The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1363-951X.htm

Testing the impact of physiological stress response on police performance during critical job tasks

Lois James
College of Nursing, Washington State University, Vancouver, Washington, USA, and
Michael S. Goldstein, Peter Lecy and Stephen Mase
Provicta, Plymouth, Minnesota, USA

Received 12 September 2020
Revised 9 November 2020
Accepted 15 November 2020

Abstract

Purpose – To add to the existing body of knowledge on the relationship between stress and job performance in policing, we monitored police officers' physiology using Hexoskin shirts while they responded to simulated scenarios.

Design/methodology/approach – We employed mixed repeated measures (baseline, intervention, post-intervention), between groups (treatment vs control group) design. Using this approach, our aims were (1) to determine whether an individualized physiological stress profile—a combination of heart rate (HR), heart rate variability (HRV), sympathetic nervous system (SNS) index and parasympathetic nervous system (PNS) index—could be developed for each participant; (2) to investigate the association between physiological stress and scenario performance and (3) to pilot test an intervention for decreasing physiological stress in real time.

Findings – We found that it was possible to individualize physiological stress profiles for each participant that alerted us when the participant was becoming stressed. We also found that physiological stress was significantly and negatively/inversely associated with scenario performance. However, our intervention to try and decrease participants' stress in real time was not successful. Several key lessons can be taken from our attempt that could inform future efforts in this area.

Research limitations/implications – This was a small pilot study, precluding generalizability of results. Furthermore, our intervention was simplistic and potentially affected by an experimenter effect. Future research should explore better ways to intervene when officers are becoming physiologically stressed to help them overcome stress in real time and safeguard against the cumulative effects of stress on health and performance.

Originality/value – This research adds to the body of knowledge on physiological stress and job-task performance in police officers.

Keywords Stress, PTSD risk, Vigilance, Performance, Police decision-making

Paper type Research paper

Introduction

"The bulletproof cop does not exist. The officers who protect us must also be protected – against incapacitating physical, mental, and emotional health problems as well as against hazards of their job." (21st Century Policing Report's Pillar Six framework)

Policing is an inherently stressful profession. Police officers are required to respond to ambiguous, fast-paced and rapidly changing encounters that have the potential to turn deadly. A police officer's response, or lack of response, to a volatile situation can result in a deadly outcome. This outcome can be influenced by how the officer responds to stress. Finding effective ways of teaching officers to manage stress and control their physiology is critical for protecting their well-being and enhancing the outcomes of police–citizen encounters.

However, helping officers condition themselves to deal with stressful situations has traditionally been dealt with by offering additional training without measuring how each

Policing: An International Journal
Vol. 44 No. 3, 2021
pp. 405-417
© Emerald Publishing Limited
1363-951X
DOI 10.1108/PIJPSM-04-2020-0060

officer is actually performing. Consequently, the effectiveness of training designed to help officers overcome stress is largely unknown. All the while, officer rates of PTSD, suicidal ideation and suicide are rising (Violanti *et al.*, 2013). In addition, the cost of "broken" officers is putting enormous financial strains on local communities.

The goal of the current study was to utilize wearable technology to monitor police officers during inherently stressful simulated job tasks. Top athletes and their trainers have taken advantage of the emerging wearable monitor market to track various biometrics to assist in the optimization of their performance. The wearable market has extended into the general consumer marketplace in the name of better fitness and health. From a police training perspective, wearable technology could provide law enforcement the opportunity to capture useful physiological metrics and establish baselines to better study how stress-induced events affect an officer's performance during both routine and critical incidents.

Literature review

A great deal of literature has been dedicated to understanding and optimizing the human response to stress. For example, Choi and Guitarez-Asuna (2009) established a "stress index" by measuring sympathetic (fight or flight) and parasympathetic (calming/stabilizing) responses. Their methodology was centered on the premise of the predictability of activation of the sympathetic and parasympathetic branches of the nervous system when measured against heart rate monitors while study participants were engaged in tasks known to increase (and conversely decrease) stress loading. The results of the study demonstrated an 83% confidence rate in discriminating stressful events–i.e. validating a "stress index" in respondents undergoing stressful tasks.

McDuff *et al.* (2016) measured the connection between cognitive stress and consequent learning. Within this study, a video was taken from a distance of 3 meters to record photoplethysmographic data, then correlated to participants' self-reported stress levels. Heart rate variability was also monitored as a means of triangulating data. The researchers found that all three data types (photoplethysmographic, physiological and self-report) correlated strongly and significantly with each other and with subsequent learning degradation on cognitive tasks. Another study that validated self-reported stress measures was done by Evans *et al.* (2013), who compared physiological stress measures (cortisol, heart rate and respiratory variability) to responses on a self-reported stress scale. They found that this stress scale could be used to monitor and predict stress loading in response to cognitive tasks.

Research has also attempted to determine "in the zone" states based on stress response. Esterman *et al.* (2013) monitored brain activity and performance fluctuations during periods of sustained attention. They analyzed the relationship between reaction time variability, attention lapses and intrinsic brain activity during task loading and new task introduction and specified two functional brain activity states: the "in the zone" state–less error prone and more stable and the "out of zone" state–more error prone and requiring more effort and use of dorsal attention regions. Similarly, Johnson *et al.* (2014) monitored expert and novice marksmen and found distinct neurophysiological indicators of expert (less error prone, greater parasympathetic response) and novice (more error prone, greater sympathetic response) participants.

The connection between stress and performance degradation has been established in other professions such as aviation. Durantina *et al.* (2014) used functional near infrared spectroscopy (FNIR) to determine cognitive loading in pilots of remotely operated vehicles. They found that as the pilot experienced cognitive overload in reaction to stressors, the ability to multitask degenerated, resulting in lower overall performance and eventual critical mission failure.

Specific to policing, several studies have found that stress responses are typical among police officers. This includes during use-of-force incidents, during situations with potential a threat, during periods of anticipation (e.g. driving to an incident with lights and sirens on), responding to use-of-force simulation scenarios and occupational stressors such as stigma (Anderson *et al.*, 2002; Arble *et al.*, 2019; Armstrong *et al.*, 2014; Carlton *et al.*, 2020a, b). The uncertain and unpredictable nature of many police–citizen encounters also adds to police stress response (Anshel *et al.*, 1997). Furthermore, many studies have found that police officers are at an elevated risk of PTSD, with common symptoms including nightmares, avoidance strategies, guilt, and hypervigilance (Violanti *et al.*, 2013). Officers who exhibit greater post-traumatic stress disorder (PTSD) symptomology are at greater risk for deficits to inhibitory control, which could affect the outcomes of police–citizen encounters (Covey *et al.*, 2013).

Anderson and colleagues have led the field in testing interventions that attempt to reduce decision-making errors in police officers by modulating physiology (Andersen *et al.*, 2018; Anderson *et al.*, 2019; Carlton *et al.*, 2020a, b). For example, these researchers used a physiologically focused intervention—specifically, heart rate variability biofeedback—to reduce lethal force errors using a simulation-based design. They found that errors could be reduced, supporting the potential of physiology modulation approaches for improving police performance (Andersen *et al.*, 2018).

Recent work by Baldwin *et al.* (2019) measured cardiovascular activity and found that officers' stress responses increased with the priority of a call (ranging from routine to very urgent), as well as any time a weapon was present. Officers' stress responses were not localized to the incident. For example, during a use-of-force call, elevated stress responses were observed during dispatch, travel to the scene and arrival at the scene, as well as throughout the encounter.

Another realm that has focused on stress among its personnel is the military. Hourani *et al.* (2016) developed and pilot tested a predeployment stress inoculation program, which combined (1) education about stress, resilience and mindfulness; (2) relaxation exercises with biofeedback and (3) simulation to practice stress reduction skills. They found that treatment group subjects who were exposed to the training were able to increase their heart rate variability (indicative of greater physiological control) compared to control group subjects.

Several studies have monitored police responses during simulation tasks, which have been shown to be an extremely effective way of eliciting strong physiological responses from participants (James *et al.*, 2014; Anderson *et al.*, 2019; Arbel *et al.*, 2019). For example, Groer *et al.* (2010) concluded that simulation-based training was capable of producing highly realistic stress responses in police officers, particularly deadly force judgment and decision-making or virtual use of lethal force training.

Although in its infancy, some police research has now connected a stress response with impaired performance on critical job tasks. Nieuwenhuys *et al.* (2012) have found stress induced decrements in shooting performance (including accuracy, reaction time and errors). Johnson *et al.* (2014) found that greater sympathetic response predicted impaired marksmanship performance. Some studies have ventured beyond marksmanship or use of deadly force and found that stress response also impairs officers' ability to perform other key aspects of the job such as arrest (Renden *et al.*, 2014).

The current study

To add to the existing body of knowledge on the relationship between stress and job performance in policing, we conducted a feasibility test of the Provicta Platform–a method of measuring stress using physiological data collected from Hexoskin monitors. Using a multiphase approach, we sought to determine:

(1) Whether the Provicta Stress Index can be readily established in police participants.
(2) Whether control over physiology can improve police performance.
(3) Whether a simple intervention can improve vigilance and performance in police officers when responding to stress-inducing scenarios.

Methods

Study design

We employed mixed repeated measures (baseline, intervention, post-intervention), between groups (treatment vs control group) design. Participants came to the training facility for testing on three separate occasions, each roughly one month apart, for an approximate two-hour testing session. The first test session was baseline testing, exposing participants to stress-inducing scenarios while monitoring their physiology to get a "Provicta Stress Index." The second test session was for the intervention, during which half of the participants were randomly assigned to receive the intervention (designed to help participants stay "in the zone" during stress scenarios). Finally, the third session was the postintervention test, where participants were again tested on a selection of high-stress scenarios. The primary aim was to determine whether participant physiology could be mapped, and whether it could predict optimal performance. The secondary aim was to pilot test a simple intervention to see if participants could be taught to "stay in the zone" in real time while responding to scenarios.

Design rationale

The rationale for our approach is that by establishing the Provicta Stress Index for a given officer, proper preparations can be tailored for police personnel to meet and exceed the challenges of the job. In real time, biometrics can provide feedback to correct and influence performance. As importantly, these measurements can help predict future behavior and prescribe corrective courses of action resulting in optimized performance and resiliency. By pilot testing, a simple intervention's ability to optimize participant vigilance and maximize participant performance, we hoped to provide information on the most effective ways of preparing police officers for meeting and exceeding the challenges of their chosen profession.

Sample and setting

In total, 40 police participants were recruited from local police departments. The setting in which these experiments were conducted is a "reality-based training environment" at a local technical college that caters to law enforcement students. The facility has mock store fronts, a bank, a bar, an elevator, various stair cases, differently sized rooms that simulate various housing types, a street setting and the ability to drive police vehicles within the space. Within this research setting, participants were exposed to stress scenarios that simulate stressful situations of varying magnitude.

Five major categories of scenarios were used: vigilance under nonstimulating conditions (e.g. crowd watch or stakeout), report writing (testing memory), stationary vehicle scenario (e.g. traffic stop), social interaction (e.g. role playing or simulation), use of force (e.g. deadly force judgment and decision-making or role play with simulations). Within each scenario type, three different scenarios were presented to ensure that participants received a new simulation on each test day. Within each scenario category, scenarios were randomly selected for participants to prevent learning effects. Performance on these stress scenarios was measured using a competency matrix (A, B or C grade).

Study procedures

For each session, participants were fitted with a Hexoskin vest for monitoring their physiology, including heart rate (HR) and heart rate variability (HRV). Heart rate variability (HRV) is the specific changes in time or variability, between different heart beats. When HRV is low, or when there is consistency between timing of heart beats, it indicates being in a sympathetic or "fight or flight" state, whereas when HRV is high, or there are changes in the timing between heart beats, that indicates being in a parasympathetic or more relaxed state. From HR and HRV, a sympathetic nervous system (SNS) index (measure of sympathetic response) and a parasympathetic nervous system (PNS) index (measure of parasympathetic response) were calculated. The first-time participants arrived at the lab they were consented into the study.

During their first session (baseline testing), they received a questionnaire to determine gender, age, years of experience, weight status, fitness status, sleep health, mental health and physical health. They were then tested on stress scenarios of varying magnitude to gather the data required for establishing their SNS and PNS indexes, as well as average HR and HRV during scenarios. At the end of the baseline testing session, officers were randomly assigned to the treatment or control group and were scheduled for their second session (intervention testing) approximately one month later.

On their second test session (intervention testing), participants that were randomly assigned to the treatment group were exposed to a simple intervention designed to keep them at an "optimal" vigilance range, determined based on their precalculated Provicta Stress Index. This consisted of intervening when participants' sympathetic responses (measured in real time by HR) became too high, by advising them to "take a deep breath" during scenarios (feedback given by instructors). The goal was to keep participants "in the zone" of optimal vigilance. The control group received the same scenarios without any feedback from instructors. Following the intervention, participants were scheduled for their third and final session.

On their third session (post-intervention testing), participants were exposed to a series of high magnitude stress scenarios (interaction, traffic stop and use of force), and their vigilance was monitored throughout testing.

Research questions

The core research questions were:

- *RQ1.* Can a "Provicta Stress Index" (a combination of HR, HRV, PNS index and SNS index) be established for participants going through stressful simulation scenarios within a laboratory setting?
- *RQ2.* Can participant performance (measured via competency matrix based on scenario testing) be predicted by participant vigilance levels (measured by the Provicta Stress Index)?
- *RQ3.* Can a simple intervention designed to keep participants "in the zone" optimize participant vigilance and performance?

Study variables

The main dependent variable of interest in the current study is vigilance. This is measured by HR, HRV, SNS index and PNS index. The second dependent variable of interest is performance on scenarios. This is measured using a competency matrix, resulting in an "A," "B" or "C" grade.

The main independent variable of interest in the current study is the intervention (treatment and control group). Furthermore, for research question two, vigilance variables were used as independent variables to test their ability to predict participant performance on stress scenarios.

Several other important variables were used both as control variables within analytical models and also to assess their independent effect on the dependent variables. These included participant age, years of experience, shift schedule and assignment (all measured by questionnaire).

Analytical plan

First, descriptive statistics were generated to explore trends within the data. Second, correlations were investigated to explore associations within the data. Third, inferential statistics were run to investigate significant patterns and effects. Significance testing comprised of multilevel modeling (MLM). This technique is particularly useful for analyzing "nested" data with repeated observations across participants. In this case, participants responded to multiple scenarios per day, across three separate days, making more traditional measures such as repeated measures or mixed analysis of variance (ANOVA) challenging. By specifying levels within the data, MLM can account for the possible violation of the assumption of independence, thus reducing the risk of a type I error (claiming a significant effect of the intervention that is in fact due to chance). At the same time, other variables (such as age, years of experience, etc.) can be entered into the model both as random and fixed variables. This ensures that they act as control variables for the main effect of the intervention, while also allowing an estimation of their independent effects on the dependent variable.

Findings

Performance scores

Overall, there was little difference in performance scores between groups, with treatment group subjects receiving an "A" grade 35% of the time and control group subjects receiving an "A" grade 37% of the time.

When comparing performance score across sessions, 40% of participants received an "A" grade preintervention, 46% during intervention and only 21% postintervention, indicating that the scenarios may have been more challenging during the third session. Alternatively, participants were expecting stressful situations and their own stress levels were higher given past experience during the study.

Vigilance

When comparing PNS index, SNS index, mean HR and HRV across sessions and between groups, no significant differences emerged between groups (see Figure 1).

PNS index was slightly lower overall for treatment participants than for control participants, whereas SNS index was slightly higher, indicating that treatment participants had stronger sympathetic responses than control participants (although not significantly so). Furthermore, HR was slightly higher for treatment participants than for control participants and HRV was slightly lower for treatment participants than for control participants.

We also examined PNS index, SNS index, mean HR and HRV across sessions and found that PNS index and HRV decreased from pre- during- to postintervention, while SNS index and mean HR increased from pre- during- to postintervention, indicating that sympathetic response increased and parasympathetic response decreased over test sessions.

Impact of sympathetic response on performance score

Correlations were run to investigate the impact of stress response on performance scores. As anticipated, performance grade was directly and significantly associated with PNS index ($r = 0.12$; $p < 0.05$) and HRV ($r = 0.21$; $p < 0.001$) and indirectly associated with SNS index ($r = -0.16$; $p < 0.01$) and mean HR ($r = -0.12$; $p < 0.05$). This indicates that PNS index and HRV are associated with better performance scores, while SNS index and HR are associated with poorer scores. See Table 1 for details.

To investigate further the apparent finding that treatment group participants had higher sympathetic responses, we ran a correlation matrix that included assigned group. We found

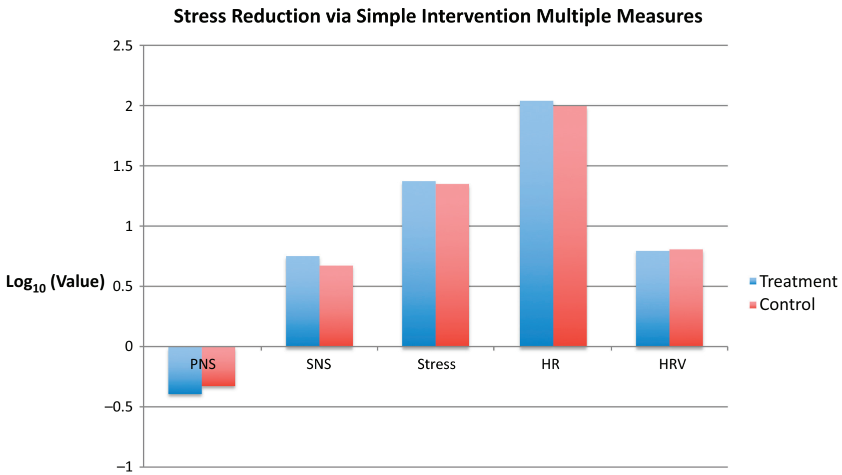

Figure 1. No significant difference in the level of multiple stress measures between the control group (no intervention) and the treatment group indicating a simple interaction is most likely not sufficient in managing officer stress

		Performance	PNS index	SNS index	HR	HRV
Performance[a]	Spearman correlation[b]	1.000	0.119*	−0.160**	−0.118*	0.212**
	Sig. (2-tailed)		0.011	0.001	0.012	0.000
	N	567	455	455	455	444
PNS index	Spearman correlation	0.119*	1.000	−0.971**	−0.973**	0.791**
	Sig. (2-tailed)	0.011		0.000	0.000	0.000
	N	455	462	462	462	451
SNS index	Spearman correlation	−0.160**	−0.971**	1.000	0.948**	−0.868**
	Sig. (2-tailed)	0.001	0.000		0.000	0.000
	N	455	462	462	462	451
HR	Spearman correlation	−0.118*	−0.973**	0.948**	1.000	−0.741**
	Sig. (2-tailed)	0.012	0.000	0.000		0.000
	N	455	462	462	462	451
HRV	Spearman correlation	0.212**	0.791**	−0.868**	−0.741**	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	444	451	451	451	451

Note(s): [a]Performance scores were ranked as $A = 1, B = 2, C = 3$, so positive correlations indicated higher performance scores
[b]Given the ordinal nature of the data, Spearman correlations were selected instead of Pearsons'
*Significant at the $p < 0.05$ level
**Significant at the $p < 0.01$ level

Table 1. Correlations between performance grade (A, B or C) and physiological data

that being in the treatment group was indirectly and significantly associated with PNS index ($r = -0.12$; $p < 0.05$) and directly and significantly associated with SNS index ($r = -0.12$; $p < 0.01$) and HR ($r = -0.19$; $p < 0.001$), indicating that treatment group participants did have stronger sympathetic responses to scenarios than control group subjects (contrary to our expectations). Performance score was not significantly correlated with assigned group.

Generalized linear mixed models

To investigate whether any of the differences between treatment and control groups were significant over test sessions, generalized linear mixed models were run comparing five dependent variables and the effect assigned group, session number, participant age, participant experience, tactical team and work shift had on the dependent variable. It is important to note that session number was significant across all models–suggesting a learning effect occurred across test sessions, despite different scenarios being used for each test session.

First, HRV was assigned as the dependent variable. Figure 2 below depicts the strength of effects of various independent variables on HRV (the thicker the line, the stronger the effect). Assigned group ($f = 8.22$; df = 1,442; $p < 0.01$), session number ($f = 114.65$; df = 1,442; $p < 0.001$), tactical team ($f = 8.26$; df = 1,442; $p < 0.01$) and work shift ($f = 4.55$; df = 1,442; $p < 0.05$) all had significant impacts on HRV.

The direction of coefficients (shown in Table 2) revealed that being in the control group predicted higher HRV. Furthermore, HRV was significantly higher in sessions 1 (preintervention) and 2 (during-intervention) than session 3 (postintervention), indicating that session 3 was more stressful than sessions 1 and 2. Not being assigned to a tactical team predicted lower HRV and not being assigned to the night shift predicted lower HRV. This indicates that tactical team officers and night shift officers (vs day or evening shift) had higher HRV or stronger parasympathetic response during scenarios (while controlling for age and experience). Symbols indicate that participant age and experience (and the dependent variable) are continuous level data, whereas all other independent variables are categorical in nature.

Similar to HRV, when PNS index was entered into a mixed model as the dependent variable, session ($f = 83.76$; df = 1,453; $p < 0.001$), tactical team ($f = 54.93$; df = 1,453; $p < 0.001$) and work shift ($f = 28.63$; df = 1,453; $p < 0.001$) were all significant (data not displayed). Assigned group, however, was not significant. PNS index was significantly

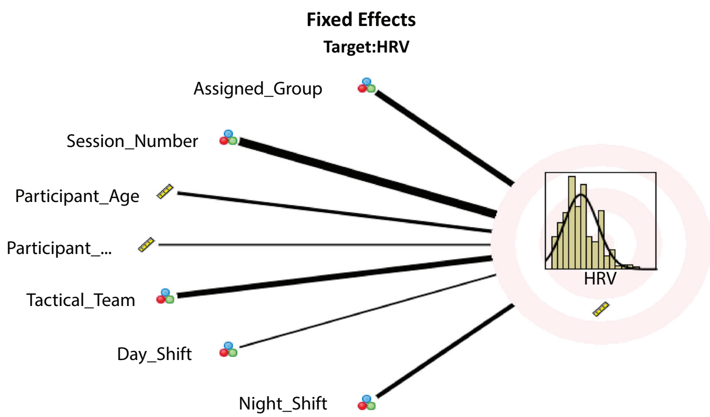

Figure 2.
Effect of assigned group, session number, participant age, participant experience, tactical team, day shift and night shift on HRV

higher in sessions 1 and 2 than session 3. Not being assigned to a tactical team predicted lower PNS and not being assigned to the night shift or the day shift predicted lower PNS index. This indicates that tactical team officers and night and day shift officers (vs evening shift) had higher PNS index scores, or stronger parasympathetic response (lower sympathetic arousal) during scenarios while controlling for age and experience.

Next, SNS index was assigned as the dependent variable. Figure 3 below depicts the strength of effects of various independent variables on SNS index (the thicker the line the stronger the effect). Assigned group ($f = 5.22$; df = 1, 453; $p < 0.05$), session number ($f = 22.03$; df = 1,453; $p < 0.001$), tactical team ($f = 4.63$; df = 1,453; $p < 0.05$) and work shift ($f = 4.33$; df = 1,453; $p < 0.05$) all had significant impacts on HRV.

The direction of coefficients (shown in Table 3) shows that SNS index was significantly lower for control group participants, as well as lower in sessions 1 and 2 than session 3. Not being assigned to a tactical team predicted higher SNS, and not being assigned to the night shift predicted higher SNS Index. This indicates that tactical team officers and night shift officers had lower SNS index scores or lower sympathetic response during scenarios while controlling for age and experience. Symbols indicate that participant age and experience (and the dependent variable) are continuous level data, whereas all other independent variables are categorical in nature.

Model Term	Coefficient	Significance
Intercept	7.88	0.001
Treatment group	−0.62	0.004
Session #1	3.63	0.001
Session #2	1.41	0.001
Age	−0.06	0.09
Years of experience	−0.03	0.46
Tactical team	0.67	0.004
Night shift	0.65	0.04
Probability distribution: Normal		
Session #3 set as reference		

Table 2. Fixed effects of independent variables on HRV

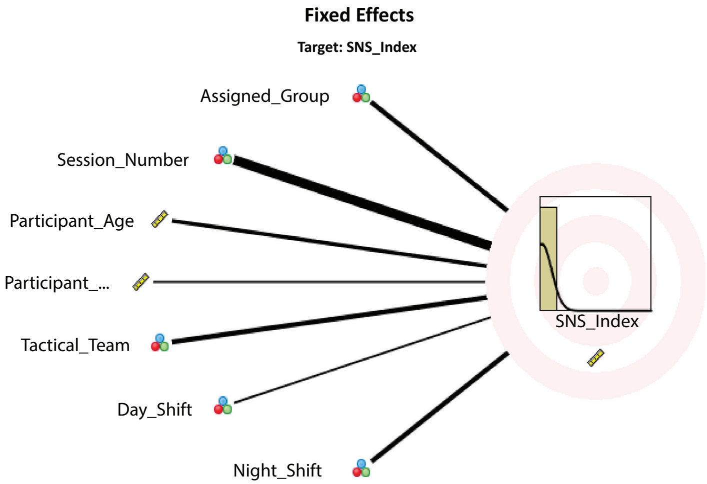

Figure 3. Effect of assigned group, session number, participant age, participant experience, tactical team, day shift and night shift on SNS index

Similar to SNS index, when HR was assigned as the dependent variable (data not displayed) it was revealed to be significantly lower for control group participants ($f = 5.15$; df = 1,453; $p < 0.05$), as well as lower in sessions 1 and 2 than session 3 ($f = 132.22$; df = 1,453; $p < 0.001$). Not being assigned to a tactical team predicted higher HR ($f = 61.74$; df = 1,453; $p < 0.001$) and not being assigned to the night shift or day shift predicted higher HR ($f = 47.51$; df = 1,453; $p < 0.001$). This indicates that tactical team officers and night and day shift officers (compared to evening shift officers) had lower mean HR or lower sympathetic response during scenarios while controlling for age and experience.

Discussion

Interpretation and implications of results

The data collected throughout this experiment revealed several key findings. First, it was feasible to establish a stress index for participants based on data collected throughout the study. Thus, our first research question was answered successfully.

Second, participant vigilance levels did predict performance on scenarios. Although every vigilance variable was correlated with performance, this was most evident for HRV. Participants who had higher HRV (indicative of greater parasympathetic response) had better performance scores than participants with lower HRV. This indicates that greater physiological control and the ability to prevent sympathetic "flooding" resulted in better performance during highly stressful scenarios. Thus, our second research question was answered successfully. Although the association between vigilance and performance was significant, it is important to note that vigilance explained only 1.5–4.5% of variance in performance, so there are certainly other (unexplored) factors that contribute to variation in participant performance.

Although our intervention to try and keep participants "in the zone" was not successful, several key lessons can be taken from our attempt that could inform future efforts in this area. The real-time nature of the intervention potentially backfired—participants in many cases were significantly more stressed by the feedback than calmed by it. It is possible this is related to an "experimenter effect" of participants feeling like they are being monitored and evaluated, which can induce some stress in and of itself.

One way to avoid this is to conduct the intervention ahead of time, for example, via protective breathing techniques such as the four square breathing technique (breathing in for a count of four seconds, holding breath for a count of four seconds, breathing out for a count of four seconds and waiting for a count of four seconds before beginning the cycle again) or mindfulness training, so that participants can feel supported during stressful scenarios without the feeling of having an instructor over their shoulder critiquing them. That the

Table 3.
Fixed effects of independent variables on SNS index

Model Term	Coefficient	Significance
Intercept	2.44	0.13
Treatment group	0.74	0.03
Session #1	−4.34	0.001
Session #2	−3.28	0.001
Age	0.1	0.09
Years of experience	0.01	0.97
Tactical team	−0.72	0.04
Night shift	−0.92	0.04
Probability distribution: Normal		
Session #3 set as reference		

intervention was unsuccessful at the vigilance level (rather than just at the performance level) is encouraging for future interventions aiming to optimize police officer vigilance and performance. In other words, our intervention did not work because it did not promote the officers' abilities to control their sympathetic response. Given the connection we established between control over physiology and better performance on scenarios, we are hopeful that interventions that can successfully promote physiological control will also promote officer performance on stressful scenarios.

Another possibility to consider is that there is simply no "quick fix" to guard against the damaging effects of stress and hypervigilance. Perhaps we need to turn our attention to a more concerted effort of stress management (nutrition, sleep, mental health, fitness, cognitive coping mechanisms, etc.). Putting money into traditional training might not be the solution—a more long-term and holistic approach might be necessary. Training can sometimes be used as a Band-Aid to cover an underlying issue. In other words, it is possible that we need to put more energy into making officers well first (i.e. solving the underlying problem) before we give them tools that they cannot yet use.

Finally, our findings may have important implications for officers with PTSD. As scenarios increased in difficulty, stress tended to increase and performance tended to decrease. From this we could posit that the more high-stress incidents officers encounter, the greater their risk for PTSD and the worse they might perform in the field. Our findings show that greater control over physiology predicted less performance degradation, suggesting that control over physiology may be protective against the risks of PTSD and poor performance from encountering stressful incidents in the field. This seemingly commonsense approach requires more research to guide best practices for protecting police officers against both PTSD (for their own sake) and poor performance in the field (for society's sake).

Limitations

Several limitations need to be addressed. First, this was a small pilot study, precluding generalizability of results. Second, measuring performance using a simple "A, B, C" scoring rubric is limited in terms of the information gathered on participant performance. Future research should consider more refined and sophisticated metrics for measuring participant performance on simulation tasks. Third, our intervention was perhaps overly simplistic and may have focused too much on reducing heart rate (by taking a deep breath) rather than actually gaining control over physiology (arguably better established by promoting each officer's perception of their ability to handle the stressor). Future research should explore better ways to intervene when officers are having a sympathetic response, so as to help them overcome stress in real time. Finally, potentially important baseline health measures were not collected that could have been useful in guiding and interpreting intervention results. These include baseline sleep parameters, mental and physical health status, etc. Future research should gather this data to improve the ability of subsequent analyses to tease out intervention success.

Conclusion

The goal of this study was to conduct a feasibility test of the Provicta Platform. Using a multiphase approach, we sought to determine: (1) whether the Provicta Stress Index can be readily established in police participants; (2) whether control over physiology can result in optimal police performance and (3) whether a simple intervention can result in optimal vigilance and performance in police officers when responding to stress-inducing scenarios.

Our results were mixed. The first two research questions were answered in the affirmative. We were able to establish an individual stress index for police participants based on their responses to stressful scenarios. We were also able to support our hypothesis that police officers who can control their physiology will optimize their performance during stressful scenarios. However, our intervention to help police officers achieve this physiological control was unsuccessful. We recommend that future research explore better ways to help officers cope with stress, both to promote the successful outcomes of police–citizen encounters and also to safeguard our police officers from the long-term risks of stress. We are confident that the pursuit of our overall goal—to reduce risk of officer PTSD while optimizing their performance—is justified and ultimately achievable.

References

Andersen, J.P., Di Nota, P.M., Beston, B., Boychuk, E.C., Gustafsberg, H., Poplawski, S. and Arpaia, J. (2018), "Reducing lethal force errors by modulating police physiology", *Journal of Occupational and Environmental Medicine*, Vol. 60 No. 10, p. 867.

Anderson, G.S., Litzenberger, R. and Plecas, D. (2002), "Physical evidence of police officer stress", *Policing: An International Journal of Police Strategies and Management*, Vol. 25 No. 2, pp. 399-420.

Anderson, G.S., Metz, G. and Andersen, J. (2019), "The impact of acute stress physiology on skilled motor performance: implications for policing", *Frontiers in Psychology*, Vol. 10, p. 2501.

Anshel, M.H., Robertson, M. and Caputi, P. (1997), "Sources of acute stress and their appraisals and reappraisals among Australian police as a function of previous experience", *Journal of Occupational and Organizational Psychology*, Vol. 70 No. 4, pp. 337-356.

Arble, E., Daugherty, A.M. and Arnetz, B. (2019), "Differential effects of physiological arousal following acute stress on police officer performance in a simulated critical incident", *Frontiers in Psychology*, Vol. 10, p. 759.

Armstrong, J., Clare, J. and Plecas, D. (2014), "Monitoring the impact of scenario-based use-of-force simulations on police heart rate: evaluating the royal Canadian mounted police skills refresher program", *The Journal of Criminology, Criminal Justice, Law and Society*, Vol. 15, p. 51.

Baldwin, S., Bennell, C., Andersen, J., Semple, T. and Jenkins, B. (2019), "Stress-activity mapping: physiological responses during general duty police encounters", *Frontiers in Psychology*, Vol. 10, p. 2216.

Carleton, R.N., Afifi, T.O., Turner, S., Taillieu, T., Vaughan, A.D., Anderson, G.S. and Hozempa, K. (2020a), "Mental health training, attitudes toward support, and screening positive for mental disorders", *Cognitive Behaviour Therapy*, Vol. 49 No. 1, pp. 55-73.

Carleton, R.N., Afifi, T.O., Taillieu, T., Turner, S., Mason, J.E., Ricciardelli, R. . . . and Donnelly, E.A. (2020b), "Assessing the relative impact of diverse stressors among public safety personnel", *International Journal of Environmental Research and Public Health*, Vol. 17 No. 4, p. 1234.

Choi, J. and Gutierrez-Osuna, R. (2009), "Using heart rate monitors to detect mental stress", *2009 Sixth International Workshop on Wearable and Implantable Body Sensor Networks*, doi: 10.1109/bsn.2009.13.

Covey, T.J., Shucard, J.L., Violanti, J.M., Lee, J. and Shucard, D.W. (2013), "The effects of exposure to traumatic stressors on inhibitory control in police officers: a dense electrode array study using a Go/NoGo continuous performance task", *International Journal of Psychophysiology*, Vol. 87 No. 3, pp. 363-375.

Durantina, G., Gagnonb, J.F., Tremblayb, S. and Dehaisa, F. (2014), "Using near infrared spectroscopy and heart rate variability to detect mental overload", *Behavioural Brain Research*, Vol. 259, pp. 16-23, doi: 10.1016/j.bbr.2013.10.042.

Esterman, M., Noonan, S.K., Rosenberg, M. and DeGutis, J. (2013), "In the zone or zoning out? Tracking behavioral and neural fluctuations during sustained attention", *Cerebral Cortex*, Vol. 23 No. 11, pp. 2712-2723.

Evans, B.E., Greaves-Lord, K., Euser, A.S., Tulen, J.H.M., Franken, I.H.A. and Huizink, A.C. (2013), "Determinants of physiological and perceived physiological stress reactivity in children and adolescents", *PloS One*. doi: 10.1371/journal.pone.0061724.

Groer, M., Murphy, R., Bunnell, W., Salomon, K., Van Eepoel, J., Rankin, B., White, K. and Bykowski, C. (2010), "Salivary measures of stress and immunity in police officers engaged in simulated critical incident scenarios", *Journal of Occupational and Environmental Medicine*, Vol. 52 No. 6, pp. 595-602.

Hourani, L., Tueller, S., Kizakevich, P., Lewis, G., Strange, L., Weimer, B., Bryant, S., Bishop, E., Hubal, R. and Spira, J. (2016), "Toward preventing post-traumatic stress disorder: development and testing of a pilot predeployment stress inoculation training program", *Military Medicine*, Vol. 181 No. 9, pp. 1151-1160.

James, L., Klinger, D. and Vila, B. (2014), "Racial and ethnic bias in decisions to shoot seen through a stronger lens: experimental results from high-fidelity laboratory simulations", *Journal of Experimental Criminology*, Vol. 10 No. 3, pp. 323-340.

Johnson, R.R., Stone, B.T., Miranda, C.M., Vila, B., James, L., James, S.M., Rubio, R.F. and Berka, C. (2014), "Identifying psychophysiological indices of expert vs. novice performance in deadly force judgment and decision making", *Frontiers in Human Neuroscience*, Vol. 8, p. 512.

McDuff, D., Hernandez, J., Gontarek , S. and Picard, R. (2016), "COGCAM: contact-free measurement of cognitive stress during computer tasks with a digital camera", *CHI '16 Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems Pages 4000-4004*, pp. 4000-4004, San Jose, California, doi: 10.1145/2858036.2858247.

Nieuwenhuys, A., Cañal-Bruland, R. and Oudejans, R.R. (2012), "Effects of threat on police officers' shooting behavior: anxiety, action specificity, and affective influences on perception", *Applied Cognitive Psychology*, Vol. 26 No. 4, pp. 608-615.

Renden, P.G., Landman, A., Geerts, S.F., Jansen, S.E., Faber, G.S., Savelsbergh, G.J. and Oudejans, R.R. (2014), "Effects of anxiety on the execution of police arrest and self-defense skills", *Anxiety, Stress and Coping*, Vol. 27 No. 1, pp. 100-112.

Violanti, J.M., Hartley, T.A., Gu, J.K., Fekedulegn, D., Andrew, M.E. and Burchfiel, C.M. (2013), "Life expectancy in police officers: a comparison with the US general population", *International Journal of Emergency Mental Health*, Vol. 15 No. 4, p. 217.

Further reading

Office of Community Oriented Policing Services (2015), *The President's Task Force on 21st Century Policing Implementation Guide: Moving from Recommendations to Action*, Office of Community Oriented Policing Services, Washington, DC.

Corresponding author

Lois James can be contacted at: lois_james@wsu.edu

For instructions on how to order reprints of this article, please visit our website:
www.emeraldgrouppublishing.com/licensing/reprints.htm
Or contact us for further details: **permissions@emeraldinsight.com**