‘It’s not about the pain – it’s about the feedback’: krav maga experts’ views on self-defence performance and the experience of contact, pain and injury in the process of skill development

Authors’ Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: Expert performance in self-defence situations has not been the subject of rigorous empirical investigation. This study aims is broaden knowledge in self-defence, its development and the role of contact, pain and injury in training, in order to stimulate future research activity.

Material & Methods: Semi-structured interviews with two Israeli krav maga experts centred on the development of expertise in self-defence. The interviews were analysed using an interpretative phenomenological framework; an inductive approach that captures the richness and complexity of the lived experience.

Results: Two analytically leading themes emerged concerning a) the characteristics of expert self-defence performance and b) the benefits, drawbacks and limitations of contact and pain in training activities.

Conclusions: By examining the analytic observation through a theoretical lens with regards to (a) the key components of decision-making and mind-set and (b) contact, pain and injury in the training process, we point the direction for further avenues of inquiry in the context of self-defence performance and the development of the associated skills.

Keywords: aggression • conflict management • expertise • interpretative phenomenological analysis • skill acquisition • violence

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Aggression (in psychology) – is deliberate behaviour by the perpetrator intended to either hurt the opponent, harm or distress him/her in any other way, cause pain (regardless of whether this aim is achieved), or destroy things [96, 97].

Aggression (in praxeology) – is to initiate destructive fight or move in a verbal dispute from material arguments to those causing distressto the opponent [98].

Violence (in praxeology) – is defined as physical pressure (physical force) or use of chemical, electrical, or other stimuli, etc., which results in subject being thrown into undesired situation and becoming an object of somebody's action [98, p.194, see also 99].

Krav maga (KM) – Israelian self-defence system, developed from military experience and constantly updated on the basis of violent incidents in military, law enforcement and civil arenas, taught to security forces and civilians worldwide.

Interpretative phenomenological analysis (IPA) – concerned with what experience is like (meaning) for the individual, requires interpretative activity on the part of the participant and the researcher, which is also referred to as 'double hermeneutic'.

Experts – characterized by a large declarative knowledge base to the application of problem solving and decision making, the ability to work independently, producing novel and innovative solutions and lifelong learning attitude.

Pain – immediate feedback mechanism in a simulation exercise. According to krav maga experts, pain is fundamental for learning and developing self-defence skills.

Rapid high-pressure decision-making – characteristic of expert performance in self-defence, including speed, efficiency and robustness of decision making under temporal constraints and environmental demands.

INTRODUCTION

Throughout history violence and aggression have been a significant part of human and social interactions [1]. Physical assaults are a pertinent problem for society worldwide [2-6]. One strategy to cope with violence at an individual level is to strengthen the capacity of an individual to defend oneself by using violence if necessary [7]. Indeed, this is central to a range of self-defence programs and systems. Self-defence classes for civilians are offered by a variety of organizations, including police departments, universities, rape crisis centres, and martial arts studios [8, 9]. In the professional domain, such as the law enforcement community, self-defence skills are taught to enable individuals to defend oneself while on duty [10, 11].

The majority of studies of self-defence training evaluate the competence of self-defence skills by use of simulated assaults [12], unopposed repetition of learned techniques [13, 14] or self-report, which typically ask how confident the trainee perceives him/herself with regards of coping with a possible self-defence situation [8, 15, 16]. Empirical work to investigate the actual competence of trainees when faced with intense violence in real incidents is limited to studies in the law enforcement domain that analysed the reflections of victimized officers following real-world violent conflict [17, 18]. The results from these studies indicated that self-defence training does not transfer sufficiently to real world scenarios. Consequently, the authors recommended (a) providing more training and (b) optimizing the self-defence training environment [10, 17], giving rise to training intervention proposals to foster skill transfer, such as the use of representative learning design [19-21].

In order to optimize skill learning environments in any given context, it is first essential to identify the key characteristics of skilled performance [22]. In the domain of self-defence, performers must manage the high dynamic physical and emotional demands that characterise violent encounters [23-25]; therefore, self-defence trainees have to acquire an assortment of motor (skill execution), perceptual-cognitive (decision making) and mental (e.g., persistence, controlled-aggression) skills [24, 26]. To this end, the self-defence coach is faced with the problem of designing practice activities that incorporate representative elements of real world incidents, without compromising health and safety of the participants [19-21]. Therefore, the use of contact and the place of pain (and possible injuries) in learning design are topics of debate amongst practitioners [27, 28].

The current study provides unique insight into self-defence training design by sharing the lived experience of authorities in the application and training of the Israelian self-defence system of krav maga. Krav maga (KM) was developed from military experience [29], is constantly updated on the basis of violent incidents in military, law enforcement and civil arenas [30, 31] and is taught to security forces and civilians worldwide [31]. It was therefore deemed as appropriate to explore skill development and the role of contact, pain and injuries in the training process and how this relates to the characteristics of expertise in self-defence.

The study aim is broaden knowledge in self-defence, its development and the role of contact, pain and injury in training, in order to stimulate future research activity.

MATERIAL AND METHODS

Research Design

In view of the scant knowledge regarding the development of expertise in self-defence and because of the complex psychosocial nature of learning environments in this context, this study was deemed best suited to qualitative methods, incorporating interpretative phenomenological analysis (IPA) [32]. IPA 'acknowledges that it is not possible to access a person's world directly because there is no clear and unmediated window into that life' [33, p. 1771]. The investigation of how events are experienced and given meaning requires interpretative activity on the part of the participant and the researcher, which is also referred to as 'double hermeneutic' [32]. IPA is concerned with what the experience is like for the individual and what sense this particular person is making of what is happening to him or her, in this instance subjective experiences, thoughts and theories about the development of expertise in self-defence. This ideographic emphasis is a core feature of IPA consequently resulting in small sample sizes.

Ethical Considerations

Ethical approval of the current study was granted by the local ethics committee. The committee required anonymity of the interviewed individuals. As such pseudonyms were used in the current work when referring to the accounts of specific participants. All participants provided informed consent prior to take part in the study.

Participants

A purposive sampling strategy was applied to recruit participants classified as expert performers *and* expert instructors in KM. The ranking system in KM grades performers at (a) practitioner level 1 to 5, (b) graduate level 1 to 5 and (c) expert level 1 to 5; therefore, an expert level qualification was the first inclusion criteria stipulated. Due to the cognitive nature of coaching and instructing, expert performers do not automatically become expert instructors [34]. Consequently, additional inclusion criteria derived from Nash et al. [34] were applied to the selection process: (a) utilizes a large declarative knowledge base to the application of problem solving and decision making, (b) utilizes perceptual skills, mental models, sense of typicality and associations, and routines, (c) demonstrates the ability to work independently, and is capable of producing novel and innovative solutions, (d) demonstrates effective reflection skills and lifelong learning attitude to their development, (e) takes their own strengths and limitations into account and (f) manages complex training processes. The above qualities were evaluated through behavioural observation of training camps, informal interviews and through peer recommendation. On the basis of the above inclusion criteria, two male Israeli KM instructors were recruited to the study and assigned the pseudonyms Adam and Henry. Both were highly ranked as KM performers (Adam: Expert Level 5; Henry: Expert Level 4) at the time of the study. Both had been teaching KM for over 20 years, were respected as top-quality instructors within the KM community (from different organizations) and were operating globally as high-level instructors (conducting seminars, instructor courses, etc.) After an explanation of the purposes of the research, and assurances of anonymity, all participants consented to take part in the study.

Data Collection

To answer the research question, each instructor underwent an interview lasting 3.5 and 4 hours. Topics covered a comprehensive description of participants' experiences of expertise in self-defence, its development, and their view of experiencing pain and injuries during the training process. The questions were used to guide rather than dictate the course of the interview. The interviews were conducted online via Skype on two separate days resulting in 7.5 hours of data. Participants were at home during the interview. Both interviews were recorded using 'Call Recorder for Skype' Version 2.5.7. and were transcribed verbatim.

Analysis of the Qualitative Data

Each interview was treated as one set of data. The transcript was read several times, and the left-hand margin was used to make notes of anything that appeared significant and of interest. The initial notes and ideas were then transformed into more specific themes or phrases, which are more abstract. This process can be described as an interplay between inductive and deductive positions. Therefore, existing theories can be endorsed, modified and/or challenged. Next the data was reduced by establishing connections between preliminary themes and clustering them appropriately. These clusters were given a descriptive label that conveys the conceptual nature of the themes therein. Some themes could only be found in the accounts of one expert, since the interview was only semi-structured and the course differed between the experts. Finally, a narrative account of the interplay between the interpretative activity of the author and the participants' account of the experience in his own words was produced, and continued into the paper preparation process.

Way of results presentations

We focuses on the super ordinate theme associated with experts' experiences of contact, pain and injury in the training process. Within this superordinate theme, 4 subthemes emerged from the IPA: (a) contact, pain and injuries as part of the training process, (b) the limits that exists with regards to contact, pain and injuries, (c) the use of pain as a feedback mechanism for learning and (d) the issue of inflicting pain on others during training. We provide a detailed account of the experts' description of these four subthemes.

Also, we provide (in our opinion) a rich descriptive account of the breadth and complexity of self-defence experts' views associated the two

Situational awareness – habit of knowing what is going on around by perceiving and gathering relevant information, basis for making fast and appropriate decisions.

Fighter´s mind-set – individual "fighting" attitude, including aggression, persistence and determination (see papers [99, 100]) whose authors justify that self-defence does not have to be based on multiplied aggression – editorial note).

Self-defence – *noun* fighting techniques used for defending oneself against physical attack, especially unarmed combat techniques such as those used in many of the martial arts [101].

Counterproductive – from praxeological perspective certain action can be: productive – non-productive – counterproductive – neutral. The action is **counterproductive** when a doer achieved goal opposite than intended [98, p. 220].

CQB (**Close Quarters Battle**) – defines combat in narrow, restrictive and confusing environments, such as indoors, streets and ally-ways where surroundings severely limits manoeuvrability and visibility used by suitably equipped and specialized military, police units or other special forces.

major themes: (a) contact, pain and injuries in training and (b) expert performance in self-defence (Table 1).

Table 1. Superordinate and subtheme analysed with the participation of KM experts.

Superordinate Theme 1: Contact, pain and injuries in training	
Subtheme 1.1:	Contact, pain and injuries as part of the practice
Subtheme 1.2:	Pain as a feedback mechanism
Subtheme 1.3:	Limits to contact, pain and injuries
Superordinate Theme 2: (Developing) Expert performance in self-defence	
Subtheme 2.1:	Rapid high-pressure decision-making and adaptable behaviour
Subtheme 2.2:	Avoidance of violent encounters by being situational aware
Subtheme 2.3:	Fighter's mind-set: aggression, persistence and determination

RESULTS

Theme 1. Contact, pain and injuries in training

1.1 Contact, pain and injuries as part of the practice

Contact, pain and injuries are recurring themes in the accounts of the two experts. Both experts describe, that in the 1980s and 1990s very hard contact in KM practice sessions was usual.

I just knew it's going to be punishment time and I'm just going to be smashed over and over again (…). (Adam).

The students, who practiced KM at that time, agreed to that kind of contact, which resulted in a lot of injuries.

Injury was part of a training, of a lesson. (Henry).

The students themselves consented to this practice by continuing to participate in KM training. If they did not agree, they left. Both experts observed that there was no adjustment of the intensity of contact to the skill level of the student. According to their description, KM practice was similar to a selection process. Students who could not cope with the intensity and contact in practice left the KM class.

Interviewer: *So all the guys in the old days there, they agreed to possible injuries. And all the guys who were a little bit afraid of it, what did they do?*

Henry: *Out. They didn't stay… 'Go, you're not tough enough to do krav maga. Get out.'*

Interviewer: *So meaning like 'survival of the fittest'?*

Henry: *Yeah, (…) We were beating up each other all the time, we were beating up each other, literally beating up each other.*

Both experts view their experiences as students in such sessions negatively and agree that there has to be a systematic approach to the development of self-defence skills that considers individual skill level. Nevertheless, they perceive pain as inherent to KM practice today as well.

Pain is part of it. (Henry).

The interaction between the attacker and the defender, and thus the issue of pain being delivered and received, is inherent to KM practice activities. Adam believes that it is important not to be afraid of pain from contact when being the attacker in a simulation exercise, since constraining contact limits the ability to perform a good attack.

(…) people who like to train, and they have a good mentality in training and are not afraid so much to get hurt. If they are afraid to get hurt, they will never become good attackers. (Adam).

In Adam's view the ability to attack well is linked to being able to cope with the pain induced by the defender's behaviour. The underlying premise of this conclusion is, that the defender applies contact – and thus pain – when performing defending behaviours. However, according to the experts, the defender restraints him-/herself to some point, so he/she does not perform a counterattack at full force. As soon as participants put on protection equipment, the contact is harder in the practice setting.

The moment the helmet is on, the defender thinks that it's OK to hit the head, so they hit, because the attacker has protection. And usually what also happens is, the aggression in the exercise goes up a little bit, because now the attacker thinks that he is safe, because his head is, so he goes a little bit harder. So

if the attacker goes harder, the defender has to perform harder. So usually it's like a loop. (Adam).

Adam argues that the introduction of additional protection equipment, like helmets, to practice views has a positive effect on the understanding of students, since results of effective attacks and defences can be felt and experienced.

And I'm a great believer in training every now and then with helmets. And every time you put on helmets, it creates "aha" moments in the people. (Adam).

As such, according to the experts, contact and pain are an important aspect of learning, since both aspects enable feedback in simulation exercises. Especially pain is perceived as an important feedback mechanism by the experts.

1.2 Pain as a feedback mechanism

The perception of pain in a simulation is a direct feedback to a mistake the student made. According to the experts, this is fundamental for learning and developing better self-defence skills. Adam refers to an incident, where he was attacked with a real baseball bat in a simulation exercise in a CQB area.

I had a nice bruise on the hand, but it didn't break my hand. I could continue the training. A little bruise, that's it. So it was definitely a good aha-moment on the stabbing. (Adam).

On the one hand, his perception of pain enabled learning from that incident, while on the other hand Adam could continue practice, because he was not injured heavily. Learning and improving his skills, is the main focus of Adam. Therefore, he seeks immediate feedback from performance (pain), while making sure, that he can continue practice (no injuries). In his view, pain is the only possibility to infer immediate feedback in a simulation exercise.

It's not about the pain - it's about the feedback. But how can you give feedback with a punch without hitting? (Adam).

The essence of the mechanism of pain is to enable direct feedback to the learner, thus supporting a good learning outcome. Adaptation to pain is not for the joy of the attacker to hit somebody. According to Henry, this is not understood by all KM practitioners. He had some experiences in the past, in which training partners did not understand the feedback mechanism of contact and pain.

(…) people come and really wants to hurt you, he doesn't want to train with you. He wants to prove that he can hurt you by hurting you. (Henry).

To conclude, the experts perceive pain as an important feature to enable efficient learning and skill development. However, the experts' accounts indicate, that the inherent feedback (in an exercise) is the important part, which they did not know how to create without the experience of pain. Furthermore, the purpose of pain as a feedback mechanism is not understood by everybody. Instead some individuals like to inflict pain on others of the sake itself.

However, the experts describe, that there are limits to the intensity of contact.

1.3 Limits to contact, pain and injuries

Besides contact, pain and injuries being part of the training process, the experts agree on several limits on these subjects. First, intensity of contact should be on a level that major injuries do not occur (*'come back … in one piece'*). However, light injuries ('marks, bruises') are acceptable as long as the individual can come to the next practice session. The responsibility for this behaviour rests with the partner: He/she has to be careful, how much intensity to put into his/her attacks or defences. This is mainly dependent on the skill level of the performer in a simulation.

Well, at the end of the day we're trying to go to training and come back home in one piece. Some marks, bruises, yes, but let's say it like this: the partner will work to my limits (…). (Adam).

According to the experts' perception, there is a threshold above which a student is afraid of engaging in a simulation exercise no more (*'too much pain'*). If the partner experiences pain too strongly in an exercise, it is likely that he/she will not continue with the exercise. In Henry's explanation, the main problem is the negative effect on self-efficacy beliefs, emotions and motivation to continue.

Don't go to the place that you stop believing this because you start to feel pain. Too much pain. (…).

And you know, to heal bones it's easier than to heal the soul. (Henry)

Adam also emphasizes the negative effects of too much contact on the motivation to engage continuously in a simulation, especially when the student's task is to be the attacker.

(…) if you hit the attacker, he doesn't want to attack anymore. They are hurt if you hit him hard. (Adam).

In the experts' views, the lack of motivation to continue attacking is an important aspect. If the attacker is not willing to attack anymore because of too much pain suffered, the performer, which is the learning student in the simulation, cannot develop his skills due to a missing stimulus.

The experts gave account of situations, where the attacker in a simulation exercise does not attack in a proper way, meaning giving a wrong stimulus for the defender, after the latter performed the first defences very hard. Adam made sense of this by explaining that too hard counter attacks create avoidant behaviour in the partner, who is supposed to attack.

(…) *if the defender is hitting too much of course, you're creating the fear in the attacker, you know he's going to get hurt, so why should he attack?* (Adam).

The experts also observed avoidant behaviours in fighting exercises, which involve the risk of being hit (*'time to put gloves on'*). They emphasize that this behaviour is often covered. As such, participants do not actually say that they are afraid of or do not want to engage with the exercise, they rather simulate injuries or sickness.

(…) there are some people that whenever it's time to put gloves on or do something that is frightening them, they develop sickness, they develop injuries (…). (Adam).

In Adam's view avoidant behaviour results from the wrong mentality. This mentality (*"I'm afraid"*) prevents the student from engaging in demanding exercises. A possible explanation for Adam is a former bad experience or lack of skills to cope with the demand the drill or exercise poses.

So the guy had a bad fight, a bad sparring session with somebody that knocked him out, you know, hurt him, he doesn't want to get in there. Or he just thinks that he doesn't have the knowledge and he needs more knowledge. (Adam).

In sum, the experts see a limit to the level of contact in training: First, no major injuries must occur and, second, contact must be at a level, that individuals still engage in the practice activity. In these situations, when a partner has an assigned task in a simulation (like attacking) too much contact can create negative further stimuli (*'bad attacks'* or *'no attacks'*). In fighting exercises avoidant behaviour can be observed, when (a) the skill level of the student is not sufficient or (b) the mind-set is not developed properly. In both cases a graded approach (e.g. increasing contact over time, systematically developmental skill set) is the solution in the experts' view.

1.4 Expert performance in self-defence

With regards to highly skilled performance in self-defence situations, the two experts share common views about key features, that constitute expert performance: Experts make rapid decisions under the situational constraints of a self-defence situation and display adaptable behaviour (subtheme 1); they avoid violent encounters by displaying situational awareness (subtheme 2) and they display a "fighter's mindset", consisting of aggression, persistence and determination (subtheme 3).

Theme 2: Expert performance in self-defence

2.1. Rapid high-pressure decision making and adaptable behaviour

Two experts agreed that a defining characteristic of expert performance in self-defence is the speed, efficiency and robustness of decision making. Adam points out that the decision-making process is fast and robust under temporal constraints (*'deal with it in real time'*) and is stable under very high environmental demands (*'under stress'*).

There's a lot of thinking here [in self-defence situations], and an expert should be the one that is making the correct decision all the time and able to, like I say, be a cold fish, deal with it in real time, and that's a real expert that he can, how do you say, make decisions under stress. (Adam).

Efficiency refers to cognitive resources that are allocated in order to solve the problem at hand.

The experts explain, that under pressure, the expert performer has free cognitive resources left, that he/she can allocate to other aspects of the situation. Henry tries to exemplify the difference between novices and experts with regards to the resources involved, by referring to a clerk who has to produce a document in 20 minutes to save his job. A novice, can only work at her/his personal limits and has problems coping with the demands at hand. However, after years of training, it is easier to cope with the situation by working more efficiently (*'the same document with less time'*).

But after a few years, you're going to produce the same document with less time with no sweat. (Henry).

Efficient processing affords an expert in a violent encounter spare cognitive resource to attend to other salient information. Henry explains this by referring to an incident, where he found himself in a self-defence situation after a car accident.

In all these events I memorized his license number because he escaped later (…). (Henry).

This capability to process information rapidly and efficient is attributed to the quantity and quality of practice (*'proper training'*) that increases self-defence competence and enables the transfer of learning to the criterion environment. Henry emphasizes that the exposure to demanding situations in training and the experience of overcoming it, is crucial for one's belief about future performance in high risk encounters. This concept is also referred to as 'self-efficacy' in the literature [35].

You believe that because of the training, the proper training, you're going to act that day better, you can never know for sure, but you know that you are above the average of getting also in stress, because you've been through situations that the stress is killing others, not killing you, because somebody already put you in this situation, stressed you enough, and you overcame it. (Henry).

Finally, Adam explains that it is helpful, when emotions are not involved in the decision-making process (*'cold fish'*). In his perspective, it is easier to defend oneself with the appropriate level of violence ('how much power to put into this reaction'), when one controls his/her emotions. In his view, this is the premise to make the best decisions.

People who are experts for me are people who can actually make the decision on the way to react and how to react, and how much power to put into this reaction, so he has to be what you call the 'cold fish', he has to make all the decisions and make them correctly so they give him the best result. (Adam).

Especially, when a situation gets out of control, it is essential not to be driven by emotions in order to act correctly. In this context, Adam recites the following quote:

That's why they say 'When you fight, you better don't be angry'. (Adam).

Besides the decision-making process being fast, efficient and stable under the environmental constraints of a self-defence situation, experts display highly adaptable behaviour in these contexts. The two experts talk about the ability to adjust techniques according to the situation ahead. In their view this is crucial, since performance in a real incident requires variability due to the changing environmental demands. Expert performers are able to adjust faster and more precisely than novices, resulting in fast and efficient physical performance when needed. As such, they see expert performance as highly adaptable to the demands at hand (*'adjust the technique to what happened'*).

It will never be the same attack as you did in the dojo, even if it will be the same type of attack. It will always be a little bit different, a little bit more ready, a little bit reacting early, a little bit later. And the way I see it is the time it takes the person to perform or to adjust his technique to what happened. This is where I see it. (Adam).

To sum up, the accounts of decision-makings processes provided by the two self-defence experts suggest that these processes are (a) fast and efficient, (b) are robust in high risk situations and (c) are less emotionally driven. Furthermore, the elicited behaviour of experts is highly adaptable.

2.2. Avoidance of violent encounters by being situational aware

The two experts see avoidance of violent encounters as the ultimate goal of self-defence. This involves avoiding contexts in which fights are

likely to emerge. In order to do so, the experts are constantly aware of the situation ahead. Henry refers to an example of an individual who knows ('already learned'), that a specific area is a common area for violent encounters. The expert then circumvents this area in order to avoid a possible encounter.

But the expert […] he already learned it's better to take a hike from there, just to walk away from there, and there is no encounter. (Henry).

In the experts' view, the avoidance of a violent encounter does not infer a lack of courage or low self-efficacy as it might in combat sports. On the contrary, they perceive avoidance as a positive behaviour. Henry provided the example he refused to engage in a fair fight with an officer in the Israeli Defence Forces.

(…) let's have a fist fight, even if I would have the chance to win him, I would spend ten day in jail, because you don't fight in the army. You're not allowed to fight. This is what I mean by getting experience all the time, in the real life. (Henry).

Henry took his stand as a positive behaviour, even though he had to refuse the fight in front of his comrades.

So I won, I mean, you don't have to [fight]. This is experience that builds up through years. (Henry).

A rationale for the perception of 'winning' and 'losing' in the context of self-defence is provided by Henry. He emphasizes that the personal and social cost of losses in violent encounters are much higher and different than in combat sports. As such, protecting the physical integrity (*'protecting your wife'*) becomes the major goal of self-defence. Behaviour that serves this outcome is therefore deemed as a 'win'.

And instead of doing self-defence techniques against stabbing from close range, short range, three opponents… protecting your wife, because you know how to do it, you just went to the other club and you won. (Henry).

Additionally, in the expert's view the environmental constraints in self-defence situations are much more complex and unpredictable *('three opponents'*), unfold from a position of disadvantage (*'stabbing from close range'*) and are more difficult to cope with than a physical combat situation in combat sports. In the light of a cost-benefit analysis, avoiding such incidents within the civilian domain seems to be the optimal solution for the experts. Consequently, they try to emphasize this fundamental approach in the training of their students as well. So, besides teaching techniques and tactics, students are taught how to attend to specific cues in order to analyze situations according to their risk level and to make proper decisions.

I'm an expert by the way, to get out of trouble, and you try to lead the students also to get out of trouble. (Henry).

Some other situation in which it's the way we were learning or studying or performing krav maga we should say, it's risk analysis. Where we can go, what we can do, all the time this kind of things like this, should I fight this, should I stay (…). (Adam).

Expert performers in self-defence develop the habit of knowing what is going on around them. This concept is also referred to as situational awareness (the links here will make the text perception easier: [36, 37]). By perceiving and gathering information, experts create mental models of possible outcomes of critical situations (identical note: [36, 37]). This allows the experts to choose avoidance, when this is still an option, compared to staying in a situation or letting a situation develop, where conflict becomes unavoidable. According to Henry, this differs with novices, who often lack situational awareness.

So it's kind of, the difference between novice and an expert is an expert's got in his daily routine, he is not in a fear mode or awareness mode that somebody will attack me all the time, he is kind of doing the correct things to avoid all this. (Henry).

Henry stresses that this behaviour should not result in continuous fear of getting attacked (*'not in a fear mode'*). The desired mind-set can be best described as a state of relaxed readiness: being aware without being fearful. Adam expands this state of relaxed readiness to situations that just start to unfold. In this context he describes a situation, where a person in a training centre ambushed him after the regular training. A third person tried to record this via a smartphone, which the expert noticed in advance. He was able to choose an appropriate level of violence, since

he had gathered enough relevant prior information to judge the situation according to its risk-level. Hence, Adam was able to defend himself without injuring the attacker.

So I actually made the decision because I was in a ready situation, I was in an alert situation and I chose all what I had to do during all this, few micro-seconds that he charged me, I had the decision making process and this is where I want everybody. You are ready, you are alert, you can make decisions. (Adam).

In Adam's view this state of relaxed readiness is the foundation of being able to make sound and fast decisions.

'I'm going to deal with whatever comes at me'. And this is the mentality I actually like because you can decide, you have the mentality of, 'I will be able to judge the situation, I'm ready, I'm alert, but I will be able to judge the situation and react when I want, not when he wants' (Adam).

He furthermore emphasizes that it is better to be active in an unfolding self-defence situation, rather than reactive (*'not when he wants'*). Taken together, the experts perceive avoidance as the optimal outcome of violent encounters. According to their views, this ultimate goal of self-defence training is achieved by a state of relaxed readiness and situational awareness. This is the basis for making fast and appropriate decisions, which constitute the next emerging sub-theme of the experts' accounts.

2.3. Fighter's mind-set: aggression, persistence and determination

The structure of self-defence situations requires a unique mind-set, which Adam refers to as *'fighting attitude'*. Since situational constraints in the domain of self-defence differ from the constraints encountered in combat sports (*'you start from a disadvantage'*), the individual has to cope when the odds, at face value, are stacked against them.

And at the end of the day you have to have the fighting spirit because most of self-defence situation starts from let's say a disadvantaged situation. (...) self-defence says that you start from the disadvantage, you've been surprised, you've been punched, you've been stabbed, you've been pushed, you've been I don't know what. You start from a disadvantage. (Adam).

According to the experts', aggression, persistence and determination are essential attributes to overcome the initial disadvantage. Adam not only describes the importance of being aggressive but the need to control this emotional state. Expert performers can act highly aggressive when needed (*'switch on'*) or immediately suppress aggressive behaviour when it is not needed or, importantly, when it is counterproductive. The capability to manipulate the level of aggression appears to be highly conscious and requires practice. Adam feels that high levels of aggression are beneficial in violent encounters; yet, aggression has to be controlled.

(...) so you need to switch on your 'crazy mode', or your 'self-defence mode'. If you didn't do that you will react totally different line of reaction, more reactive, more defensive, and we don't want that. So you need to have this, how do I say, this switch on. Then you have to have the mentality that will say, I need to get out of this alive (...). (Adam).

Determination helps to focus on the goal, in the face of draw-/set-backs, whereas, persistence refers to – what the experts describe as – the KM attitude of 'never giving up', which means to keep on fighting in the face of an almost impossible task ahead. Henry described how he adopted these crucial aspects of a fighter's mind-set to other domains of his life. For example, after a car accident he was faced with a major set-back, meaning his physical abilities decreased because of the injuries suffered from the accident. Persistence and determination, which he said he learned through KM training, helped him to recover.

So this (car accident) was another milestone to understand, even though your body's like, bleugh you get a result from the ashes and continue practice. (Henry).

To sum up, the unique constraints of self-defence situations, require the individual (a) to act aggressively when needed, (b) to focus on the goal in the face of drawbacks and (c) to keep fighting, even when the odds to win are very small.

DISCUSSION

In the experts' description of their experiences with contact, pain and injuries and their experiences of expert performance, several sub-themes were identified and presented in detail. In this section, we build on some of the analytic observation by examining through a theoretical lens.

First, we reflect on the experts' experiences with regards to contact, pain and injuries (subtheme 1.1, 1.2 and 1.3) as it relates to skill development. In this context, we examine how experts' views on the fighter's mind-set (subtheme 2.3) corresponds to current research on the topic of mental toughness. Next, we focus on the key components of situational awareness (subtheme 2.2), decision-making and adaptable behaviour (subtheme 2.1). Finally, strengths and limitations of the study, scopes for further research and implications for practice are pointed out.

Contact, pain and injuries in the training process

The results show, that experts experienced contact, pain and injuries being part of the training during their career. Yet, they remain critical regarding the amount necessary for developing expertise in self-defence. If the paramount objective of training is to enhance self-defence skills of the trainee, practice activities have to be designed, that foster the development of skills and prevent injuries. Applied contact varies depending on if the focus is more on the development of cognitive skills (i.e. making optimal tactical decisions), motor skills (i.e. practice to hit harder) or mind-set (i.e. keep attacking while being hit).

The results of the experts' account in the current study indicate that they primarily focus on information processing events, when creating and applying simulation exercises. In order to provide the learner with the correct cues to support high levels of decision-making [38], the experts have a clear conception of how attacks should be. They want the attacks to be 'good', meaning 'as close to reality as possible' [39, p. 8] that is fast attacks, which are started from the right distance. This is in line with views, that the spatial location and the timing structure of the movement should not change, in order to avoid negative transfer of a motor task [40]. Partner drills in KM are seen as an opportunity for the student to see and feel how the problem and the solution work in a controlled reality [41]. However, it has to be emphasized, that contact and pain are not necessarily connected, even though the experts state a different opinion.

It's not about the pain – it's about the feedback. But how can you give feedback with a punch without hitting? (Adam).

While the experience of pain when being hit by a partner involves contact, it is theoretically possible to hit with contact (i.e. touching the skin softly) without inducing pain. The experts clearly state, that they are looking for direct, immediate feedback, which is an important aspect of effective learning [42-44]. Contact is mandatory for the trainee in order to be provided with feedback if a technique was applied correctly. In order to prevent injuries in this context, strategies for drill design by the experts include working on pads or dummies or protecting the partner adequately [24, 45]. Regardless the level of contact and the applied drill or simulation, the experts favor a graded approach to intensity and contact based on the individual skill level, in order to allow for successful skill development and to prevent injuries from happening.

Besides potential drawbacks of contact (e.g. demotivation due to pain, injuries), it may serve a benefit with regards to the development of mental skills. In the experience of the experts, a component referred to as the *"fighter's mind-set"* is important in self-defence situations. The importance of a specific mind-set for optimal performance in violent encounters has been advocated regularly [24, 46-49]. However, no consensus about the conceptualization of such a mind-set exists so far. Likewise, considerable debates exist about the conceptualization of the construct known as "mental toughness" [50-52], which has been identified by coaches and athletes as one of the most crucial attributes in expert performance [53, 54]. With its relevance across a wide range of contexts, including business, military action and high-level sports [55], it can be broadly described as the ability of some people to continue to strive forward and achieve their goals in psychological circumstances where others fail [56]. As such it reflects the components of determination and perseverance, that have been described by the experts' behavioural conceptualization of the *"fighter's mind-set"*.

The component of aggression, however, seems to be unique to the mind-set for violent encounters. Being able to aggress, defined as the ability to carry out any intentionally behaviour to harm another person who is motivated to avoid the harm [1, 57], is important in the context of (a) survival, (b) legitimate use of force by authorities, like the military or the police, and (c) combat sports.

With regards to developing the component of a *"fighter's mind-set"*, the issue of aggressive contact in the training process also plays an important role. The development of aggressive contact such as attacking a partner with contact will be beneficial. Furthermore, willingly receiving attacks with aggressive contact in order to both recognise cues and consequences of being attacked and being able to re-act while being attacked first, also seems beneficial. In both cases, this will require the fighter to overcome the inhibition to attack, or be attacked by, a human being [58].

Likewise, the components of determination and persistence are related to the issue of "contact" in the domain of self-defence. Violent attacks, being unfair in its nature, pose demands to the individuals ability to focus on a specific goal in the face of encountered obstacles or problems (i.e. get away, protect a partner) and to not give up, when the situations seems hopeless. The obstacles, drawbacks and possible hopelessness, stems from (a) either performing self-defence behaviour (i.e. hitting), that does result in the outcome, the individual was hoping for, or (b) being hit, injured by the attacker or experiencing pain, that makes it more difficult to perform effective self-defence behaviours. As such, the *"fighter's mind-set"* with its components (aggression, determination, persistence) directly relates to the issue of contact, pain and injuries in the training process.

Taken together, feedback, contact and pain seem to be an integral part of self-defence training, with regards to the development of perceptual-motor skills and mind-set needed for violent encounters. However, since the current findings are exploratory in nature, further research with regards to different aspects of the training process in self-defence is clearly needed.

Perceptual-cognitive skills and adaptable behaviour in expert self-defence performance

There were many descriptions about the need of developing perceptual-cognitive skills and adaptable behaviour in order to prevail in violent encounters. Besides proficient physical skills and abilities to cope with the unfairness, the aggressiveness and the inherent dangers for one's physical and emotional integrity, individuals have to deal with the surprising and unknown character of violent assaults. According to the experts, situational awareness, decision-making skills and adaptable behaviour are key components of self-defence performance. As such, developing expert performance through effective practice requires the self-defense coach to creatively integrate and develop motor, perceptual-cognitive and mental skills.

The avoidance of violent encounters is the main goal in self-defence according to the experts. By being situational aware (SA), potential violent encounters can be avoided before they unfold. SA is understood as a cognitive product comprising *'the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future'* [36, p. 36]. It comprises of three different level: First, the perception of cues in the current situation, which is a fundamental aspect, since without the basic perception of important information, the odds of forming an incorrect picture of the situation increases dramatically. Second, it encompasses how people combine, interpret, store, and retain information. The integration of multiple pieces of information and the determination of the relevance to the individual's goals forms the second level of SA. Third, the highest level of SA is the ability to forecast future situation events and dynamics [36, 37]. In Endsley's model SA is conceptualized as a stage separate from decision making and performance. The reason being, that it is possible to have perfect SA without making correct decisions.

Vice versa, good decisions can be made (by luck) with poor SA [37]. In naturalistic conditions, cognitive resources are allocated to gather and update SA, in order to prepare for rapid changes in the situation. Conversely, the reasons for incorrect decision making frequently can be found in incorrect SA rather than in a flaws in the decision making process [59, 60]. SA involve schemata that direct information searching and that actively build mental models of the situation [61, 62]. These models help expert decision makers to quickly focus on critical aspects

of the situation through recognition and pattern matching [62, 63]. SA becomes more proficient the more an individual gathers experience in a particular environment. For example, novices may be aware of perceptual cues, but do not comprehend them in order to influence future actions [64]. As such the exposure to representative designed learning environments is a crucial aspect regarding the development of SA.

Developing optimal cognitive functioning for high-pressure environments is addressed thoroughly in the domain of sports [65-73] and in professional domains, such as fire-fighters [74] or medicine [75-77]. Implications for elite military service personnel are also drawn from the research on expertise in sport [67, 78]. Yet, current research and publication in the domain of developing self-defence skills seem to miss or do not address the development of perceptual-cognitive skills for self-defence situations [79-81]. Angleman [79, p. 92] conclude, that *'the most important components to successfully warding off an attack are proficiency in physical skills combined with an ability to execute these skills under duress'. Even though they acknowledge that the ability to quickly improvise is associated with expert performance, the researchers perceive the concept of automaticity as central to the preparedness for dangerous situations, suggesting practicing a technique 'at least 10.000 times before it can be used automatically'*.

Similar conclusions and recommendations for self-defence practice are continuously emphasized in the literature [17, 82]. However, such pedagogical practices are based on a traditional reproductive style of coaching, which recently has been criticized for its value with regards to skill development in self-defence and the police use of force domain [19, 83]. In this approach the coach retains a mental template of a movement pattern (e.g. a typical defence against a knife attack), that trainees should aim for. Verbal instructions on movement execution guides the learner through repetitive practice drills, which are often broken down in to separate components of action [84]. After several attempts the learner receives verbal feedback about corrections and instructions about how to further perform the prescribed movement pattern. In the reproductive approach information load is managed by gradually increase the complexity of drills so that movement patterns can eventually be practiced in more complex exercises [85].

However, there a several drawbacks of this approach in the context of self-defence training: First, the traditional pedagogical approach erroneously assumes that one movement pattern can act as an optimal template, that is suitable of all individual learners [86, 87]. Hence it tends to prevent the individual learn from exploring and discovering their own functional movement solution to a performance problem [84]. Second this decontextualised approach is not compatible with the aim of developing creative, intelligent individuals that are able to cope with situations and solve problems they have not been encountered before [29, 83].

Based on these drawbacks and the evidence emerging from practice and training programs in sports that advocate a nonlinear pedagogy [88-91], it has recently been argued to shift the emphasis in self-defence training to representative learning designs [19-21]. This approach is underpinned by both an ecological dynamics [92] and decision training perspective [93] to learning, advocating that skill acquisition is predicated on continuous information-based interaction between the learning system, the task at hand and the performance environment. The interactive process between the trainee, the task and the environment in both slow deliberative and fast dynamic learning environments leads to the connection of key information sources to goal-directed decisions and movements as each individual adapts to changes in the performance context.

Taken together, the experts' accounts in conjunction with current research from the skill development domain emphasizes the importance of developing individualized perceptual-cognitive skills for real violent encounters through sound pedagogical practices and representatively designed tasks.

Further research

The exploratory findings reported in the current study suggest various avenues for further inquiry.

A first line of research activities should focus on the key components of expertise in self-defence. For example, the expert performance approach [67] could be used as guiding framework to further study expertise in self-defence. The identification of typical self-defence situations and their accompanying situational

indicators would allow for the investigation for expert-novice differences in key components of self-defence performance. Further research could then identify the mediating mechanisms and how these are acquired.

A second line of research should aim at further disentangling the aspects of pain [94, 95] and contact and their relation to skill development and motivation in the context of self-defence training. First, with regards to skill development, future studies could explore possibilities to enable feedback in self-defence and fighting exercises without incorporating pain and what level of contact and pain at which stage of the development of self-defence skills should be applied. Second, with regards to participant motivation, the following questions should be focused on: How does the level of contact affect learner motivation to engage in simulation exercises? To what extent should contact be introduced in the beginning of self-defence training? How and to what extend can the motivation to hurt other people for practice purposes be developed? Investigating the effects of different pedagogical approaches (i.e. Sport Education) on the interaction between partners and how the apply contact and pain may provide further insights into motivational aspects in the domain of self-defence.

Strengths and limitations

When interpreting the findings of a qualitative investigation, it is important to recognize the strength and limitations of the approach. A notable strength of the study is the characteristics of the sample. Specifically, the self-defence experts who participated in the interviews were some of the most eminent figures in the field of KM. Furthermore, utilizing semi-structured interviews to collect the data from these individuals ensured that insightful vignettes and authentic data, rich in information relating to the development of expert performance in self-defence, were gathered. However, it has to be acknowledged, that only participants from one self-defence system were interviewed. Research investigating the development of expert performance in self-defence from various perspectives will provide a better and more comprehensive understanding of developing superior performance in violent encounters.

CONCLUSIONS

The findings of the study yielded new insights with regards to highly skilled self-defence performance and the role of contact and pain in the development of these skills. The results indicate that expertise in self-defence heavily relies on perceptual-cognitive performance and mind-set. Furthermore, in experts' view, contact and pain function as a feedback mechanism and are an essential part of the development process of such skills. However, the study suggests, that contact and pain can be separated in training performance and must be carefully considered with regards to the current objective in the training process. The current work with its exploratory nature provides valuable information for further research in the domain of expert performance in self-defence and how such skilled performance can be developed efficiently.

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