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An Exploration of De-escalation Behaviour and Physiological Arousal in Police Officers Within a Virtual Reality Simulation-Based Training Environment

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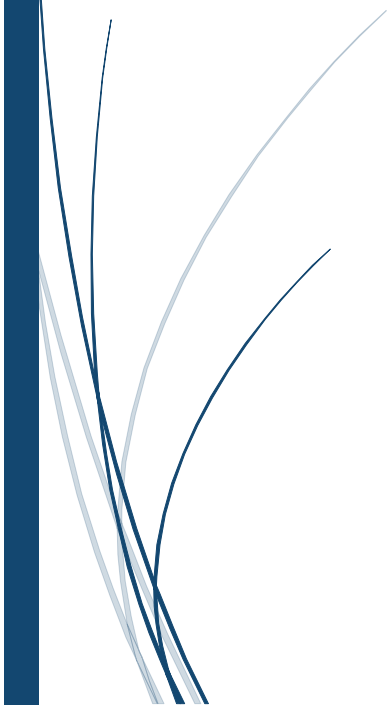

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Abstract

Policing is a high-stress and dynamic occupation wherein risk is the norm. Particularly, in recent decades, police have come under extreme scrutiny globally for their handling of these high-risk, high-stress tasks. This is especially the case in their utilisation of use-of-force in procedure leading to unnecessary loss of life. Therefore, the promotion of de-escalation behaviour has become more and more prevalent in recent times as calls for the immediate reduction in these policing tragedies and controversies become more and more vocalised.

This study aims, with the use of a multimodal design, to explore the relationship between officer's physiological arousal state and their de-escalation behaviours. This is done to gain insight into whether officers change or adapt their de-escalation behaviors under higher levels of stress. In total, 16 officers participated across six simulations in this study. In general, this research discovered that officers were far more likely to engage in "Verbal Use of Force" de-escalation behaviour during these scenarios with other less aggressive forms of de-escalation generally being utilised in addition to this. The officers were more likely to engage in de-escalation behaviour when experiencing a medium level of physiological arousal as compared to less de-escalation behavior when under high or low pressure. Under non-moderate arousal levels, they still engaged in de-escalation behaviour by and large just to a lesser extent.

This study provided insight into the interaction between physiological arousal and the display of de-escalation behaviour amongst police officers. Furthermore, this research showcased the potential benefits of virtual reality simulation-based training for developing skills in officers as well as promoting police de-escalation training in general in the future. However, it is important to note that further research is needed in order to fully flesh out the relationship between physiological arousal and de-escalation behaviour. This study only marks moments of de-escalation behaviour but cannot assess whether the behaviour is utilised correctly or effective. Moreover, the study does not give a full grasp of how much physiological arousal really fluctuates the usage of de-escalation behaviour as we do not observe the participants perform multiple simulations in order to compare and contrast this effect.

Keywords: Police action teams, De-escalation behaviour, Physiological arousal, Virtual reality simulation-based training, Multimodal

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Abbreviations

AAR After-Action Review

DB De-escalation Behaviour

HRV Heart-Rate Variability

PA Physiological Arousal

SB-VRT Simulation-Based Virtual Reality Training

Zephyr Medtronic Zephyr Bioharness 3.0

Introduction

Policing is an occupation synonymous with danger and stress due to the volatility of the environment they must work in and the effect that environment has on their mental and physical health (Pinizzotto, Davis, & Miller, 2006; Gershon et al.2009; Chopko, & Schwartz, 2012; Violanti, 2014; Andersen, Papazoglou, & Collins, 2016a). Especially the role of a police officer is a position that requires the ability to aptly respond to stressful circumstances and communicate and coordinate required actions effectively with the rest of the team (Sapolsky, 2004). This level of exposure and necessity to manage stressful encounters is a feature of action teams such as the police. An action team was first defined by Sundstrom (1999) as "teams that conduct complex, time-limited engagements in challenging environments in which team members possess specific skillsets". Alongside the general stress of law enforcement, police also have to maintain a level of authority that is often difficult to handle effectively, leading police officers to be placed under a hyper-critical lens. The highly publicised nature of policing has been further exacerbated by a continuous trend of high-profile controversies within the police force globally in recent decades. Many of these scandals consist of violent incidents regarding police brutality, abuse of power and ultimately, the misuse of lethal force (Cooper, 2015). Many prominent examples of this have been widely publicised in international media, most notably, the George Floyd murder on May 20th, 2020, that sparked global outrage and calls for widescale police reform in the United States.

As a result of this, academics and practitioners have been steadfastly seeking a solution to effectively train police officers to avoid the occurrence of these violent scandals. In recent decades, the concept of de-escalation has grown in popularity as a means of amending this issue with some calling on the police to prioritise de-escalation strategies in police training and on-field decision-making (Pelfrey & Young, 2020). Currently, research regarding police de-escalation has focused on the promotion of police de-escalation trainings (Bennell, et al., 2020, Andersen et al., 2018; Andersen and Gustafsberg, 2016b), the identification of effective police de-escalation tactics, techniques, and behaviours (Todak, 2017; Oliva, Compton, & Morgan, 2010) as well as the implementation and efficacy of police de-escalation in the field of policing in general (Engel, McManus, & Herold, 2020; Krameddine et al., 2013). These studies delved into the supports and detractions for increased focus on de-escalation behaviour (DB) in active-duty policing as well as exploring the necessity for police de-escalation training. Arguments in favour of de-escalation expressed that actions such as slowing down, taking cover and other more passive approaches will lead to less misuse-of-force incidents. Detractors, however, believe that these more passive actions run contrary to safety protocol for officers and will actually place the officers in much more danger than if they would follow common practice. Furthermore, de-escalation training has been called for in order to optimise the execution of DB in the field with one study showing that even a single day scenario-based training for de-escalation can significantly improve verbal de-escalation in officers up to 6 months after conclusion of the de-escalation training. These studies tend to focus squarely on operationalising and discussing de-

escalation along with the exploration of other mutually exclusive variables. Where there is currently a dearth of information is in how other variables interact with the DB of police officers. Research by Haller et al. (2014) and Akinola and Mendes (2012), have explored the effects of stress regulation on performance in police officers. Their findings posit that controlled exposure to common stressors in policing can help promote the fostering of more effective behaviours to regulate their stress levels and ultimately improve performance including in regard to their DB. There has been a growing number of academics calling for further research into de-escalation and the influence of physiological factors on police officers. However these measures have not been actively used in studies to capture what happens during de-escalation and in instances when higher stress levels are observed within individual police officers within a police unit (Arvey & Zhang, 2015; Boyatzis et al., 2012; Heaphy & Dutton, 2008; Zyphur, Narayanan, Koh, & Koh, 2009). This would be a valuable approach as research has posited that physiological and behavioural processes are closely intertwined (Colarelli & Arvey, 2015; Erez, Misangyi, Johnson, LePine, & Halverson, 2008) and thus might help to better understand the process of effective de-escalation. Therefore, in this study, the aim is to gain an understanding of the baseline DB of officers coupled with the physiological arousal (PA) state level that they experience when using these behaviours in order to ascertain the relationship between the two. In order to achieve this, a multimodal approach in which behavioural observation, coding and physiological measures are utilised has been adopted. Up until now, the extant literature has never combined these measures to research de-escalation and PA. The decision to opt for this multimodal approach to explore these behavioural and emotional processes and their connection is apt as these factors are complex and multi-faceted due to their intertwined nature.

Thus, to explore this relationship extensively, the following paper will contain a theoretical framework in which all relevant variables are discussed in depth ultimately being distilled into the overall research questions of the paper. This will be followed by a methods section wherein all measurement tools will be described as well as an explanation of the data collection process and data analysis plan. Subsequently, the results of the study will be outlined, and a discussion of these results will be presented including an analysis of results, future implications of these results, ideas for future research in the field, limitations of this study and finally an overall conclusion of the research.

Theoretical Framework

Police Action Teams

The type of team being explored in this research is an action team. An action team is defined as a team "where members with specialized skills must improvise and coordinate their actions in intense, unpredictable situations" (Sundstrom et al. 1990) Thus, being a member of such a team can be a stressful and potentially dangerous task at any given moment. From the work of Ishak and Ballard (2012) where they forged a typology of action teams, action teams can be segmented into three distinct

categories. Firstly, contending, where the task goal is competing against an opponent. Examples of a contending action team include professional sports teams and political campaign teams. Secondly, performing, where the task goal is the effective performance in front of an audience. Examples of a performing action team are choirs and orchestras. Lastly, critical, where the task goal encompasses both competition and performance but in a high-risk, high-stress environment. Examples of a critical action team include fire crews, surgical units and the action team that is the focus of this research, police teams.

Police teams have to contend with generally unplanned events potentially requiring improvisation with an inward focus on team performance as well as an outward focus on the behaviour of the suspects they encounter. Due to the highly-publicised, complex and fluctuating nature of the occupation, evaluating performance can be difficult to measure objectively and can be assessed internally or externally (Ishak and Ballard, 2012). Police teams responsibilities consist of law enforcement, upkeep of public safety and crime response and resolution (Giessing, 2021). The duty of police teams is diverse and volatile often requiring the ability to adapt to unpredictable and constantly fluctuating situations quickly and effectively (Marks, 2000). This high-speed, high-risk environment facilitates an increased exposure to stressful stimuli that can lead to high PA (Nieuwenhuys & Oudejans, 2011; Renden et al., 2015). Police teams may have to handle various dangerous situations such as domestic abuse cases, active shooter situations and suicide prevention cases (Todak, 2017). Empirical research focused on police team performance concluded that psychological and physiological stress responses in vital moments are a potentially deciding factor in the overall outcome of an incident (Arnetz, Arble, Backman, Lynch, & Lublin, 2013; Arnetz, Nevedal, Lumley, Backman, & Lublin, 2009). In Arnetz et al. (2013), a sample of police cadets received additional psychological training and coaching on stress and anxiety relief techniques and were compared to a control group. These cadets showed improved general health and problem-based coping skills in comparison to the control group after 18 months. In Arnetz et al. (2009), rookie officers participated in additional trainings related to trauma resilience. After 12 months, the rookies showcased less negative mood, hear rate reactivity and improved performance compared to control groups. They also reported feelings of stress less often and possessed lower cortisol levels than the control groups.

The goal in any incident encountered by a police team is to identify the cause of the issue, stabilise the situation and reduce the potential negative outcomes of the event as quickly as possible (van der Haar, Segers, & Jehn, 2013). A potentially key component of attaining this goal is found within the police teams utilisation of de-escalation tactics, techniques, and behaviour. Todak (2017) suggests that if implemented correctly, DB can aid police teams in achieving their core duties as well as positively impacting their public perception and ultimately saving lives in the line of duty.

Police De-Escalation Behaviour

De-escalation is a concept that has grown in prominence in recent times, particularly in law enforcement. For example, the Police Executive Research Forum (PERF), tasked with investigating and troubleshooting issues within the police force have shown their support for the implementation of de-escalation measures in recent times (PERF, 2023). Furthermore, in research circles, a de-escalation approach to policing is being championed as the new standard for effective policing (Engel et al., 2020; Ferris, 2018; Todak, & James, 2018; Todak, & White, 2019).

There are a multitude of definitions of police de-escalation. Several organisations related to the police use their own definitions of the concept. The International Asssociation of Police Chiefs (IACP) define de-escalation as "taking action of communicating verbally or non-verbally during a potential force encounter in an attempt to stabilize the situation and reduce the immediacy of the threat so that more time, options, and resources can be called upon to resolve the situation without the use of force or with a reduction in the force necessary" (IACP, 2020). Alternatively, the California Commission on Peace Officer Standards and Training defines de-escalation as the process of using strategies and techniques intended to decrease the intensity of the situation" (Cal. Commission on Peace Officer Standards and Training, 2020). Academics in the field have also offered their own definition. Accinni (2021), defines de-escalation as a "process comprising the ability to gradually resolve potentially violent situation". However, the definition that makes up the basis of this research is one devised by Natalie Todak in her paper that aimed to build a consensus police de-escalation definition to aid future empirical research on the topic (Todak, & White, 2019). Todak utilised the input of several police officers considered by their peers to be particularly adept in de-escalation practices. Three core components of police de-escalation were identified through these interviews. Firstly, the focus of de-escalation is on restoring calm to an individual or situation in a timely manner. Secondly, gaining the cooperation of the citizen(s) involved in the situation is key. Lastly, using the least amount of force possible is paramount. This conceptualisation of police de-escalation is founded in three core principles namely, the protection of the lives of all parties involved, the showcasing of great discretion across all potential police incidents (Walker, 1993), and the understanding that police-citizen encounters are a transactional process wherein each party is acting on and reacting to the behaviour and decision-making of the other (Fyfe, 1986; Terrill, 2005).

Several studies have examined various techniques conducive to optimal DB. One of the most commonly cited sources of police DB is that of the Crisis Intervention Training (CIT) group whose manual (Georgia CIT Program, 2006) details the optimal and potentially inhibiting behaviour involved in the de-escalation process focused mainly on interactions with mentally ill citizens (Dupont, Cochran, & Pillsbury, 2007; PERF, 2012). However, despite widespread adoption and promotion of CIT models, very little empirical proof of their effectiveness is available. A study by Taheri (2014) in conjunction with the work of Compton, Bahora, Watson, and Oliva (2008) concluded that CIT models had no discernible effect on the rate of arrests or on police safety in use-of-force encounters. Taheri

(2014) suggests that further adaptation of the models may help and that these findings should not discourage further research into CIT models as a whole.

In the end, the empirical foundation for the DB explored in this study builds upon the work of Todak (2017). She outlines five core tactics to be initiated to de-escalate a dispute. Firstly, the tactic "Humanity" is described. It involves at its core, the emphasis on one's shared humanity with citizens rather than wielding their police authority. This focus on equality intends to reduce the potential tensions that stem from the hierarchical imbalance between officer and citizen. Todak (2017), describes behaviours that constitute the use of "Humanity" as "showing the citizen emotion, treating citizens with dignity and respect, minimizing authoritativeness, condescension, and cop talk, and talking to citizens like people.". "Listening" involves being openly attentive to the citizens perspective in order to make them feel heard and understood as well as offering the officer a better opportunity of grasping the issue at hand based on the citizen's testimony. Furthermore, "Compromise" advises to take a more lenient approach to policing if feasible. Reducing the severity of the charges being pressed can aid in de-escalating and gaining compliance whilst allowing the appropriate justice to be enacted. Moreover, the "Honesty" tactic involves the police officer providing relevant context to decision-making so that the citizen understands the officer's stance and reasoning. This is adopted so as to avoid miscommunication leading to further conflict with a citizen. Lastly, "Empower" constitutes incorporating the civilian in the decision-making process, educating them on their offence and how to avoid being placed in the same situation in the future. Todak and James (2018) found that these tactics were significantly associated with an improved calmness among civilians after a police encounter when utilised. It must be understood however, that the effectiveness of these tactics will be situation dependent. The officers interviewed in Todak (2017) expressed how there is a level of volatility or danger to officer and civilian that is exceeded where these de-escalation tactics cannot be effective and more aggressive methods must be enforced. Generally speaking, however, these tactics will always be used initially in an incident until that safety limit is considered breached by the officer attending to the situation.

In other studies, additions to Todak's identified de-escalation tactics have been published (Todak, 2017). Another important DB can be found in Stanford Law School's Centre for Racial Justice's paper "Model Use of Force Policy Beta Release Version 1.0" in chapter 2 on de-escalation (Stanford Law School, 2023). This document describes is a description of various verbal use of force behaviours that can be used by police to de-escalate a situation. These include verbal advisements, verbal warnings, and verbal persuasion. Verbal advisements would constitute "respectfully explaining the person's rights or what the police want the person to do". Verbal warnings are instances in which the officer informs the suspect of the "consequences of continued non-cooperation and then offering the person a chance to cooperate". Lastly, verbal persuasion refers to explaining, without threats, how the person would benefit from cooperation". Verbal use-of-force is seen as a vital initial de-escalation step to be taken when first encountering a situation where de-escalation is called for before further

use-of-force can be initiated (Stanford Law School, 2023). In addition, the work of Oliva et al. (2010) is also useful and has a direct relationship to the aforementioned CIT guidelines (Georgia CIT Program, 2006). Outlined in these guidelines is an advisement to utilise open and closed-ended questions in order to garner relevant information about the current situation. Closed-ended questions are basically inquiries that only require a yes or no response and are usually utilised to reach agreement with a suspect. On the other hand, open-ended questions allow for a broader range of responses from the civilian and are intended to uncover additional information if needed. An example of a closed-ended question is one that includes the preface "Are you ...," "Do you ...," or "Will you ...." such as "Will you let us talk to you?" or "Are you safe?". An example of an open-ended question would be "Can you explain to me what happened?". This "asking for information" principle differs from the "Humanity" principle of Todak (2017) for example, in that the "Humanity" principle is utilised in order to build rapport with a suspect and is generally unrelated to the incident in question whilst "Asking for Information" is exclusively used to garner more information directly related to the incident with the aim of diffusing the situation as well.

Physiological Arousal

PA is a concept that has garnered ever increasing attention in a workplace and performance context including action teams such as the police (Andersen, & Gustafsberg, 2016; Andersen et al., 2018; Arble, Daugherty, & Arnetz, 2019; Ta, Lande, & Suss, 2021). PA is defined as being the representation of the level of stimulation an individual experiences ranging from "calm" to "exciting" (Ta et al., 2021). It is often associated with the negative component of the concept "stress" (Baldwin, Bennell, Andersen, Semple, & Jenkins, 2019; Bennell et. al, 2021). Stress is defined as a behavioural and physiological response that is "arousing and aversive, but importantly, whose effects are mediated by cognitive and dispositional factors within the individual" (Kim & Diamond, 2002).

Biologically, PA occurs when a stimulus triggers the activation of the sympatethic nervous system (SNS). Concurrently, the parasympatethic nervous system (PNS) which soothes and stabilises the body is deactivated. Moreover, the more intense the SNS activity, the higher the PA with this intensity being mediated by the individual's cognitive perception of the stimuli threat level (Kalisch, Müller, & Tüscher, 2015). When a stimulus is perceived as a threat, a higher level of SNS arousal is achieved which at the extreme, is commonly referred to as a "fight or flight" response (Lovallo, 2016). This survival response is often intense and is coupled with strong negative emotions such as fear, anxiety, and anger (Lipton, 2008; Lovallo, 2016).

Neuromodulatory systems also play an important role in the arousal process. The noradrenergic (NA), locus coeruleus (LC), and the cholinergic basal forebrain (BF) which manage one's central arousal state influence fluctuations in endogenous activity related to one's cortical state (Harris & Thiele, 2011; Lee & Dan, 2012). This also has an effect on certain cognitive processes such as attention (Thiele & Bellgrove, 2018). Both your cortical state and attention have an effect on how

you process information and how you perform certain behaviours. In summation, one's state of arousal influences your stress levels and level of attention which can subsequently effect performance and overall functioning.

The intensity of the PA state is also an important component when analysing PA. For example, high arousal levels are linked with an increase in heart rate, decreased heart-rate variability and an increased pupil width (Mulder, Rusthoven, Kuperus, de Rivecourt, & de Waard, 2007; Bradley, Miccoli, Escrig, & Lang, 2008). High levels of arousal have been shown to elicit and be elicited by several negative stimuli and emotions such as anxiety (Ravaja, Turpeinen, Saari, Puttonen, & Keltikangas-Järvinen, 2008; Nieuwenhuys, Savelsbergh, & Oudejans, 2015). High stress incidents cause increased PA that may account for an impairmrent in performance (Oxford, 1991). High arousal can lead to attentional and perceptual deficits such as tunnel vision and auditory exclusion which inhibits the processing of important situational cues stress (Vickers, 2007; Honig, & Lewinski, 2008). Moderate PA on the other hand has been illustrated as providing a myriad of benefits. These include alertness, improved focus and attention, and better cognitive performance (Jameson, Mendes, Blackstock, & Schmader, 2010). Moderate levels of arousal are attributed to stronger memory formation and retrieval (Cahill & Alkire, 2013). Likewise, an individual's senses such as visual, auditory, and olfactory are enhanced thus allowing for improvement in how a threat is identified and handled (Kalisch et al., 2015). A study on command-and-control teams and the influence of their PA on performance showed that low arousal is generally associated with high performance and likewise, high arousal is associated with poor performance (Schmitz-Hubsch, Stasch, & Fuchs, 2021). This effect was illustrated by approximately half of the participants in both cases. Maladaptive PA can negatively influence various cognitive processes including situational awareness and decision-making (Roos et al., 2013). In regards to decision-making, maladaptive PA leads to more "impulsive, disorganised, and inefficient" decisions in general (Johnston, Driskell, & Salas, 1997). With performance in mind, maladaptive PA can lead to an uptick in errors and a decline in accuracy on tasks due to its detrimental effect on cognitive functioning (Driskell & Salas, 1996). It would appear that PA has a strong relationship with performance with extreme levels proving damaging for effectiveness in general (Keitel et al., 2011).

In the context of police teams, there is an array of literature studying the effects of PA on police officer decision-making and occupational effectiveness (i.e, detainment success, zero casualty operations etc…). PA is linked with impaired communication skills (Schlotz, Schulz, Hellhammer, Stone, & Hellhammer, 2006), particularly regarding verbal communication amongst police officers (Renden et al., 2015). However, it appears that non-verbal communication and tactical performance may not be affected (Arble et al, 2019). In fight or flight instances, an officer's hand/eye coordination and precision can be impeded by the physical consequences of their PA state weakening their fine motor skills (Johnson, 2008). This intense fight or flight response causes blood vessels to constrict, reducing the amount of oxygen in the pre-frontal cortex negatively impacting memory storage and

information retention (Lipton, 2008; Westmoreland & Haddock, 1989). These deficiencies can lead to poor tactical and use-of-force decisions being enacted by police officers in critical scenarios. Law enforcement is a particularly difficult occupation to temper heightened PA levels due to the dynamic, intense, and potentially fatal nature of the job in which vital decisions must be made with immediacy despite the information overload and rapid evolution that occurs in police incidents (Doumouras Keshet, Nathens, Ahmed, & Hicks, 2012; Hunziker et al., 2011). However, low arousal is also not beneficial for police duties as it can cause a lack of focus that inhibits the identification of threat cues which may endanger officer lives (Haller et al., 2014). Moreover, a maladaptive (too high or too low) stress response in the line of duty at critical moments can carry with it grave ramifications, placing both officer and civilian(s) at risk and can negatively impact officer wellbeing and job effectiveness over time (Covey, Shucard, Violanti, Lee, & Shucard, 2013; Violanti, 2010). This is further indication that maladaptive arousal is a factor in lethal force errors, where if it's too low, officers do not act fast enough and endanger themselves and if it's too high, they act too rashly and impulsively and endanger civilians.

It must be noted that there is an array of factors that contribute to the relationship between PA and law enforcement behaviour and outcomes. Examples include the officer's decision-making style (Brown & Daus, 2015), dispositional factors (Daus & Brown, 2012), organizational training and culture (Loyens & Maesschalck, 2010), and situational characteristics (Westmarland, 2005). Thus, the negative outcomes of PA can vary from officer to officer (Arble et. al, 2019). Level of experience has also been shown to be an influencing factor on the level of arousal experienced by an officer when responding to a police matter. Officers with more experience are likely to be less aroused than those possessing less experience (Ta et al., 2021). It is believed that this disparity is due to their exposure to novel stimuli. Novel stimuli invoke a higher arousal response than familiar stimuli (Satpute, Hanington, & Barrett, 2016; Weierich, Wright, Negreira, Dickerson, & Barrett 2010) and novice officers are more likely to experience novel stimuli in the field than their more experienced counterparts.

Simulation-Based VR Training

Another challenge is how can police teams be more optimally trained to exhibit effective de-escalation behaviors in stressful situations/encounters and how can police trainings be effectively adapted in order to learn these de-escalation responses (Andersen et al., 2016). To achieve this, an immersive environment that replicates the reality of law enforcement duties (i.e., ecological valid environment) as accurately as possible whilst remaining a safe learning space is needed.

A recent development in training models as a result of technological advancements, namely Simulation-Based Training (SBT) could be the optimal solution in this case. An array of research has illustrated how implementing real-world stressors in the training environment positively effects

performance in the real incidents including in the case of the police (Low et al., 2020; Schmidt & Lee, 2013). Simulation environments offer a risk-free opportunity for police to practice technical skills as well as getting a gauge of how one will react to stressful stimuli (Kneebone, Nestel, Vincent, & Darzi, 2007). SBT has already been shown to improve team-level performance during critical nonroutine incidents (Helmreich, Merritt, & Wilhelm, 1999; Shapiro et al., 2008; Wehbe-Janek Lenzmeier et al., 2012).

The effectiveness of SBT has been investigated through several studies with a particular focus on use-of-force events (Andersen & Gustafsberg, 2016; Nieuwenhuys & Oudejans, 2011; Staller, Cole, Zaiser, & Koerner, 2019). Taverniers, Smeets, Van Ruysseveldt, Syroit, and von Grumbkow (2011) found that (1) reality-based training in which officers are at risk of being shot elicits a more similar stress response to that observed in the field, compared to training without the added pressure of return fire; (2) working memory deteriorates significantly during scenario-based training and (3) in spite of the stress experienced and its effects on memory, officers report that they learn more (i.e. acquire task-relevant skills) from high-pressure reality-based training compared to less stressful training scenarios.

More specifically, VR allows the possibility for the individual to immerse himself/herself into the virtual world which allows him/her to safely practice given scenarios that might also be encountered in the real world. This also enhances the ecological validity as individuals can seamlessly move around the virtual scene and examine its descriptors from all possible viewpoints (Rao, Chandra, & Dutt, 2020). In terms of observing DB and the influence of PA on those behaviours, VR-SBT can be quite a useful tool. Firstly, VR-SBT can be used in conjunction with physiological measures such as HRV, allowing for behavioural observation and HRV data to be synced up. Furthermore, Lavoie (2023) tested the effectiveness of VR-SBT on developing de-escalation skills in officers when dealing with mentally-ill subjects in comparison to live action training and a control group. This study found that officers engaging in the VR-SBT environment showcased improved de-escalation skills especially in comparison to the control group.

Research Goal

The above literature appears to point towards one key issue facing police teams currently. Police teams struggle to control their PA state in their intense and highly publicised occupation. This issue is particularly noticeable during critical incidents and might influence whether they can display DBs. This lack of emotional regulation and stress modulation ability is leading to grave errors both for the lives of police officers and the citizens they are tasked to protect. Literature posits that the utilisation of de-escalation tactics where necessary can be of benefit in achieving positive outcomes in police encounters. Furthermore, an improved focus on developing self-regulation skills and reducing the intensity of the officer's physiological response to stressors can yield benefits for officer performance and ultimately their health (McCraty & Atkinson, 2012; McCraty, Atkinson, Tomasino, & Bradley 2009). The implementation of SBT is being championed as a potential option to achieve these goals.

Its immersive nature and low-risk environment can allow officers to experience real-life stressors and learn the skills necessary to offset them that can then be utilised in real world incidents. These trainings can be adapted to focus on developing and learning de-escalation techniques as well. Furthermore, Researchers are calling for the relationship between behavioural antecedents of workplace outcomes such as DB and physiological antecedents like arousal to be explored further as it is an area of the extant literature that is currently underdeveloped (Hoogeboom et al., 2021; Arvey & Zhang, 2015; Boyatzis et al., 2012; Heaphy & Dutton, 2008; Zyphur et al., 2009).

Within the scope of this research, the goal of this study is to answer the following questions:

1. When do police officers show de-escalation behaviour in a simulation-based VR scenario where their skills are being trained?
2. Do police officers show different de-escalation behaviours during different levels of arousal (i.e., low, medium and high)?

This study intends to contribute to the dearth of literature on how de-escalation behaviour and physiological arousal interact in police teams. This additional insight may facilitate the continued promotion of a de-escalation-based focus in modern policing both in terms of policy and training practices. This improved focus hopefully can impact the effectiveness of use-of-force incidents in the field and reduce the number of negligent encounters between officer and civilian in the long term. Moreover, this research can showcase VR-SBT as a viable training method for de-escalation amongst the police.

Methods

Study Design

The current study aims to measure the frequency at which DB is initiated at various levels of PA ranging from low to very high in order to pinpoint which DB is most frequent at each of these levels in a VR SBT environment. For this study, a multimodal design was opted for. The two modes of data collection were heart-rate variability (HRV) measurements to measure the PA levels of the participants. These measurements were captured by the Medtronic Zephyr Bioharness 3.0 (Zephyr). Zephyr categorises the data into low, medium, and high levels of PA. The second measurement was codings of videos provided by a Dutch tech company that design and use VR training gear for the training purposes of action teams such as the military, fire department and in the case of this data, the police force. All team members involved in the research consented to participating in the VR simulation and for the data to be used for the purposes of this study. Ethical approval for this study was applied for and was granted by the BMS Ethics Committee of the University of Twente (No. 230225).

Participants

There was a total of nine police action teams consisting of a total of twenty-two officers who performed the simulations in groups reflecting how they would conduct themselves as a team in a real-life situation. All groups were composed of two or three members. Three of the teams did not possess any HRV data and thus were excluded from the study. In the remaining teams, a further six participants did not have HRV data and were also excluded. In total, there were a total of ten participants from six simulations. The duration of the simulations ranged from 198 to 665 seconds (M = 502.0, SD = 209.67). Eight of the participants were male (80%) and two were female (20%). Other descriptives, such as age, race, role, and experience level were not disclosed.

Table 1

Simulation and Participant Data

Simulation	***Duration***	***Team Member***	***Gender***	***HRV Data***
The Confused Person 1	534 seconds	T1 T2	Female Female	Available Available
The Confused Person 2	306 seconds	T3 T4 T5	Male Male Male	- - Available
The Confused Person 3	275 seconds	T6 T7 T8	Male Male Male	- - Available
The Arrest 1	665 seconds	T9 T10 T11	Male Male Male	Available Available -
The Arrest 2	611 seconds	T12 T13	Male Male	Available Available
The Arrest 3	198 seconds	T14 T15 T16	Male Male Male	Available Available -

Note. Descriptive data such as age, race, and level of experience were not disclosed.

There were two types of scenarios that the participants had to engage in. The first of these was called “The Arrest”. This scenario involved the officers searching an apartment for an assailant and apprehending them. This scenario was performed in three of the simulations. The duration of the arrest simulations ranged overall from 198 to 665 seconds (M = 491.33, SD = 255.46). In the “The Arrest 1” and “The Arrest 2”, the simulation was completed fully, however, in “The Arrest 3”, the simulation was halted prematurely due to one of the participants suffering motion sickness as a result of the VR headgear. Each of these simulations were conducted in English.

The second scenario was titled “The Confused Person”. The task was to search an apartment and discover weapons, a child and a potentially suicidal citizen and resolve the situation accordingly.

All three of these simulations were completed successfully. This scenario was conducted in three of the simulations. The duration of these simulations ranged from 275 to 534 seconds (M = 371.67, SD = 141.44). “The Confused Person 1” and “The Confused Person 2” were conducted in Dutch and “The Confused Person 3” was conducted in English.

Measurements

Physiological Arousal

The Medtronic Zephyr BioHarness 3.0 belt was utilised to measure the PA of the participants. Zephyr measures multiple physiological functions in real-time. It captures data on HRV, respiration rate, body temperature, movement and one-lead electrocardiography, and VO2max which is the optimal level at which the heart, lungs, and muscles can consume oxygen during exercise (Gancitano et al., 2021). The focus of this study was exclusively on the HRV. Heart rate has been shown to be an accurate marker of autonomic activity and PA (Akinola, 2010; Benedek & Kaernbach, 2010). When threatened, blood pumps through the heart faster leading to increased levels of PA (van Prooijen, Ellemers, Van der Lee, & Scheepers, 2018). HRV captures the fluctuation in SNS and PNS activity (Thayer, Fredrikson, Sollers, & Wager., 2012). HRV does this by identifying the gap between heartbeats or by marking the peak R of one beat to the other also known as the RR interval in the QRS complex (Gancitano et. al, 2021). HRV is a straightforward, easily replicated and non-invasive measure that can accurately the physical condition of an individual (Gancitano, et. al, 2021).

Figure 1

Diagram of Medtronic Zephyr Bioharness 3.0

Note. Diagram retrieved from *HRV in active-duty special forces and public order military personnel*, by G. Gancitano et al., 2021, Sustainability, 13, p. 4. Copyright by Zephyr Technology Corporation.

Using Zephyr, the average and maximum values of BPM were noted at a frequency of 1 Hz (Zephyr™ Technology, 2016). A systematic review conducted by Nazari et al. (2018) posited that Zephyr is a valid and reliable measurement of HRV and aligns itself with other current gold standard measurement equipment. In the police context, HRV has been utilised in research to aid in understanding officer's response to stress and stressful stimuli (Bertilsson et al., 2020; Kleygrewe, Hutter, Koedijk, & Oudejans 2023; Zechner et al., 2023).

In this study, the participant's real-time PA level needed to be recorded. To achieve this, the root mean square of the successive differences (RMSSD) method was adopted as a machine-learning algorithm. This involves the comparison of thirty second HR and HRV intervals taken during the scenario with the officer's baseline level recorded at rest prior to participating in the simulation. These comparisons were subsequently weighted and translated into an overall PA state that is then colour coded and categorised into low, medium, high and very high PA levels to show the officers fluctuation from baseline HRV level at any given moment. (Laborde, Mosley, & Thayer, 2017; Zechner et al., 2023). These PA scores were then categorised into low, moderate, and high levels represented by the colour green, yellow, and red respectively. Missing values were present due to a number of participants not being connected to a Zephyr device. This was due to a shortage of Zephyr devices being available in comparison to the number of participants present. These missing values were marked in grey. The HRV data was transferred from Zephyr to the After-Action Review (AAR) Software allowing for them to be visualised in the programme.

Officer Behaviour

For the purpose of analysing the officer's behaviour during the study, the VR simulations were recorded, then transferred and stored in the AAR Software. The AAR allows for a 3-D representation of the simulation including all relevant variables to the simulation such as people, animals, objects and household interior. All audio during the simulations is also recorded.

These audio-visual 3-D simulations were subsequently coded to categorise the behaviour being portrayed during the scenarios. An established codebook was incorporated that focused on team interactions amongst police teams. The basis for these codes stems from various other validated codebooks centred around action teams (Lei, Waller, Hagen, & Kaplan, 2016; Stachowski, Kaplan, & Waller, 2009; Waller, Gupta, & Giambatista, 2004). A code, namely "standby" was added to account for instances where an officer is not in position to answer a question from another officer but still acknowledges the question. Moreover, a category was created to represent non-verbal actions performed by the officers such as "Open a Door", "Use Handcuffs" (Schrom-Feiertag et al., 2021).

Unused codes such as “checklist” and “disagree” were excluded from the research. This above section of the codebook was not relevant to this study and was utilised in other research.

In regards to the present study, DB codes were added to the existing codebook based on the work of Todak (Todak, 2017; Todak & James, 2018; Todak & White, 2019). Initially, all of Todak’s de-escalation tactics, “Humanity”, “Compromise”, Honesty”, “Listening”, and “Empower” were being coded for. Over the course of the coding process, two of these tactics (“Compromise”, and “Empower”) were excluded from the study as they did not appear in any of the simulations. Furthermore, the “Listening” principle was also excluded as despite it appearing in the simulations, it is not mutually exclusive to the other behaviours and therefore, too complicated to measure effectively. Moreover, it was discovered inductively that some DB was present in the simulations that was not represented by any of Todak’s (2017) de-escalation tactics. Thus, two further DB codes were added: “Asking for Information”, and “Verbal Use-of-force”. (Oliva et al., 2010; Stanford University Law Department, 2023). Overall, all codes used in the research were placed into three categories: “Team Interactions”, “De-escalation”, and “Actions”. Any events in the simulations that were either incomprehensible or irrelevant were coded as “Zero Behaviour”. The final codebook consisted of 17 mutually exclusive codes.

Three students attending the University of Twente who were enrolled in the Master’s programme Educational Science and Technology coded the simulations independently using the coding software Observer XT (Noldus et al., 2000). This was done to aid in the validity and reliability of the research. In order to optimise the coding process, a transcription of each simulation was created (Waller & Kaplan, 2016). To test for reliability, inter-rater reliability percentages were generated between the coders individual codings of the simulations. To calculate the inter-rater reliability percentages, over 15% of each simulation was coded by two of the coders with a 2-second window where codes can occur and be recorded as occurring at the same time in both codings being applied (Hoogeboom et al., 2021). If the same code does not occur within 2 seconds of each other in both codings, that is classed as “Disagreement”. The initial inter-rater reliability was 74% (Cohen’s Kappa = .78; Cohen, 1960), which is considered substantial (Landis & Koch, 1977). The coders then held a discussion on how the coding could have been improved and optimised and revisions were made accordingly. As a result of these revisions, a final inter-rater reliability of 90.9% (Cohen’s Kappa = .91; Cohen, 1960). This is an ideal level of agreement (Landis & Koch, 1977).

Table 2

List of Coded Behaviours

Code Name	Definition	Example	Reference
Team Interactions			
Command	Specific assignment of responsibility	“You look left; I look right.”	Lei, Waller, Hagen, and Kaplan (2015)
Observe	Noting a fact or occurrence	“There is a door on the right.”	Lei, Waller, Hagen, and Kaplan (2015)

Suggest	Recommendation for action	"Let's go in one line."	Lei, Waller, Hagen, and Kaplan (2015)
Opinion	Expression of one's own opinion	"I think we should escort him outside."	Lei, Waller, Hagen, and Kaplan (2015)
Inquiry	Request for information, statement, analysis	"What is that?"	Lei, Waller, Hagen, and Kaplan (2015)
Question	*Request for confirmation or rejection statement*	"Should I open the door for you?"	Lei, Waller, Hagen, and Kaplan (2015)
Acknowledgement	Confirmation ("yes") or rejection ("no") statements to indicate that a message has been received or for yes/no replies to questions.	"Yes."	Lei, Waller, Hagen, and Kaplan (2015)
Answer	Supplying information beyond acknowledgement	"I can see a gun."	Lei, Waller, Hagen, and Kaplan (2015)
Briefing	Information to team members on what to expect in the next stage. Also used to code the providing of information without request.	"When I open the door, you are directly in line."	Lei, Waller, Hagen, and Kaplan (2015)
Expression	Comment, emotional remark	"I'm behind you."	Lei, Waller, Hagen, and Kaplan (2015)
Standby	Used when the speaker has heard the message but needs a moment to process or respond	"Standby"	-
Actions			
Open a Door	Used when a team member opens a door	-	-
Use Handcuffs	Used when a team member handcuffs a suspect	-	-
De-escalation			
Ask For Information	Using questions to solicit additional information	"Who are you?"	Oliva, Morgan, and Compton (2010)
Humanity			

	Social communication with a calm demeanour	"What's the dog's name?"	Todak (2017)
Honesty	Explaining the goal, rules or process to an external individual	"We are searching for a suspect."	Todak (2017)
Verbal Use of Force	Using verbal commands	"Get down on your knees!"	Stanford University Law Department (2023).

Data analysis

Initially, the PA data was exported from the AAR Software into an Excel spreadsheet. This spreadsheet consisted of six sections devoted to each of the simulations explored in this study. The layout of the spreadsheet was as follows; there were three columns, one to record the time, one for the duration of each simulation, and one to record the PA levels that were obtained from the AAR Software. There was a time synchronisation issue wherein simulation start times were later than that developed from the exportation process from AAR to Noldus. This led to complications accurately syncing up the observed behaviour with the recorded PA levels of the officers. To rectify this, the deviation between the times was calculated by comparing the video footage with the recorded times in Excel. This deviation was then used as a buffer to calculate the correct time and duration so that accurate synchronisation could be achieved. These values were then added to a new column in the spreadsheet.

In order to answer the two research questions, the moments of DB were exported from Noldus and compiled in an additional column of the Excel spreadsheet. They were aligned with the individual's concurrent PA state already columnized in the Excel spreadsheet.

Results

Breakdown of De-escalation Behaviour and Physiological Arousal Findings

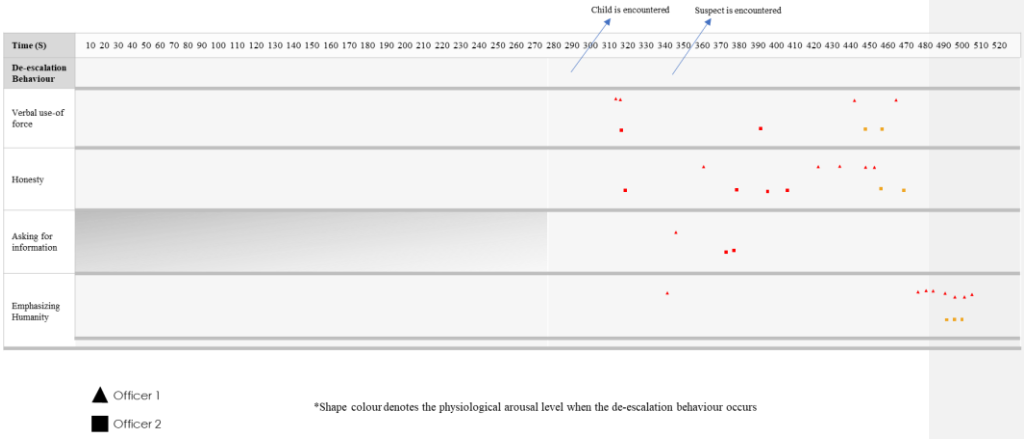
In the following section, a breakdown of the findings regarding the observed DB and PA data will be undertaken in order to answer RQ1 and RQ2. To answer RQ1 "When do police officers show DB in a stressful simulation-based VR scenario where their skills are being trained?", a graph for each individual scenario was produced documenting the timeline and occurrence of moments of de-escalation and which officer is displaying these behaviours. This allows for an overview of what events trigger DB in officers, how this differs across officers, and which DBs are most prominent during which stages of a given simulation. Each plotted DB is also colour-coded to align with the PA level that the officer is showcasing when engaging in the behaviour for further comparative depth. A frequency table of the DB exhibited by each officer for each individual simulation was also developed to add further insight into the differences in utilisation of DB across officers in general.

To answer RQ2, "Do police officers show different DBs during different levels of arousal (i.e., low, medium, high and very high)?", two standardised tables documenting the breakdown of each individual officer's frequency of exhibiting each DB and their PA state when doing so was produced. This allows for a comprehensive assessment of the differences and similarities between each officer's utilisation of DB and what impact their PA level has on how often and which DBs are used in general. The frequencies were standardised as they are heavily influenced by the length of the individual simulations which can skew the data somewhat. As a result, the following formula was utilised in order to account for this: standardised frequency of a DB = coded frequency of a DB * (duration of the shortest simulation / duration of the simulation being assessed) (Endedijk et. al, 2018).

The Confused Person 1

Figure 2

Timeline and Plot of De-escalation Behaviour in The Confused Person 1



In "The Confused Person 1", the officers begin by searching the property. A small child is encountered after 290 seconds. The suspect is encountered after 346 seconds into the simulation. The suspect has a hammer. The officers ask what the suspect is holding and if the small child is her son. The suspect is asked to sit down so they can speak quietly. The officers inform the suspect that they are worried about items they've found in the house and the erratic behaviour of the suspect. The officers reiterate their concern and that they simply want to talk with the suspect. The officers ask the suspect if they would like to go outside to talk. The officers ask that the hammer is put down and then they can talk and see what help can be given. After 465 seconds, the suspect complies and drops the hammer. The officers ask the suspect to follow them. After 480 seconds, the suspect is detained. The officers

command the suspect to follow them. The officers ask the suspect about their dog and child. After 508 seconds, the suspect is escorted outside, thus concluding the simulation.

Overall, there were 33 counts of DB recorded in "The Confused Person 1". 8 of these were verbal use of force, 11 were honesty, 3 were asking for information, and 11 were emphasising humanity. DB accounted for 21.3% of all recorded behaviour in this simulation. Both officers utilised every DB at least once throughout the scenario. Officer was coded for on 18 occasions and officer 2 on 15 occasions in total. The officers' PA level during acts of DB both stay consistently very high at first. Officer 1 remains at a very high level throughout, however, officer 2's PA decreases to a high level of arousal as the simulation progresses.

Table 3

Frequency Table of Coded Behaviour of the Officers in The Confused Person 1

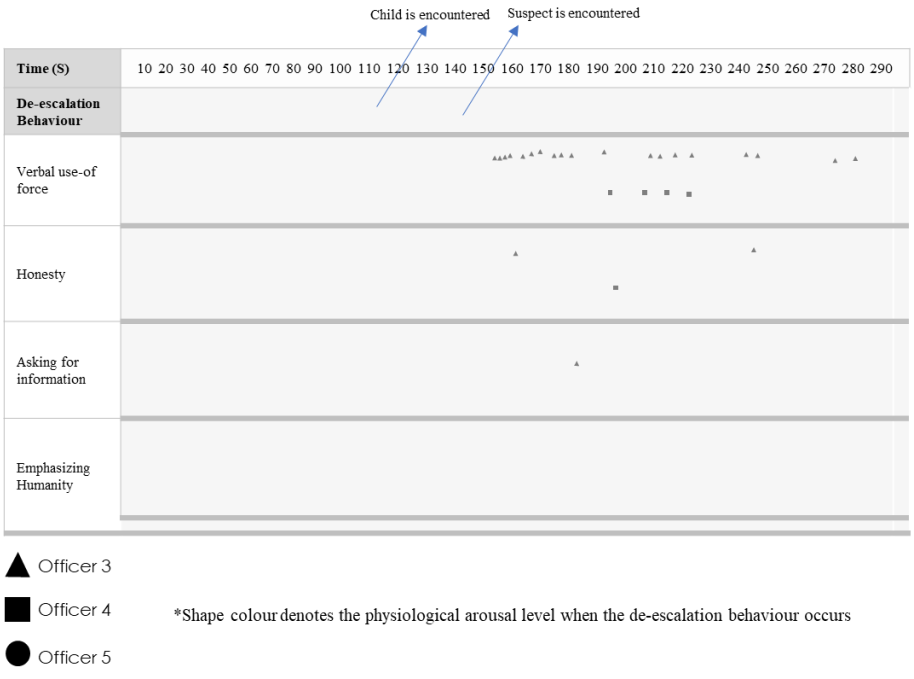
	Officer 1		Officer 2		Frequency	Proportion
Team Interactions						
Command	-	0%	1	0.6%	1	0.6%
Observe	9	5.8%	19	12.3%	28	18.1%
Suggest	6	3.9%	1	0.6%	7	4.5%
Opinion	3	1.9%	3	1.9%	6	3.9%
Inquiry	1	0.6%	-	0%	1	0.6%
Question	3	1.9%	12	7.7%	15	9.7%
Acknowledgement	19	12.3%	22	14.2%	41	26.5%
Answer	4	2.6%	5	3.2%	9	5.8%
Briefing	2	1.3%	-	0%	2	1.3%
Expression	2	1.3%	4	2.6%	6	3.9%
Standby	-	0%	-	0%	-	0%
Actions						
Open a Door	3	1.9%	-	0%	3	1.9%
Use Handcuffs	-	0%	-	0%	-	0%
De-Escalation						

Verbal Use of Force	4	2.6%	4	2.6%	8	5.2%
Honesty	5	3.2%	6	3.9%	11	7.1%
Asking for Information	1	0.6%	2	1.3%	3	1.9%
Emphasising Humanity	8	5.2%	3	1.9%	11	7.1%
Zero Behaviour	-	0%	3	1.9%	3	1.9%
Total	88	56.8%	67	43.2%	155	100%

The Confused Person 2

Figure 3

Timeline and Plot of De-escalation Behaviour in The Confused Person 2



In “The Confused Person 2”, the officers begin by searching the property. After 156 seconds, they encounter their suspect. The suspect is wielding a knife. The suspect is asked to calm down and stay quiet multiple times by the officers. The suspect is commanded to drop the knife. The officers advise the suspect to take a seat so that they can talk to him. The suspect is commanded to place the knife on the floor multiple times again. After 223 seconds of the simulation, the suspect complies and drops the weapon. The officers ask the suspect to stay calm and whether he will come outside with them for questioning. After 245 seconds, the suspect is detained. The officers inform the suspect that they are going outside, and they will help him as best they can. After 281 seconds, the suspect is escorted outside, concluding the simulation.

Overall, DB was recorded on 27 occasions in “The Confused Person 2”. DB accounted for 35.5% of all recorded behaviour in this simulation. Officer 3 and officer 4 utilised DB on at least one occasion during the simulation. Officer 5 was not coded for any DB at any point. Officer 3 was coded for on 22 occasions and officer 4 on 5 occasions. Both officer 3 and officer 4 used verbal use of force and honesty during the simulation. Officer 3 was the only participant to be coded for asking for information in this simulation. There was no recorded HRV data for any of the participants of this simulation.

Table 4

	Officer 3		Officer 4		Officer 5		Frequency	Proportion
Team Interactions								
Command	-	0%	-	0%	-	0%	-	0%
Observe	4	5.3%	7	9.2%	6	7.9%	17	22.4%
Suggest	-	0%	-	0%	-	0%	-	0%
Opinion	-	0%	-	0%	-	0%	-	0%
Inquiry	1	1.3%	-	0%	-	0%	1	1.3%
Question	3	3.9%	2	2.6%	2	2.6%	7	9.2%
Acknowledgement	2	2.6%	4	5.3%	1	1.3%	7	9.2%
Answer	-	0%	1	1.3%	-	0%	1	1.3%
Briefing	1	1.3%	-	0%	1	1.3%	2	2.6%
Expression	-	0%	-	0%	-	0%	-	0%
Standby	-	0%	-	0%	-	0%	-	0%
Actions								

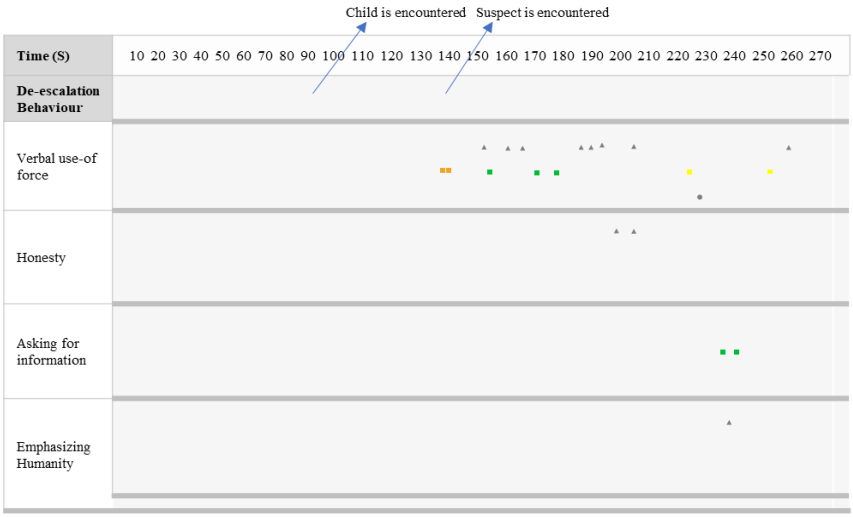
Open a Door	4	5.3%	1	1.3%	3	3.9%	8	10.5%
Use Handcuffs	-	0%	-	0%	-	0%	-	0%
De-Escalation								
Verbal Use of Force	19	25.0%	4	5.3%	-	0%	23	30.3%
Honesty	2	2.6%	1	1.3%	-	0%	3	3.9%
Asking for Information	1	1.3%	-	0%	-	0%	1	1.3%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%
Zero Behaviour	-	0%	-	0%	-	0%	-	0%
Total	39	51.3%	22	28.9%	15	19.7%	76	100%

Frequency Table of Coded Behaviour Across Officers in The Confused Person 2

The Confused Person 3

Figure 4

Timeline and Plot of De-escalation Behaviour in The Confused Person 3



Officer 6
Officer 7
Officer 8

*Shape colour denotes the physiological arousal level when the de-escalation behaviour occurs

In “The Confused Person 3”, the officers begin by searching the property. After 144 seconds, the suspect is encountered. The suspect has a knife. The officers command the suspect to stop and stay put. The suspect is advised to put their weapon down several times. After 192 seconds, the suspect complies and drops the knife. The officers ask the suspect to take a seat on the sofa and inform her that they will get help. The officers ask to enter the room in order to collect the weapon. The officers then ask the suspect to follow them out of the room. After 232 seconds, the suspect is now detained. The officers ask about the suspect’s dog. The officers order the suspect to follow them again. After 247 seconds, the suspect is escorted outside, completing the simulation.

Overall, there were a total of 21 coded DBs in “The Confused Person 3”. 16 counts of verbal use of force, 2 counts of honesty, 2 instances of asking for information, and 1 occasion of emphasising humanity. DB made up 33.4% of all recorded behaviour in this simulation. All officers were recorded utilising DB at some stage in the scenario. Officer 6 was coded for on 11 occasions, officer 7 on 9 occasions, and officer 10 just once. All DBs were present in “The Confused Person 3”. All officers were recorded using verbal use of force. Only officer 6 used honesty and emphasising humanity in the simulation. Likewise, only officer 7 utilised asking for information. Officer 7’s PA levels fluctuated throughout the simulation when using DB. They began at a high level, then reduced to low and

subsequently rose to a medium level by the conclusion of the simulation. Officer 6 and officer 8 possessed no HRV data.

Table 5

Frequency Table of Coded Behaviour Across Officers in The Confused Person 3

	Officer 6		Officer 7		Officer 8		Frequency	Proportion
Team Interactions								
Command	7	11.1%	-	0%	-	0%	7	11.1%
Observe	6	9.5%	7	11.1%	-	0%	13	20.6%
Suggest	-	0%	-	0%	-	0%	-	0%
Opinion	-	0%	-	0%	-	0%	-	0%
Inquiry	2	3.2%	2	3.2%	-	0%	4	6.3%
Question	3	4.8%	2	3.2%	-	0%	5	7.9%
Acknowledgement	1	1.6%	1	1.6%	-	0%	2	3.2%
Answer	1	1.6%	-	0%	-	0%	1	1.6%
Briefing	3	4.8%	1	1.6%	-	0%	4	6.3%
Expression	3	4.8%	1	1.6%	-	0%	4	6.3%
Standby	-	0%	1	1.6%	-	0%	1	1.6%
Actions								
Open a Door	-	0%	1	1.6%	-	0%	1	1.6%
Use Handcuffs	-	0%	-	0%	-	0%	-	0%
De-Escalation								
Verbal Use of Force	8	12.7%	7	11.1%	1	1.6%	16	25.4%
Honesty	2	3.2%	-	0%	-	0%	2	3.2%
Asking for Information	-	0%	2	3.2%	-	0%	2	3.2%
Emphasising Humanity	1	1.6%	-	0%	-	0%	1	1.6%
Zero Behaviour	-	0%	-	0%	-	0%	-	0%
Total	37	58.7%	25	39.7%	1	1.6%	63	100%

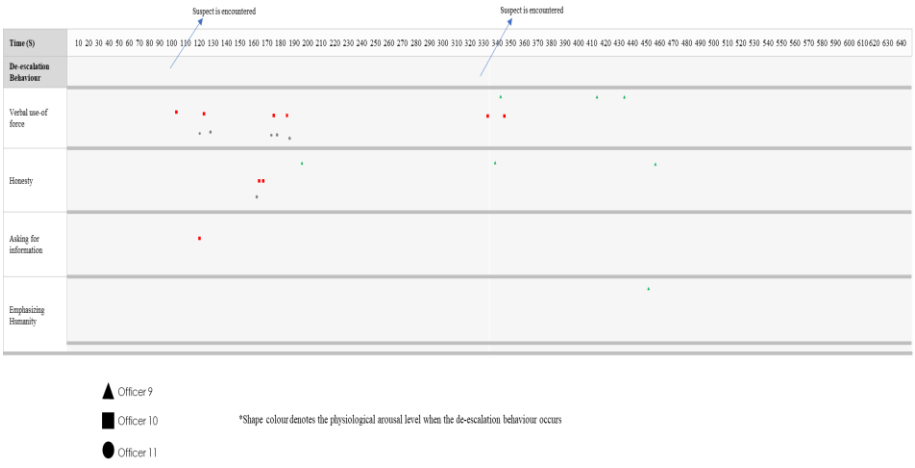
Summary of De-escalation Behaviour Observed in The Confused Person Scenario

Overall, a couple of trends became apparent regarding the use of DB in the "Confused Person" simulations. DB was in every instance immediately triggered when a suspect was encountered. From the point at which the DB was triggered, DB was then utilised regularly throughout the remainder of all of the simulations. Verbal Use of Force was the most commonly used DB by a wide margin. Verbal Use of Force accounted for 58% of all DB recorded across the 3 simulations. Verbal Use of Force was always the initial DB used when a suspect was encountered. Verbal Use of Force would then be utilised heavily until the detainment of the suspect and then gradually decrease in frequency until the simulation concluded. However, in "The Confused Person 1", there is a more balanced usage of DB prior to detainment in comparison to the other two simulations. Emphasising Humanity when used was only utilised towards the end of the simulations once the suspect had been detained. Asking for Information and Honesty were used sporadically throughout the simulations, but no clear pattern of behaviour was identified for these behaviours. The overall proportion of DB utilised in this scenario ranged from 21.3% in "The Confused Person 1" and 35.5% in "The Confused Person 2". It is worth noting that large portions of the simulations either do not require de-escalation or it is simply not possible to de-escalate during that time which may skew the proportion of DB recorded.

The Arrest 1

Figure 5

Timeline and Plot of De-escalation Behaviour in The Arrest 1



In the Arrest 1, the officers begin by searching the property. 100 seconds pass before the first suspect is encountered by the officers. This suspect is unarmed. Verbal use of force is initially deployed in the form of an advisement for the suspect to get onto his knees multiple times. The suspect does not comply. The officers brandish their weapons. Officer 10 asks the suspect what he is doing on the property which is an example of asking for information. The suspect is requested to get on his knees again. 127 seconds into the simulation, the suspect complies and gets onto his knees. The suspect is advised to lie down face down and place their hands behind their back in order to be handcuffed. After 142 seconds, the suspect is detained. The officers explain to the suspect he is under arrest and that he is a wanted fugitive showcasing the honesty DB. They advise the suspect to stand up but he is unable so they advise him to kneel instead. The first suspect is then escorted outside the property after 204 seconds. The officers then continued searching the property.

After 325 seconds, the 2nd suspect is encountered. The suspect is brandishing a gun. Immediately, verbal use of force tactics are utilised through advisements for the suspect to drop his weapon. Officer 9 informs the suspect that if he does not comply then they will have to use lethal force. The officers then request that the suspect gets on his knees after persistent non-compliance. After 378 seconds, the suspect complies and drops the gun. The officers advise the suspect to place his hands behind his back on several occasions. The suspect is detained after 430 seconds have elapsed in the simulation. Officer 9 asks how the suspect is doing in order to emphasise humanity and then explains to the suspect why they are arresting him. After 461 seconds, the second suspect is escorted outside thus completing that simulation.

Overall, in The Arrest 1, there were 22 instances in which DB was exhibited by the participating officers. 14 of those instances were verbal use of force, 6 were honesty, 1 was a case of asking for information and there was 1 instance of emphasising humanity. DB accounted for 15.4% of all behaviour exhibited by the officers in this simulation. There was a fairly even spread of DB amongst the individual officers with them showcasing DB on 7, 9, and 6 occasions respectively. All the officers utilised verbal use of force and honesty at some stage during the simulation. Officer 9 was the only officer to use emphasising humanity and officer 10 was the only officer coded for asking for information. The officers arousal levels during DB remained consistent within officers but differed between officers. Officer 9 recorded low arousal levels during each of their acts of de-escalation, whilst, officer 10 possessed very high PA levels throughout the simulation. Officer 11 had no recorded HRV data.

Table 6

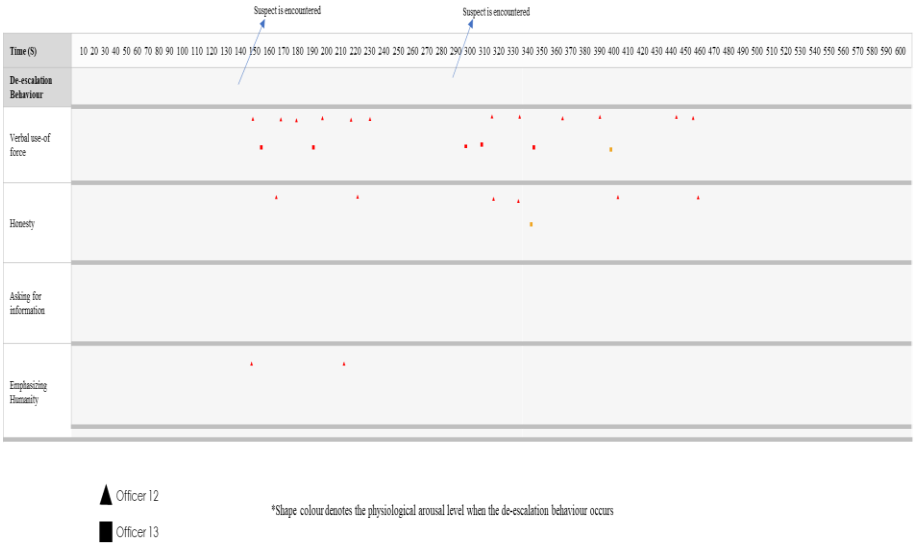
Frequency Table of De-escalation Behaviour Across Officers in The Arrest 1

	Officer 9		Officer 10		Officer 11		Frequency	Proportion
Team Interactions								
Command	4	2.9%	9	6.5%	2	1.4%	15	10.8%
Observe	5	3.6%	7	5.0%	3	2.2%	15	10.8%
Suggest	1	0.7%	2	1.4%	-	0%	3	2.2%
Opinion	-	0%	-	0%	1	0.7%	1	0.7%
Inquiry	4	2.9%	2	1.4%	1	0.7%	7	5.0%
Question	8	5.8%	6	4.3%	3	2.2%	17	12.2%
Acknowledgement	10	7.2%	7	5.0%	5	3.6%	22	15.8%
Answer	2	1.4%	3	2.2%	1	0.7%	6	4.3%
Briefing	3	2.2%	2	1.4%	3	2.2%	8	5.8%
Expression	1	0.7%	1	0.7%	4	2.9%	6	4.3%
Standby	2	1.4%	2	1.4%	3	2.2%	7	5.0%
Actions								
Open a Door	2	1.4%	4	2.9%	-	0%	6	4.3%
Use Handcuffs	1	0.7%	1	0.7%	-	0%	2	1.4%
De-Escalation								
Verbal Use of Force	3	2.2%	6	4.3%	5	3.6%	14	10.1%
Honesty	3	2.2%	2	1.4%	1	0.7%	6	4.3%
Asking for Information	-	0%	1	0.7%	-	0%	1	0.7%
Emphasising Humanity	1	0.7%	-	0%	-	0%	1	0.7%
Zero Behaviour	-	0%	1	0.7%	1	0.7%	2	1.4%
Total	50	36.0%	56	40.1%	33	23.7%	139	100%

The Arrest 2

Figure 7

Timeline and Plot of De-escalation Behaviour in The Arrest 2



In the Arrest 2, the officers begin by investigating the property. After 136 seconds, the first suspect is encountered. The suspect is unarmed. The suspect is asked for his name. The officers brandish the firearms. The officers command the suspect to raise their hands, freeze and stay put on multiple occasions. The suspect is also informed that that the officers are police and that they are searching for a suspect at this property. The officers command the suspect to get on their knees. The suspect complies with 173 seconds gone in the simulation. The suspect is advised to get on his chest and place his hands behind his back. After 217 seconds, the suspect is detained. The suspect is informed that he will now be escorted outside the property. The first suspect is escorted outside after 231 seconds of the simulation. The officers continue searching the property.

After 288 seconds, the second suspect is encountered. The suspect is in possession of a firearm. The suspect is asked to show his hands and drop the gun and is informed that these are police here. The suspect attempts to evade the officers by entering a room. The suspect is commanded to come out or the officers will come in and to show his hands again. The officers brandish their weapons after continuous non-compliance from the suspect. The suspect is again told to drop the gun as well as told to get on his knees. The officers command the suspect to freeze, stay still and then slowly lower to their knees. After 381 seconds has elapsed, the suspect complies. The suspect is is informed that they are under arrest and that he will now be handcuffed and escorted outside. The suspect is detained after 455 seconds. The suspect is told the officers are searching for a suspect with a firearm and that is the

reason for his arrest. After 490 seconds, the second suspect is escorted outside thus completing the simulation.

Overall, in "The Arrest 2", there were 27 instances of DB recorded. 18 of these were verbal use of force, 7 were honesty, and 2 counts of emphasising humanity. No instance of asking for information was recorded. DB accounted for 18.4% of all recorded behaviour in "The Arrest 2". Both officers utilised DB at some stage in the simulation. Officer 12 on 20 occasions, and officer 13 on 7 occasions. Both officers were coded for verbal use of force and honesty whilst only officer 12 utilised emphasising humanity. Both officers exhibited mainly very high PA levels when using DB. However, officer 12's arousal level reduced to high towards the end of the simulation.

Table 7

Frequency Table of Coded Behaviour Across Officers in The Arrest 2

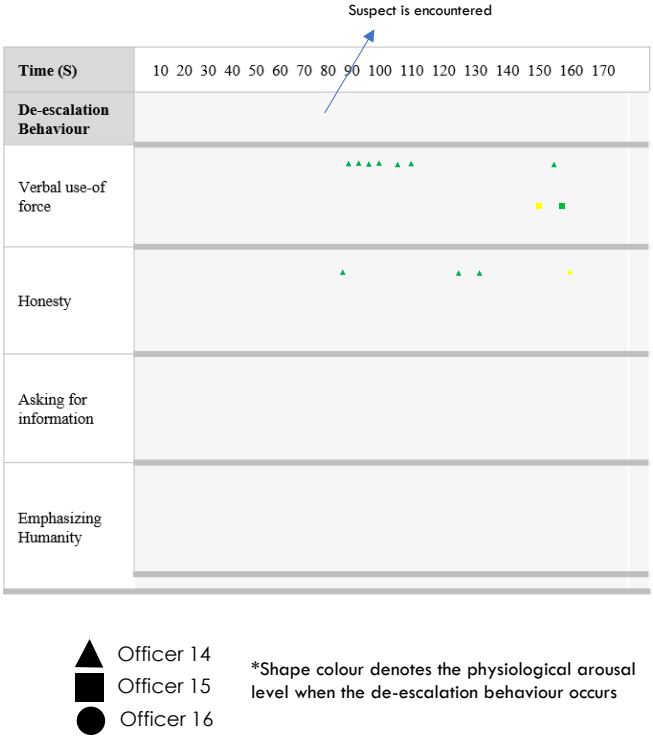
	Officer 12		Officer 13		Frequency	Proportion
Team Interactions						
Command	4	2.7%	7	4.8%	11	7.5%
Observe	17	11.6%	12	8.2%	29	19.7%
Suggest	1	0.7%	4	2.7%	5	3.4%
Opinion	-	0%	-	0%	-	0%
Inquiry	2	1.4%	4	2.7%	6	4.1%
Question	6	4.1%	4	2.7%	10	6.8%
Acknowledgement	17	11.6%	16	10.9%	33	22.4%
Answer	4	2.7%	2	1.4%	6	4.1%
Briefing	5	3.4%	8	5.4%	13	8.8%
Expression	1	0.7%	-	0%	1	0.7%
Standby	-	0%	-	0%	-	0%
Actions						
Open a Door	3	2.0%	1	0.7%	4	2.7%
Use Handcuffs	2	1.4%	-	0%	2	1.4%
De-Escalation						
Verbal Use of Force	12	8.2%	6	4.1%	18	12.2%
Honesty	6	4.1%	1	0.7%	7	4.8%
Asking for Information	-	0%	-	0%	-	0%

Emphasising Humanity	2	1.4%	-	0%	2	1.4%
Zero Behaviour	-	0%	-	0%	-	0%
Total	82	55.8%	65	44.2%	147	100%

The Arrest 3

Figure 7

Timeline and Plot of De-escalation Behaviour in The Arrest 3



In “The Arrest 3”, the officers begin by searching the property. After 82 seconds, the first suspect is encountered. The suspect is unarmed. The officers command the suspect to raise his hands and place them on top of his head. The suspect is informed that he is being placed under arrest. The suspect is commanded to stay put and get on his knees. The suspect is warned that non-compliance may lead to

use of lethal force. After 115 seconds, the suspect complies. The suspect is informed that he will have his arms placed behind his back, be handcuffed, and escorted outside. After 138 seconds, the first suspect is detained. After 157 seconds, the first suspect is escorted outside. Due to motion sickness as a result of the VR gear, this simulation is subsequently ended prematurely.

Overall, DB was recorded on 14 occasions. 10 were instances of verbal use of force and 4 were honesty. Asking for information and emphasising humanity were not recorded during the simulation. DB accounted for 38.8% of all behaviour coded in the "The Arrest 3". 2 of the officers utilised DB in the scenario. Officer 14 used DB 12 times and officer 15 twice. Only officer 14 utilised the honesty tactic. Officer 16 did not utilise DB at any point. Officer 14 and 15 generally contained low arousal levels when initiating DB. Both officers did have an instance of heightened arousal when de-escalating towards the end of the scenario with their levels raising to medium intensity.

Table 8

Frequency Table of Coded Behaviour Across Officers in The Arrest 3

	Officer 14		Officer 15		Officer 16		Frequency	Proportion
Team Interactions								
Command	5	13.9%	-	0%	-	0%	5	13.9%
Observe	3	8.3%	1	2.8%	-	0%	4	11.1%
Suggest	-	0%	-	0%	-	0%	-	0%
Opinion	-	0%	-	0%	-	0%	-	0%
Inquiry	-	0%	-	0%	-	0%	-	0%
Question	-	0%	1	2.8%	-	0%	1	2.8%
Acknowledgement	-	0%	2	5.6%	1	2.8%	3	8.3%
Answer	-	0%	-	0%	-	0%	-	0%
Briefing	2	5.6%	-	0%	-	0%	2	5.6%
Expression	1	2.8%	-	0%	2	5.6%	3	8.3%
Standby	-	0%	-	0%	-	0%	-	0%
Actions								
Open a Door	3	8.3%	-	0%	-	0%	3	8.3%
Use Handcuffs	1	2.8%	-	0%	-	0%	1	2.8%
De-Escalation								
Verbal Use of Force	8	22.2%	2	5.6%	-	0%	10	27.8%

Honesty	4	11.1%	-	0%	-	0%	4	11.1%
Asking for Information	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%
Zero Behaviour	-	0%	-	0%	-	0%	-	0%
Total	27	75.0%	6	16.7%	3	8.3%	36	100%

Summary of De-escalation Behaviour Observed in The Arrest Scenario:

Overall, several trends became apparent when observing "The Arrest" simulations. DB was immediately initiated each time a suspect was encountered across all of the simulations regardless of whether the assailant was in possession of a weapon or not. After being initiated, DB was then regularly adopted until the threat of both suspects was neutralised. Verbal Use of Force was the most commonly utilised DB and was always the initial DB that occurred when a suspect was encountered in all simulations. Honesty was also used regularly in conjunction with Verbal Use of Force during the detainment process of the suspects in each simulation. Both were adopted often throughout the de-escalation process and not just prior to the detainment of the suspects. Emphasising Humanity and Asking for Information were only utilised with the unarmed suspect and within a single instance with the armed suspect, after being detained.. The proportion of DB across simulations ranged from 15.8% in "The Arrest 1" and 38.9% in "The Arrest 2". It is worth noting again that large parts of the scenario do not involve a situation in which DB is either necessary or possible. Once DB was first engaged in, it then occurred regularly until the conclusion of the simulations.

Breakdown of De-Escalation Behaviour across Physiological Arousal Levels

Table 9

Standardised Breakdown of De-Escalation Behaviour across Physiological Arousal Levels by Officer

	Low		**Medium**		**High**		**Very High**		**Missing**	
Officer 1										
Verbal Use of Force	-	0%	-	0%	-	0%	1.48	2%	-	0%
Honesty	-	0%	-	0%	-	0%	1.85	2.5%	-	0%
Asking for Information	-	0%	-	0%	-	0%	.37	0.5%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	2.97	4%	-	0%
Officer 2										
Verbal Use of Force	-	0%	-	0%	.74	1%	.74	1%	-	0%
Honesty	-	0%	-	0%	.37	.5%	1.48	2%	-	0%
Asking for Information	-	0%	-	0%	-	0%	.74	1%	-	0%

Emphasising Humanity	-	0%	-	0%	1.11	1.5%	-	0%	-	0%
Officer 3										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	12.29	16.7%
Honesty	-	0%	-	0%	-	0%	-	0%	1.29	1.7%
Asking for Information	-	0%	-	0%	-	0%	-	0%	.65	.9%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 4										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	2.59	3.5%
Honesty	-	0%	-	0%	-	0%	-	0%	.65	.9%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 5										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	-	0%
Honesty	-	0%	-	0%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 6										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	5.76	7.8%
Honesty	-	0%	-	0%	-	0%	-	0%	1.44	2%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	.72	1%
Officer 7										
Verbal Use of Force	2.16	2.9%	1.44	2%	1.44	2%	-	0%	-	0%
Honesty	-	0%	-	0%	-	0%	-	0%	-	0%
Asking for Information	1.44	2%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 8										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	.72	1%
Honesty	-	0%	-	0%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 9										
Verbal Use of Force	.89	1.2%	-	0%	-	0%	-	0%	-	0%
Honesty	.89	1.2%	-	0%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	.30	.4%	-	0%	-	0%	-	0%	-	0%

Officer 10										
Verbal Use of Force	-	0%	-	0%	-	0%	1.79	2.4%	-	0%
Honesty	-	0%	-	0%	-	0%	.60	.8%	-	0%
Asking for Information	-	0%	-	0%	-	0%	.30	.4%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 11										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	1.49	2%
Honesty	-	0%	-	0%	-	0%	-	0%	.30	.4%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 12										
Verbal Use of Force	-	0%	-	0%	-	0%	3.89	5.3%	-	0%
Honesty	-	0%	-	0%	-	0%	1.94	2.6%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	.65	.9%	-	0%
Officer 13										
Verbal Use of Force	-	0%	-	0%	.32	.4%	1.62	2.2%	-	0%
Honesty	-	0%	-	0%	.32	.4%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 14										
Verbal Use of Force	8	10.8%	-	0%	-	0%	-	0%	-	0%
Honesty	3	4.1%	1	1.4%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 15										
Verbal Use of Force	1	1.4%	1	1.4%	-	0%	-	0%	-	0%
Honesty	-	0%	-	0%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
Officer 16										
Verbal Use of Force	-	0%	-	0%	-	0%	-	0%	-	0%
Honesty	-	0%	-	0%	-	0%	-	0%	-	0%
Asking for Information	-	0%	-	0%	-	0%	-	0%	-	0%
Emphasising Humanity	-	0%	-	0%	-	0%	-	0%	-	0%
	17.68	24%	3.44	4.7%	4.3	5.8%	20.42	27.7%	27.9	37.8%

From the data presented in table 9 and table 10, documenting the frequency and proportion of DB at each PA level, several points of interest were identified. 37.8% of the DB data lacked accompanying HRV data with it. Officers 3, 4, 5, 6, 8, and 16 had no HRV data recorded during their simulations. Of those officers, officer 5 and 16 also recorded no DB at any stage. The remaining data with accompanying HRV data is broken down below.

Firstly, the low PA level was experienced for 38.6% of all recorded instances of DB across all simulations when excluding missing data (i.e, recorded DB without accompanying arousal data). The DB that was most present at the low PA level was "Verbal Use of Force" which made up 26.3% of the data. "Honesty" was recorded at 8.5%, "Asking for Information" at 3.1%, and "Emphasising Humanity" at 0.7%. Only four of the officers were recorded at the low PA level utilising DB of any kind, namely, officers' 7, 9, 14, and 15. Officer 7 made up 4.9% of the data, officer 9 accounted for 2.8% of the DB, officer 14 was responsible for 14.9% of the data at this level and lastly, officer 15 made up 1.4% of the DB.

DB was coded at the medium PA level 7.5% of the time. "Verbal Use of Force" was again the most represented DB at this level, accounting for 5.3% of the data. "Honesty" made up the remaining 2.2%. "Asking for Information" and "Emphasising Humanity" were not recorded at any point at the medium PA level. Three officers used DB at the medium PA level. They were officer 7, 14, and 15. Officer 7 made up 2% of the data. Officer 14 accounted for 1.4% as did officer 15.

DB was present 9.4% of the time at the high PA level. "Verbal Use of Force" again was the most prominent DB at this level making up 5.5% of the data. "Honesty" accounted for 1.5% of the data, and "Emphasising Humanity" was responsible for 2.4% of the DB recorded. "Asking for Information" was not coded for at the high PA level. Only officer 2 and officer 7 recorded DB at the high PA level. Officer 2 made up 3.8% of the data and officer 7 made up 2% of the DB.

DB was noted 44.6% of the time at the very high PA level. As with all other PA levels of this study, "Verbal Use of Force" was the most common DB that was recorded with 20.8% of the data attributed to that behaviour. "Honesty" accounted for 12.8% of the DB, "Asking for Information" was responsible for 3.1% of the data, and "Emphasising Humanity" made up 7.9%. Five officers exhibited DB at the very high PA level. Those officers were officer 1, 2, 10, 12, and 13. Officer 1 made up 9% of the data. Officer 2 accounted for 4% of the data. Officer 10 was coded 3.6% of the time. Officer 12 was responsible for 8.8% of the data and officer 13 made up 2.2% of the data at the very high PA level.

Overall, DB was most prevalent at the "Low" and "Very High" PA levels. In particular, "Verbal Use of Force" was heavily used at these levels and was the most prominent DB across all PA levels.

Table 10

Standardised frequency of individual de-escalation behaviour across physiological arousal levels

	Low	Medium	High	Very High
Verbal Use of Force	12.05 26.3%	2.44 5.3%	2.5 5.5%	9.52 20.8%
Honesty	3.89 8.5%	1 2.2%	.69 1.5%	5.87 12.8%
Asking for Information	1.44 3.1%	- 0%	- 0%	1.41 3.1%
Emphasising Humanity	.3 .7%	- 0%	1.11 2.4%	3.62 7.9%

Discussion

Exploration and Analysis of Results

Policing is a dangerous and volatile occupation wherein the levels of stress that is endured daily can be quite high in comparison to other workfields. Especially, within this critical context, it is of high importance that police officers continue to collaborate effectively with eachother, even under increasing stress levels. This research intended to explore the relationship between police DB and the PA of officers. The following section will discuss the findings for each of the research questions of this study. Subsequently, the limitations, theoretical implications, practical implications, and ideas for future research will be expressed ending with an overall conclusion of the research.

Research Question 1

The first research question was as follows: “When do police officers show DB in a virtual reality simulation-based environment?”. Overall, the findings were that DB is exhibited as soon as a person of interest is encountered, beginning with Verbal Use of Force in order to get the suspect to submit without any potentially deadly force being used. Often times Honesty will be used in tandem with Verbal Use of Force when initially encountering the suspect to provide calm by reaching a sense of understanding with the assailant. Asking for Information was used at any point post-apprehension in order to gain further insight or detail on the situation from the suspect as well as attempting to create a rapport with the individual. Emphasising Humanity was used generally towards the end of scenarios to further build rapport with the suspect once apprehended to maintain the peace. The uptake and progression of these behaviours may vary depending on gender also.

No DB is present in any scenario until a potential suspect is encountered. This is unsurprising as the officers cannot de-escalate a situation if there is no situation to de-escalate. Secondly, “Verbal Use of Force” and “Honesty” were utilised in all scenarios. Verbal Use of Force was almost always used when initially encountering a suspect pre-apprehension. The presumption here is that this is due to this being the most dangerous part of the scenario, when the officer(s) and suspect are in the same room and the threat has not yet been handled. Verbal Use of Force is the initial and most aggressive

form of de-escalation that can be used making it preferential for this tense stage of the scenarios. The other DBs are much more present once the suspect is apprehended. It is assumed that this is the case because post-suspect apprehension is a safer stage of the scenarios to utilise less traditional police methods where the officer can try to connect with the suspect in order to further de-escalate the situation.

Another interesting finding was that there was a distinct disparity in application of DB between genders. Both of the female participants of this study were paired up in "The Confused Person 1" simulation. This was the only simulation where any officer utilised another DB other than "Verbal Use of Force" more prominently. Therefore, it would appear that the female officers were much more likely to resort to less aggressive and more rapport building forms of de-escalation in comparison to their male counterparts. They also utilised the DBs in a more balanced manner than the male officers, utilising each behaviour relatively evenly. The male officers in comparison almost always utilised "Verbal Use of Force" liberally with the other behaviours being performed sparingly alongside it if at all.

Research Question 2

To answer the second research question, "Do police officers show different DBs during different levels of arousal (i.e., low, medium, high and very high)?", two standardised tables documenting the breakdown of each individual officer's frequency of exhibiting each DB and their PA state when doing so was produced. This allows for a comprehensive assessment of the differences and similarities between each officer's utilisation of DB and what impact their PA level has on how often and which DBs are used in general. Overall, "Low" and "Very High" PA levels were where the highest frequency of DB was recorded. Furthermore, "Verbal Use of Force" was the most prominent DB observed across all PA levels.

"Low" and "Very High" are by far the most prominent arousal levels when DB is used. It must be mentioned that these findings align with the overall behaviour data in the sense that there is very little fluctuation in arousal whether the officer is exhibiting non-DB or are utilising DB across all participants. Therefore, officers tend to either experience very high or low arousal when performing any behaviour not just DB. The reasoning for more frequent low arousal levels may be due to an immersion issue with the VR-SBT as in those officers did not view the simulation as real and connect with the stakes of the scenario appropriately as a result thus providing no stimulation when engaging with the simulation. The opposite may be true in the case of those who registered very high arousal levels in that they were fully immersed and that spiked their arousal levels. In both instances, personality differences may also be a factor in the disparity amongst participants.

"Verbal Use of Force" was the most prominent DB observed across all arousal levels. It would appear that the PA level of the officers does not discernibly affect what type of DB an individual officer may adopt. Moreover, the low rate of medium and high PA during DB mirrors that of the other

behaviours so one cannot infer whether DB is truly more prevalent at the extremes of arousal but more so that officers generally experience more extreme states of PA when acting out these scenarios.

Limitations

Over the course of the research, several limitations presented themselves that may have impacted the results. Firstly, the sample size could have been larger to accommodate for a broader and more conclusive set of results. The research was limited to nine scenarios of which only six had any HRV data at all. Several of the participants in the six scenarios used were also missing HRV data, leaving only 11 participants possessing HRV data in total. Access to more scenarios and/or the provision of HRV data for all participants would have aided in gaining more insight into the relationship between the variables explored in this study.

Another potential limitation was the focus of the various simulations provided for this research. Both "The Confused Person" and "The Arrest" scenarios involved dealing with suspects acting erratically and/or possessing a deadly weapon of some kind. These are not the most applicable kind of scenarios in which to investigate DB usage outside of "Verbal use-of-force" as officers are much more likely to use alternative police methods to de-escalation when placed in a potentially deadly situation (Engel, McManus, & Herold, 2020). Furthermore, it takes a large chunk of the scenarios duration before encountering a suspect, especially in "The Confused Person" simulations. This likely skewed the proportion of DB used as the officers did not have an opportunity to de-escalate for large portions of the simulations.

Furthermore, 67.1% of DB recorded was "Verbal Use of Force", with fourteen of the sixteen officers utilising it at some point during the study. 20.7% of coded DB was attributed to "Honesty" with eleven officers adopting this behaviour. Only five officers utilised "Asking for Information" and "Emphasising Humanity" and they only made up 4.8% and 7.8% of the de-escalation data respectively. It is worth noting that there were individual outliers represented within some of these variables that may have skewed the data somewhat. Officer 3 (16.7%), officer 6 (7.8%), and officer 14 (10.8%) made up a large portion of the "Verbal Use of Force" data and officer 1 accounts for over half of all the "Emphasising Humanity" codes (4%).

Another limitation of this study is the use of HRV as the exclusive measurement methodology for PA. First of all, the extant literature on PA often favours Electrodermal activity (EDA) as the measurement method for their studies as opposed to HRV. EDA, otherwise known as skin conductance, is measured through the shifts in the eccrine sweat gland in response to stress (Benedek & Kaernbach, 2010). EDA has been found to be the most sensitive marker of arousal when compared to other similar measures such as HRV (Lidberg & Wallin, 1981; Marci, Ham, Moran, & Orr, 2007; Picard, Fedor, & Ayzenberg, 2016). EDA is especially useful when utilised in interactions that may lead to intense emotional responses (Akinola, 2010; Figner & Murphy, 2011) such as police encounters with civilians. applicability of HRV in measuring emotional variables such as PA has been

disputed in the literature. The argument here is that HRV is calculated based on the previous 30 seconds of a subject's heart rate which leads to too slow of a response to changes in heart rate overall (Alugubelli, Abuissa, & Roka, 2022). Nardelli et. al. (2015) however, managed to capture reliable emotion data, gaining an 84.2% recognition accuracy on the arousal dimension of their study. Thus, the solution brought forward towards this topic would appear to be that combining multiple arousal measures will provide the most accurate data on emotional stimuli such as PA (Mauss and Robinson, 2009; Bota et. al., 2019).

Lastly, the operationalisation of police de-escalation or lack thereof poses several challenges to the present study. Firstly, there is yet to be a universal definition of de-escalation in the police context, forcing the researcher to arbitrarily choose one of the several existing and competing definitions to focus on thus creating a difficulty in comparing literature on this topic. Likewise, there is no consensus as to what behaviours make up de-escalation. However, to study de-escalation behavior, we built upon previous observational studies to compose the codebook. Moreover, there was no way to decipher whether the DB presented during the research was good, or effective in any way. The lack of a performance metric in the research makes inferring from the results more challenging.

Theoretical Implications

The current research provided a number of fresh insights expanding on the extant literature available. Whilst de-escalation and PA have been explored on the individual level and in relation to other variables, the exploration of the relationship between the two particularly in a police context was lacking. And why is this important/what new insights can we get from making this combination? The findings of this study allowed for the creation of an introductory understanding of how these variables interact in high-stress police encounters.

Regarding DB, an increased understanding of when DB is triggered in officers and what style of de-escalation, they utilise in general can allow for further tailoring of de-escalation literature. There is a dearth of literature that aims to define and outline what constitutes DB and how this can be perceived in the occupational environment. This study both clearly defines a series of DBs and describes how they manifest themselves in the field of policing. These findings could allow for improved understanding and pinpointing of core behaviours of de-escalation and how these emerge over time that could be universally compiled and coached in de-escalation trainings in the future. When looking at the criteria for effective police training (Hutter et. al, 2023), based on the simulations observed in this study, there are several areas that can be focused on and optimised when tailoring de-escalation trainings. In regards to self-efficacy and the need for the officers to be challenged but feel capable, it would be desirable for the actors roleplaying the assailants in these simulations to be briefed on how to react to certain responses provided by the officers if they are not already. For example, the actor playing the suspect with a weapon in "The Arrest" scenario would be told that if the

officers respond too aggressively or do not employ any DB that they must further escalate the situation. This allows the officers the challenge of needing to perform certain behaviours to resolve the situation whilst also giving them a clear pathway to success that is attainable. Furthermore, it is unknown as to whether the officers are given a clear outline of the focus of the simulation in this study. Clarity of assignment or what is going to be trained would be beneficial for de-escalation training in order to direct the focus of the officers. Lastly, model learning is also a useful tool in optimising de-escalation training. Demonstrating optimal performance and the necessary skills needed to attain that can allow the officers a better understanding of the skills being honed through the opportunity of mirroring the behaviour they're observing. Having these demonstrations perhaps in between simulations so that they get a dry-run in order to approach the task and then gain the insight of how the behaviours are effectively performed prior to the next simulation could be beneficial. Moreover, the frequency of DB exhibited illustrated a benchmark for where the average officer stands in terms of their baseline utilisation of DB in highly stressful encounters. In summation, there is now micro-level insight within the police context as to when DB is triggered in police officers, how often this DB occurs amongst police officers, what types of DB is often exhibited in this context in general, and how these insights can inform future de-escalation training.

Regarding PA, this study provided insight into what arousal state the officers tend to be under when engaging in their duties. This may be of use in further understanding the influence of PA on officer behaviour and how it's fluctuation may impact performance. Furthermore, this study provides context as to what behaviours the officers exhibit most frequently when experiencing various levels of arousal. In connection with arousal's relationship with DB, the study draws inferences as to what arousal level an officer is most likely to be experiencing when showcasing DB. Likewise, insight into what style of DB is most likely to be utilised at each arousal level was also alluded too.

Lastly, this study is the first of its kind within the police context to utilise the combination of VRSBT and wearable sensor technology as a tandem approach to measuring emotional stimuli and behaviour in a controlled but realistic environment. This allowed for accurate simulated data on PA and police de-escalation to be recorded safely and conveniently. This study also showed that this type of research methodology can be useful and beneficial for research purposes. This study showcases VR as a viable tool for the context of training in the police force and hopefully can help to promote its use further in this sector.

Practical Implications

As a result of this research, a number of practical implications were displayed. This study utilised the Zephyr wearable sensor technology to measure the HRV levels of the officers. It proved to be a useful and insightful tool for this purpose. Zephyr allows for full range of movement from the participant whilst still accurately recording HRV data (Alugubelli, Abuissa, & Roka, 2022). This makes Zephyr an ideal tool to use in conjunction with real-world training both physical and virtual if one wishes to

explore team behaviour and PA in a controlled setting. It shows how the participants react under stressful conditions. What would be beneficial in the case of this study and future studies like this would be to provide all participants with a wearable sensor so that one can get a complete overview of the team's PA levels in order to explore how the officers respond differently to similar stimuli and how their arousal levels impact that process directly in comparison with eachother.

Moreover, VRSBT is a training concept that is growing in popularity annually, including in the police context. VRSBT facilitates the security of the participants involved whilst exposing them to real-world stressors that they can engage with realistically to improve their on-field skills and behaviour (Zechner et al., 2023). This study showcased the usefulness of VRSBT as both a tool to observe behaviour that may mirror the participant's real-world response to a threat as well as a valuable training methodology that could benefit police training procedure in the future. Some work still needs to be done in terms of the immersion and realism of the environment as some participants did show instances of either not taking the scenario completely seriously at times or not possessing the necessary training to be able to interact with the VRSBT environment optimally which may have affected some of the arousal data of this study. This issue was most commonly exposed in the moments where an officer had to use their handcuffs or open a door. Therefore, further technological advancements to improve the immersion and an initial tutorial on how to interact with the environment may prove beneficial.

Furthermore, AAR is a tool used to analyse VRSBT recordings and contains a multitude of options towards this end. Aspects such as the participants stress level, walking line, eyeline, and visual field as well as an animated recreation of the scenario that can be observed allow for an in-depth breakdown of each simulation conducted (Giessing, 2021). The general purpose of AAR software is solely as an addendum to the VRSBT for feedback purposes. This research illustrated AAR software's applicability as a research tool in order to explore behavioural and emotional variables qualitatively. There are certain amendments that could be made to improve the effectiveness of AAR in this context. Improved microphone quality and the option to isolate participants audio would help during the transcription phase of qualitative analysis as you could now identify with absolute certainty what is being said and who is saying it which would prove beneficial for the validity and reliability of the research. A metric in which to objectively measure the performance of the participants may also be of value as it would aid in understanding whether the behaviour being exhibited, and the actions being taken are effective or not. This would help to further tailor future trainings and research on the topic in order to reach optimisation.

In regards to the results generated from this study, there is a clear inclination to adopt "Verbal Use of Force" amongst the majority of officers. Trainings that encourage the adoption of the less aggressive forms of de-escalation could be worth exploring or at least trainings that promote a more balanced approach to de-escalation as a whole. Furthermore, in terms of the scenario design, having at least some scenarios that provide instant need to de-escalate could also be useful. Including a scenario,

such as a domestic dispute where the officers will have to diffuse the situation on arrival to the scene can provide task variability for the officers as well as allowing for a clear focus on DB above all other aspects of policing making the trainings more efficient.

Future Research

As a result of this study, a number of potential topics to be explored in future research became apparent. Firstly, this research lacked any kind of performance metric to assess the effectiveness of the DB being exhibited as well as the overall performance of the officers. This could have been beneficial in giving context as to what constitutes good and bad DB. This data would also provide insight into how the officer's arousal levels influence the likelihood of using effective DB. In its current iteration, this research lacks the ability to discern between effective and ineffective DB and only highlights when DB will be used in any way. Furthermore, a performance metric can aid in the tailoring of future trainings to focus on developing effective DB and testing whether de-escalation is an effective strategy in general in the police context. This performance metric can encompass multiple relevant perspectives such as the inclusion of instructor ratings and insight from the participant's themselves on their own performance both as individuals and as a team.

De-escalation training in itself is an area of the literature that can be expanded on following on from this research. The simulations that were used in this study were not specifically designed to train de-escalation. Scenarios that more closely home in on DB could provide more insightful and broader results. In general police de-escalation training is an area growing in popularity. Many academics, law enforcement professionals and community leaders have advocated for de-escalation focused training for police in recent years (Final Report of the President's Task Force on 21st Century Policing 2015; Limiting Police Use of Force: Promising Community-Centered Strategies 2014; President's Commission on Law Enforcement and the Administration of Justice 2020). However, Engel et al. (2019) conducted a multidisciplinary systematic review of de-escalation that identified that no de-escalation training was clearly present in the field of criminal justice including policing despite these calls for change across the law enforcement community. The belief from the de-escalation training advocates is that if officers receive adequate de-escalation training that there would be "(a) fewer fatal encounters between the police and the public, (b) fewer injuries for officers and suspects, (c) greater flexibility in the use of misdemeanour charges, (d) fewer people with serious mental illnesses being sent to jail, (e) fewer law suits, (f) improved community relations, and (g) improved officer job satisfaction" (Guiding Principles on Use of Force 2016; President's Commission on Law Enforcement and the Administration of Justice 2020; Morin et al. 2017; Oliva et al. 2010; Vickers 2000). Moreover, PA measurement can be incorporated into these trainings. Trainings to aid officers in controlling and harnessing their heightened emotional states remains a core unaddressed issue within police trainings. Furthermore, it is posited that effective de-escalation requires an officers' understanding of their own emotional state and how to manage said emotions in their high-stress occupation (Thomas, 2021).

Therefore, a combination of these two variables as the focus point of police trainings may lead to optimisation of de-escalation trainings.

The main issue in implementing and researching police de-escalation training, however, is that there is no consensus about what de-escalation is, what behaviours and strategies it contains and whether it is even an effective method of policing at all (Engel, McManus, and Herold, 2020a). Thus, it remains vitally important in this field of research that studies devoted to the operationalisation of de-escalation in the police context continue to be produced so that this consensus can be reached. Only then can work progress towards designing de-escalation-based trainings and eventually optimising them so that policing and the controversy surrounding the profession may dissipate and thus more lives will be served and protected adequately.

Lastly, it would also be interesting to see how if the officers' arousal levels increase or decrease over time whether in the same simulation or across several simulations, how this would impact their DB and how that then can influence their overall job performance.

Conclusion

Policing is a vital occupation devoted to the safety and peace of all citizens. In recent times this devotion has been publicly questioned as a slew of scandals continue to emerge globally on an annual basis. This has led to calls for a shifted focus towards de-escalation as the core strategy of modern policing. Likewise, more understanding and awareness towards an officer's emotional state and its influence on decision making has become more prevalent also. In analysing these two variables, this study discovered that officers predominantly experienced very high PA levels during VRSBT scenarios. However, they were more likely to exhibit DB when at a medium level of PA. Officers also, regardless of emotional state generally utilised verbal use of force as their DB of choice particularly prior to the detainment of the suspect.

Overall, this research provides insight into the relationship between police de-escalation and PA that can act as a foundation for future research into this area. Furthermore, this research also helps to promote VRSBT as a viable training method for the police force as well as a potentially useful outlet for future police de-escalation training in the future. This research will further add to the growing numbers of literature calling for clearer operationalisation of police de-escalation so that that quicker and more precise progress can be made on the topic both academically and practically in the future.

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