3):153–163. <https://doi.org/10.33336/aik.96748>
- Saus E-R, Johnsen BH, Eid J, Riisem PK, Andersen R, Thayer JF (2006) The effect on brief situational awareness training in a police shooting simulator: an experimental study. *Mil Psychol* 18:3–21. https://doi.org/10.1207/s15327876mp1803s_2
- Vickers JN, Lewinski W (2012) Performing under pressure: gaze control, decision making and shooting performance of elite and rookie police officers. *Hum Mov Sci* 31(1):101–117. <https://doi.org/10.1016/j.humov.2011.04.004>
- Wortley S, Lanionu A, Laming E (2020, July) Use of force by the Toronto Police Service: final report. Ontario Human Rights Commission, Government of Ontario. Available online: <https://www.ohrc.on.ca/en/disparate-impact-second-interim-report-inquiry-racial-profiling-and-racial-discrimination-black#> (Retrieved 4 October 2022)

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.