Pulling the trigger: The effect of a five-minute slow diaphragmatic breathing intervention on psychophysiological stress responses and pressurized pistol shooting performance

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Abstract

This study examined the effect of slow diaphragmatic breathing on psychophysiological stress responses and pressurized performance. Sixty-seven participants (40 female; $M_{\text{age}} = 20.17 \pm 2.77$ years) were randomly assigned to either a diaphragmatic breathing, paced breathing, or control group. Participants completed a non-pressurized shooting task, then received instructions about a pressurized version. Next, the diaphragmatic group were told to breathe at six breaths per minute, the paced group at 12 breaths per minute, and the control group received no instructions. Following a five-minute intervention period, participants completed the pressurized task while performance was assessed. Psychophysiological stress responses (e.g., cognitive anxiety, heart rate) were recorded throughout. Results revealed that diaphragmatic breathing had mixed effects on stress responses, with some unaffected (e.g., heart rate) and others reduced (e.g., cognitive anxiety), and little effect on performance. Findings suggested that slow diaphragmatic breathing might not aid pressurized performance but could benefit psychological stress responses.

**Keywords:** heart rate variability, motor skill, psychological pressure, state anxiety.
Introduction

Whether an amateur or elite athlete, on the tennis court or on the football field, the ability to perform under pressure (e.g., serving at match point in tennis) is a key determinant of success (Hardy et al., 2017). Often, the greater the potential for success and recognition, and the more severe the consequences of failure, the higher the psychological pressure (Baumeister & Showers, 1986). In high-pressure environments such as sport, stress can cause some individuals to excel (e.g., clutch performance; Otten, 2009), but it can overwhelm others, reducing performance well below usual standards (i.e., choking under pressure; Mesagno & Beckmann, 2017). A maladaptive response to pressure can manifest both psychologically (e.g., loss of task-focus; Roberts et al., 2019) and physiologically (e.g., increased heart rate; Trotman et al., 2019). Given the potential negative responses, applied practitioners teach athletes strategies to help them manage pressure more effectively (e.g., mindfulness; Noetel et al., 2019; Rumbold et al., 2012). One strategy that has shown promise in promoting more adaptive psychophysiological stress responses and performance under pressure is breath control (Morgan & Mora, 2017; Pagaduan et al., 2020). Thus, this study evaluated the effects of a breathing intervention on stress responses and pressurized performance.

During highly pressurized situations, breathing rate can elevate to meet the perceived demands of the stressor, which can result in hyperventilation (i.e., breathing rate exceeding metabolic demands; Grossman & Wientjes, 2001). This in turn can cause maladaptive physiological (e.g., higher blood pressure) and psychological (e.g., reduced cognitive function) responses (Kaplan, 1997; Li et al., 2012; Nardi et al., 2009). In contrast, the intentional slowing of breathing rate (< 10 breaths per minute) has been shown to benefit physiological (e.g., lower blood pressure and cortisol) and psychological (e.g., reduce state anxiety and negative affect) stress responses (Joseph et al., 2005; Ma et al., 2017; Russo et al., 2017; Yu et al., 2011; Zaccaro et al., 2018).

Breathing techniques have long been used in many cultures, most notably through traditional practices such as pranayama (i.e., nasal and yogic breathing; Kuppusamy et al., 2018) and meditation (e.g., Buddhist mindful breathing; Gerritsen & Band, 2018). Breathing techniques involve an intentional alteration to breathing rhythm, which can come from changing breathing rate (e.g., following an on-screen pacer in heart rate variability-biofeedback [HRV-BFB]), or through forceful
inhalation and exhalation (e.g., fast-paced pranayama; Saoji et al., 2019). Breathing techniques have recently gained popularity due to the pursuit of positive well-being (Gilmartin et al., 2017; Shonin et al., 2014), and many techniques have been advanced by technology (e.g., HRV-BFB; Lehrer et al., 2000). While beneficial, these technological advancements come with barriers including cost, time, knowledge, and expertise (e.g., Chittaro & Sioni, 2014).

Despite being explored extensively in non-performance settings (e.g., yoga; Pascoe et al., 2017), the performance benefits of slow breathing techniques have only recently been investigated in various high-pressure domains including sport (e.g., Gross et al., 2017), the military (e.g., Lewis et al., 2015), and business (e.g., De Couck et al., 2019). Specifically, slow breathing has been shown to benefit cognitive performance in tasks requiring reaction time (Cheng et al., 2017), decision-making (Andersen et al., 2018), and attentional control (Ma et al., 2017), as well as behavioural performance in sporting tasks such as basketball (Paul & Garg, 2012), golf (Lagos et al., 2011), and dancing (Raymond et al., 2005). To date, more studies have assessed the effects of slow breathing on the performance of cognitive, compared to behavioural tasks, with these techniques shown to benefit cognitive performance more than behavioural performance (Conlon et al., under review).

Additionally, in their review, Conlon et al. (under review) found that slow breathing techniques improved psychological stress responses (e.g., state anxiety) to a greater extent than physiological stress responses (e.g., heart rate). While potentially efficacious in laboratory settings, some slow breathing techniques such as HRV-BFB may be impractical to use in performance situations where the individual has limited time to prepare (e.g., being selected to take a penalty kick in a final). Therefore, research needs to identify which slow breathing techniques are most effective and easy to use immediately before highly pressurized competition.

Diaphragmatic breathing could be one solution as it can be achieved with minimal instruction, does not require technology or feedback, and can be performed immediately before or during pressurized situations (Yang et al., 2020). Although the health benefits of slow diaphragmatic breathing have been identified (e.g., lower blood pressure; Hopper et al., 2019), to date, limited research has explored if slow diaphragmatic breathing aids the performance of pressurized sporting tasks (Conlon et al., under review). This is surprising given that some research has shown that slow
diaphragmatic breathing may benefit the performance of cognitive tasks (Ma et al., 2017). For example, De Couck et al. (2019) found that a two-minute diaphragmatic breathing intervention improved decision-making during a business simulation task. While improving cognitive processes in isolation is of interest, highly pressurized tasks generally require the collaboration of cognitive processes and motor skills (e.g., surgery; Modi et al., 2020), thus it is important to establish whether slow diaphragmatic breathing can aid motor performance as well as improve psychophysiological stress responses (e.g., state anxiety, heart rate variability; Hopper et al., 2019). When looking to explain the beneficial effects of slow breathing techniques such as diaphragmatic breathing, their ability to enhance vagus nerve (i.e., primary branch of the parasympathetic nervous system) activity appears key (Gerritsen & Band, 2018; Shaffer & Ginsberg, 2017). As such, one theoretical framework that might help explain how slow breathing aids stress responses and pressurized performance is the neurovisceral integration model (Thayer & Lane, 2009).

The neurovisceral integration model (Thayer & Lane, 2009) proposes a dynamic relationship between cardiac activity (e.g., heart rate variability [HRV; the difference in interbeat intervals]), emotional regulation (e.g., emotional control), and executive function (e.g., attentional control), as mediated by the vagus nerve (indexed by vagal tone; Zahn et al., 2016). Prefrontal cortical structures involved in executive function and cardiac modulation share a neural circuitry with the heart via vagal efferent nerves (Thayer et al., 2012). An increase in vagus nerve modulation of cardiac activity, leads to enhanced activity in those prefrontal cortical areas shared by executive processes (e.g., working memory, inhibition), and as a result, can lead to improved executive functioning (Smith et al., 2017). Furthermore, an increase in vagal tone can modulate certain maladaptive amygdala responses (e.g., avoidant behaviour related to safety; Gillespie et al., 2018). Given that higher levels of vagal tone are associated with more adaptive responses during stressful competition (Alacreu-Crespo et al., 2018), increasing vagal tone could aid processes such as decision-making and attention control, thereby benefitting pressurized performance (Forte & Casagrande, 2019; Meier et al., 2020). Indeed, Mosley et al. (2018) reported that smaller reductions in vagal tone reactivity benefitted pressurized shooting performance. Notably, slow-paced breathing has demonstrated an ability to increase vagal tone (e.g.,
You et al., 2021), evidencing its potential in facilitating more adaptive psychophysiological stress responses, and thereby benefitting performance under pressure.

To extend previous research, this study examined the effects of a five-minute slow diaphragmatic breathing intervention on psychophysiological responses to stress (e.g., state anxiety, HRV) and performance (i.e., accuracy) during a pressurized shooting task. It was hypothesized that participants who received the slow diaphragmatic breathing intervention would display more adaptive psychophysiological stress responses (e.g., less state anxiety, lower HR) and better task performance (i.e., greater shooting accuracy) than participants in a comparative control (i.e., paced breathing) or control group. The findings of this study furthered our understanding of slow diaphragmatic breathing and tested whether it is a technique that applied practitioners (e.g., sports psychologists) could use with their athletes to help them perform better under pressure.

Method

Study design

To examine if the slow diaphragmatic breathing intervention influenced pressurized shooting performance, a 3 (Group: experimental, comparative control, control group) × 2 (Test: baseline test, pressure test) mixed-model design was used. Moreover, to investigate if the breathing intervention affected psychological stress responses, a 3 (Group: experimental, comparative control, control) × 3 (Time: pre-pressure instructions, post-pressure instructions, post-intervention) mixed-model design was employed. Finally, to examine if the breathing intervention influenced physiological stress responses, a 3 (Group: experimental, comparative control, control) × 5 (Time: baseline, pre-pressure instructions, post-pressure instructions, intervention, post-intervention) mixed-model design was used.

During recruitment, participants were stratified by gender into groups of three, then randomly allocated (https://www.random.org/) to one of three groups: (1) slow diaphragmatic breathing (experimental; n = 23), (2) paced breathing (comparative control; n = 23), or (3) control (no intervention control; n = 21), to ensure an even number of males and females per group.

Participants

A power calculation using G*Power software (Faul et al., 2007) with a repeated-measures ANOVA design revealed that, based on a medium effect size ($f = 0.25$; Cohen, 1992) inspired by
previous research (e.g., Laborde et al., 2019), a minimum of 54 participants (18 per group) were required to achieve a power of 0.95, given an alpha of 0.05. To be eligible, participants had to: (1) be over 18 years of age, (2) have received no formal shooting or breathing training, (3) be free from respiratory or cardiovascular disease, (4) be a non-smoker, and (5) have normal or corrected vision. In total, 67 students (40 females, 27 males; $M_{age} = 20.17$ years, $SD = 2.77$) took part. Participants were from a range of sports (e.g., rugby, rowing, dance), had taken part for an average of 6.36 years ($SD = 4.44$), and trained or competed for an average of 7.94 hours ($SD = 5.42$) per week. In terms of competitive level, 20% of participants competed at a national level, and 13% performed at an international level. The remaining participants competed at lower levels (e.g., University).

**Task Setup**

During the pressurized shooting task, participants used a single shot laser training pistol (Pentashot GLS 17 Laser Simulator, dimensions: 355 mm x 150 mm x 50 mm, weight: 830 g), and shot eight times at a fixed target. The target was located at the competition height of 1400 mm from the ground (Union Internationale de Pentathlon Moderne, 2017). The target area was 140 mm in diameter and consisted of 10 concentric circles. The innermost circle (target centre) was 14 mm in diameter, while the remaining nine circles each were 7 mm in diameter. Pilot testing took place with six participants (three male, three female; $M_{age} = 24.66$), which identified a distance of 4 m from the target as sufficient to provide an appropriate level of task difficulty for novice shooters. A 1 m tape was positioned on the floor of the laboratory, 4 m from the target, and participants were required to stand behind this tape while shooting (Figure 1). Brief technical instructions were given to participants regarding the correct shooting technique (e.g., “front and rear aiming sights must be aligned with the centre of the target for accurate shooting”). All participants were familiarised with the shooting task until they had hit the target eight times. A shooting task was deemed appropriate because it could be performed in a laboratory setting with relative ease, thus affording a high degree of internal control. Further, task conditions could be readily manipulated to increase pressure (e.g., limited number of shots, enforced time limit, performance visible, etc.). Finally, shooting tasks have been used in previous research to assess the psychophysiological markers employed in this study (e.g., heart rate variability), as well as performance under pressure (e.g., Mosley et al., 2018).
Measures

Task performance

During the baseline and pressure tests, task performance was measured in terms of shooting accuracy. Participants had 50 s in which to take eight shots. Each shot was awarded a score based on where it landed on the target, with a score of one awarded if the shot hit the outermost circle, and a score of ten given if the shot hit the innermost circle (i.e., target centre). A score of zero was given to each shot that missed the target (this occurred in 28% of shots). Thus, for each test, participants could score between zero and 80 points. The accuracy of each shot was determined by analysing video footage recorded on a Crosstour 1080P camera (Crosstour; Shenzhen Long Tou Optics), with the researcher unaware of each participants’ group allocation at the time of analysis.

Psychological stress responses

Psychological data was measured in response to the non-pressurized and pressurized task instructions (both before and after the breathing interventions or control task).

State anxiety. State anxiety was assessed via the immediate anxiety measurement scale (Thomas et al., 2002). This scale provided definitions of cognitive anxiety and somatic anxiety before assessing these constructs in terms of both intensity (e.g., to what extent are you experiencing cognitive anxiety right now?), and direction (e.g., what effect do you think this cognitive anxiety will have on your upcoming performance?). Responses were recorded on a 7-point Likert scale ranging from 1 (not at all) to 7 (extremely) for the two items assessing intensity, and -3 (very negative) to +3 (very positive) for the two items assessing direction. This scale has demonstrated good validity (Thomas et al., 2002), and has been used in previous research (e.g., Gray et al., 2013).

Stress appraisal. Stress appraisals were assessed using two items from the cognitive appraisal ratio (Tomaka et al 1993). The first item assessed perceived demands (i.e., how demanding do you expect the upcoming task to be?), while the second item assessed perceived resources (i.e., how able are you to cope with the demands of the upcoming task?). Responses to both items were recorded using a 6-point Likert scale ranging from 1 (not at all) to 6 (extremely). Perceived demands were then subtracted from resources to calculate a demand resource evaluation score (DRES) ranging from -5 to
+5 (Moore et al., 2013). Zero or a positive score reflected a challenge appraisal (coping resources matched or exceeded task demands), and a negative score reflected a threat appraisal (task demands exceeded coping resources). The measure has been used widely in the literature (Hase et al., 2019).

Perceived stress. Perceived stress was assessed using a single item (i.e., how stressed do you feel right now?), with responses recorded on a 7-point Likert scale ranging from 1 (not at all) to 7 (extremely). This item was intended to assess the effect of the pressure manipulation instructions, and has been used in previous research (e.g., Brown et al., 2017). Despite some concerns in the literature regarding their psychometric properties (e.g., Loo, 2002), single-item measures have been employed successfully in previous research (e.g., Eddy et al., 2019). Further, the single-item measure of perceived stress (as well as state anxiety and stress appraisals) was used for brevity, to minimise the time between our pressure manipulation instructions and task performance. Thus, helping to ensure the effects of the pressure manipulation instructions did not dissipate and the task remained pressurized.

Physiological stress responses and respiration frequency

Physiological data was recorded in response to the non-pressurized and pressurized task instructions (both before and after the breathing interventions or control task). Specifically, indices of HRV were used to measure vagal tone (Laborde et al., 2017) and were recorded using a Bittium 180° Faros electrocardiogram (ECG) recorder (Bittium Inc., Oulu, Finland). The ECG recorder was attached using three pre-gelled electrodes (Ambu BlueSensor L, Ballerup, Denmark), with two electrodes positioned on the left and right clavicles, and one electrode positioned on the left side of the chest, below the twelfth rib (Mosley et al., 2019). As some debate remains over which HRV metrics most accurately reflect vagal tone (Laborde et al., 2017), both time-domain (i.e., root mean square of the successive differences [RMSSD] and percentage of adjacent NN intervals that differ from each other by more than 50 ms [pNN50]), and frequency-domain (i.e., high frequency [HF] power) measures were obtained following processing using Kubios software (Tarvainen et al., 2014). The HRV data was processed via the low threshold artifact correction function in the Kubios software and visual inspection of any corrected artifacts (Laborde et al., 2017; Mosley et al., 2018).

Additionally, the ECG recorder was used to measure heart rate (HR) and the number of breaths per
minute via ECG-derived respiration (Tarvainen et al., 2014). Respiratory frequency was calculated by multiplying ECG-derived respiration values by 60 (e.g., 0.1 Hz*60 = six breaths per minute), and only examined during the five-minute intervention period as a manipulation check.

**Confounding factors**

Mental health, sleep quality, and trait anxiety were assessed as control variables given that they have been shown to influence HRV (Laborde et al., 2017). Mental health was assessed using the Depression Anxiety Stress Scales (Antony et al., 1998), which consisted of 21 items (e.g., I found it hard to wind down) assessing the symptoms of depression, anxiety, and stress experienced over the past week. All items were assessed on a 4-point Likert ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). The items for each subscale were summed, with higher scores indicating more severe symptoms of depression, anxiety, and stress. Sleep quality was assessed via the Groningen Sleep Quality Scale (Van der Meulen et al., 1980), which consisted of 15 items (e.g., I feel that I slept poorly last night). Responses were awarded either one point or zero depending on if the statement was true or false, respectively. Responses to all items were then summed, with a higher score reflecting poorer sleep quality. Finally, trait anxiety was assessed via the Sports Anxiety Scale-2 (Smith et al., 2006), which consisted of 15 items (e.g., I worry I will not play my best) relating to somatic anxiety, worry, and concentration disruption. All items were rated on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much). Scores for all items were summed, with a higher score indicating greater trait anxiety.

**Procedure**

The study protocol is outlined in Figure 2. Before attending the laboratory, participants were asked to avoid high intensity exercise and alcohol for 24 hours, and to abstain from food and caffeine for two hours (Laborde et al., 2017). Upon arrival at the laboratory, participants provided written informed consent and completed a questionnaire that assessed demographic information (e.g., age, gender), mental health, sleep quality, and trait anxiety. Next, participants were given technical instructions about how to shoot the laser pistol, and then familiarised themselves with the shooting task. Participants were then fitted with the ECG recorder before resting for five minutes while baseline physiological data was recorded. Next, participants were given non-pressurized instructions
about the shooting task, after which, HRV data was recorded for one minute. Next, stress appraisals and state anxiety were assessed. Participants then performed a non-pressurized trial of the shooting task (baseline test) while performance was recorded.

After completing the baseline test, participants were informed about a second pressurized trial of the shooting task. To elevate pressure, verbal instructions were given to participants that were adapted from previous research (e.g., Moore et al., 2015). Specifically, participants were informed that: (1) their task performance would be recorded on digital video camera and assessed by an elite pentathlon coach, (2) prizes would be available for the top five performers, (3) the worst five performers would be interviewed about their poor performance, and (4) their performance in the baseline test positioned them in the bottom 30% of those who had already taken part, and that they needed to improve for their data to be used in the study (non-contingent feedback). Following receipt of these instructions, HRV data was recorded for one minute, and then stress appraisals and state anxiety were assessed.

Next, participants received their breathing intervention or completed the control task for ~10 minutes depending on their group allocation. Following the breathing intervention or control task, the pressure instructions were repeated, and HRV data was recorded for one minute. Stress appraisals and state anxiety were then assessed. Subsequently, participants completed the pressurized trial of the shooting task (pressure test) while performance was recorded. Finally, participants were debriefed and thanked for their participation.

Breathing interventions and control task

**Slow diaphragmatic breathing intervention**

For five minutes before the intervention, the experimental group received slow diaphragmatic breathing training from the lead investigator which instructed them to practice drawing breath from their stomach, while inhaling through their nose and exhaling through pursed lips (Trevisan et al., 2015; Vostatek, et al., 2013). Specifically, participants were trained and practiced inhaling for four seconds, and exhaling for six seconds (Lehrer et al., 2000). Next, the five minute intervention period began, with participants told to breathe diaphragmatically in time with an on-screen pacer that helped
them inhale for four seconds and exhale for six seconds. Previous research has shown the benefit of breathing at six breaths per minute (Lehrer et al., 2000). Furthermore, given that the intervention was brief and delivered over a single-session, a 4:6 inhale to exhale ratio was selected to amplify potential therapeutic effects (Gerritsen & Band, 2018; Shaffer, & Venner, 2013; Strauss-Blasche et al., 2000). Finally, the intervention was delivered for five minutes to replicate the short timeframe an athlete may have to execute a breathing technique before a pressurized competition (e.g., in the changing rooms before an important tennis match).

**Paced breathing intervention**

A comparative control group was used to control for biases such as Hawthorne and placebo effects (Adair, 1984). For the five minutes before the intervention, participants assigned to the paced breathing group were given five minutes of training and practice by the lead investigator that instructed them to inhale through their nose and exhale through pursed lips at a rate of 12 breaths per minute. Specifically, participants were told to inhale for two and a half seconds, and exhale for two and a half seconds. Next, like the experimental group, the five minute intervention period began, with participants told to breathe in time with an on-screen pacer that helped them to inhale for two and a half seconds and exhale for two and a half seconds. Not only were 12 breaths per minute twice as quick as the slow diaphragmatic breathing intervention, providing a clear distinction between the interventions, it still fell within the typical range for spontaneous breathing (i.e., 10 to 20 breaths per minute; Russo et al., 2017).

**Control task**

Akin to previous research (e.g., DeCouck et al., 2019; Laborde et al., 2019), the control group watched an educational video on the anatomy of the respiratory system for 10 minutes to match the amount of time the intervention groups spent learning and executing the breathing techniques. To encourage engagement, participants were asked questions once the video had finished (e.g., What new fact did you learn having watched this video?).

**Pilot testing**

Pilot testing was conducted trialling both respiration rates (i.e., six breaths or twelve breaths per minute), and breathing instructions (i.e., inhale through the nose, exhale through the mouth,
breathing through the diaphragm). Participants in each condition (i.e., experimental and comparative) noted that the breathing instructions were straightforward, and the respiration rates were achievable.

**Statistical analysis**

Between-group differences in demographic (e.g., age, experience), confounding (i.e., mental health, sleep quality, and trait anxiety), and manipulation check (i.e., respiration frequency during the intervention period) variables were analysed via a series of one-way ANOVAs with follow-up independent *t*-tests. The results revealed no significant differences between the groups for any variables, and so these variables were not included as covariates in the final analyses. Skewness and kurtosis scores revealed that the respiration frequency data was not normally distributed (i.e., *z*-scores > 1.96), thus between-group differences were assessed via a Kruskall-Wallis test with follow-up Mann-Whitney *U* tests.

The task performance data (i.e., shooting accuracy) was normally distributed and thus analysed via a 3 (Group: experimental, comparative control, control) x 2 (Test: baseline test, pressure test) mixed-model ANOVA with follow-up independent and dependent *t*-tests.

The psychological stress response data (i.e., state anxiety, stress appraisals, and perceived stress) was analysed via a series of 3 (Group: experimental, comparative control, control) x 3 (Time: pre-pressure instructions, post-pressure instructions, post-intervention) mixed model ANOVAs with follow-up independent and dependent *t*-tests. The state anxiety data was normally distributed, while the stress appraisal and perceived stress data were non-normally distributed (i.e., skewness and kurtosis *z*-scores > 1.96). However, following the winsorization of outliers to 1% larger or smaller than the next most extreme value (i.e., two values for stress appraisal and four values for perceived stress), the stress appraisal and perceived stress data were normally distributed.

The physiological stress response data (i.e., HR, RMSSD, pNN50, and HF) was analysed using a series of 3 (Group: experimental, comparative control, control) x 5 (Time: baseline, pre-pressure instructions, post-pressure instructions, intervention, post-intervention) mixed model ANOVAs with follow-up independent and dependent *t*-tests. Due to incomplete ECG recordings, three participants’ physiological data could not be analysed (experimental group = one; comparative control group = two). The HR and pNN50 data were normally distributed, while the RMSSD and HF
data were non-normally distributed and were thus normalised via log10 transformations (Laborde et al., 2017). For all analyses, an alpha of .05 was used, and partial eta-squared effect sizes are reported.

Results

Demographic and confounding variables

There were no significant between-group differences for age, $F(2, 64) = 0.10, p = .904, \eta^2 = .01$, hours of training per week, $F(2, 64) = 0.64, p = .529, \eta^2 = .02$, years of experience, $F(2, 64) = 0.10, p = .904, \eta^2 = .01$, symptoms of depression, $F(2, 64) = 2.17, p = .123, \eta^2 = .56$, anxiety, $F(2, 64) = 0.67, p = .513, \eta^2 = .02$, or stress, $F(2, 64) = 0.31, p = .738, \eta^2 = .01$, sleep quality, $F(2, 64) = 1.94, p = .153, \eta^2 = .06$, or trait anxiety $F(2,64) = 0.23, p = .794, \eta^2 = .01$ (see Table 1).

Respiration frequency

There was a significant difference between the groups in respiration frequency during the intervention period, $X^2(2, 64) = 52.32, p < .001$. Follow-up tests indicated that the experimental group exhibited a lower respiration frequency than the comparative control, $U = 616.00, z = -3.85, p < .001, r = .59$, and control, $U = 667.50, z = -5.00, p < .001, r = .76$, groups. Furthermore, the comparative control group displayed a lower respiration frequency than the control group, $U = 643.00, z = -4.99, p = .000, r = .77$ (see Table 2).

Task performance

There was no significant main effect for Group, $F(2, 64) = 0.78, p = .461, \eta^2 = .02$, no significant main effect for Time, $F(2, 64) = 2.25, p = .139, \eta^2 = .03$, and no significant interaction effect, $F(2, 64) = 0.27, p = .766, \eta^2 = .01$ (see Table 2).

Psychological stress responses

Cognitive anxiety

In terms of cognitive anxiety intensity, there was no significant main effect for Group, $F(2, 64) = 0.29, p = .749, \eta^2 = .01$. However, there was a significant main effect for Time, $F(2, 128) = 15.35, p = .000, \eta^2 = .33$, and a significant interaction effect, $F(4, 128) = 2.65, p = .036, \eta^2 = .08$. Between-group comparisons revealed that the control group experienced more cognitive anxiety than
the comparative control group pre-pressure instructions ($p = .021$). No other between-group differences were revealed at the other timepoints (all $p > .05$).

Follow-up within-group tests revealed that the experimental group reported more cognitive anxiety post-pressure instructions than pre-pressure instructions ($p = .001$), and less cognitive anxiety post-intervention than pre-pressure instructions ($p < .001$). The comparative control group reported more cognitive anxiety post-pressure instructions than pre-pressure instructions ($p < .001$), more anxiety pre-pressure instructions than post-intervention ($p = .036$), and less anxiety post-intervention than post-pressure instructions ($p = .018$). The cognitive anxiety reported by the control group did not change (all $p > .05$).

With regards to cognitive anxiety direction, there was no significant main effect for Group $F(2,64) = 0.60, p = .548, \eta^2 = .02$, and no significant interaction effect $F(4,128) = 1.48, p = .210, \eta^2 = .05$. However, there was a significant main effect for Time $F(2, 128) = 7.43, p = .001, \eta^2 = .19$. Follow-up tests revealed that on average, all groups reported viewing cognitive anxiety as more debilitative for performance post-pressure instructions than pre-pressure instructions ($p = .020$), and more facilitative for performance post-intervention than post-pressure instructions ($p < .001$). There was no difference in cognitive anxiety direction between pre-pressure instructions and post-intervention ($p = .481$) (see Table 3).

**Somatic anxiety**

In terms of somatic anxiety intensity, there was no significant main effect for Group, $F(2, 64) = 1.55, p = .220, \eta^2 = .05$, no significant main effect for Time, $F(2,128) = 3.18, p = .059, \eta^2 = .09$, and no significant interaction effect, $F(4, 128) = 0.79, p = .536, \eta^2 = .02$.

With regards to somatic anxiety direction, there was no significant main effect for Group, $F(2,64) = 1.09, p = .344, \eta^2 = .04$, no significant main effect for Time, $F(2,128) = 2.91, p = .062, \eta^2 = .08$, and no significant interaction effect, $F(4,128) = 0.94, p = .443, \eta^2 = .03$ (see Table 3).

**Stress appraisals**

There was no significant main effect for Group, $F(2, 64) = 2.10, p = .131, \eta^2 = .06$, and no significant interaction effect, $F(4, 128) = 0.52, p = .721, \eta^2 = .02$. However, there was a significant main effect for Time, $F(2, 128) = 18.23, p < .001, \eta^2 = .27$. Follow-up tests revealed that on average,
across all groups, participants reported more of a threat appraisal post-pressure instructions than pre-pressure instructions \((p < .001)\), and more of a threat appraisal post-intervention than post-pressure instructions \((p < .001)\). However, stress appraisals did not differ between post-intervention and post-pressure instructions \((p = .648)\) (see Table 3).

**Perceived stress**

There was no significant main effect for Group, \(F(2, 64) = 0.56, p = .572, \eta^2 = .02\). However, there was a significant main effect for Time, \(F(2, 128) = 27.20, p < .001, \eta^2 = .30\), and a significant interaction effect, \(F(4, 128) = 4.55, p = .002, \eta^2 = .12\). Follow-up between-group comparisons indicated no differences in the perceived stress reported by the group’s pre-pressure instructions or post-intervention \((ps > .05)\). Furthermore, there were no differences in the perceived stress reported by the experimental and comparative control groups \((p = .822)\), or the comparative control and control groups \((p = .055)\), post-pressure instructions. However, the control group reported less perceived stress than the experimental group post-pressure instructions \((p = .016)\).

Follow-up within-group comparisons revealed that the experimental group reported higher perceived stress post-pressure instructions than pre-pressure instructions \((p < .001)\) and post-intervention \((p < .001)\). However, the perceived stress reported by the experimental group did not differ between pre-pressure instructions and post-intervention \((p = .788)\). Furthermore, the comparative control group reported higher perceived stress post-pressure instructions than pre-pressure instructions \((p < .001)\) and post-intervention \((p = .016)\). The comparative control group also reported lower perceived stress pre-pressure instructions than post-intervention \((p = .029)\). Finally, the perceived stress reported by the control group did not change between the different timepoints \((all \ p > .05)\) (see Table 3).

<<< Table 3 near here >>>

**Physiological stress responses**

**HR**

There was no significant main effect for Group, \(F(2, 61) = 0.31, p = .738, \eta^2 = .01\), and no significant interaction effect, \(F(8, 244) = 0.75, p = .652, \eta^2 = .02\). However, there was a significant main effect for Time, \(F(4, 244) = 4.41, p = .002, \eta^2 = .07\). Follow-up tests revealed that on average,
across all groups, participants displayed higher HR at intervention ($p = .002$) and post-intervention ($p < .001$), than at post-pressure instructions. No other differences emerged between the other timepoints (all $p > .05$) (see Table 4).

**RMSSD**

There was no significant main effect for Group, $F(2, 61) = 0.59, p = .096, \eta^2 = .05$, no significant main effect for Time, $F(4, 244) = 1.56, p = .184, \eta^2 = .03$, and no significant interaction effect, $F(8, 244) = 1.71, p = .556, \eta^2 = .05$ (see Table 4).

**pNN50**

There was no significant main effect for Group, $F(2, 61) = 0.33, p = .722, \eta^2 = .01$, no significant main effect for Time, $F(4, 244) = 2.22, p = .067, \eta^2 = .04$, and no significant interaction effect, $F(8, 244) = 0.75, p = .651, \eta^2 = .02$ (see Table 4).

**HF-HRV**

There was no significant main effect for Group, $F(2, 61) = 0.73, p = .485, \eta^2 = .02$, no significant main effect for Time, $F(4, 244) = 0.50, p = .733, \eta^2 = .01$, and no significant interaction effect, $F(8, 244) = 1.30, p = .245, \eta^2 = .04$ (see Table 4).

<<< Table 4 near here >>>

**Discussion**

A key requirement for successful athletes is the ability to perform under pressure, consequently, practitioners commonly teach athletes psychological techniques to help them to manage pressure and perform optimally (e.g., self-talk; Gröpel & Mesagno, 2019). One potentially valuable, but understudied technique relative to other strategies (e.g., imagery), is slow-paced breathing. Thus, the purpose of this study was to examine the effect of a five-minute slow diaphragmatic breathing intervention on psychophysiological responses to stress and performance during a pressurized pistol shooting task. The respiration frequency data largely supported the effectiveness of the diaphragmatic breathing intervention, with the experimental group displaying a lower respiration frequency during the intervention period than both the comparative control (i.e., paced breathing) and control (i.e., no breathing instruction) groups. Indeed, the respiration frequency of the experimental group dropped below 10 breaths per minute (~8 breaths per minute), which is consistent with previous research on
slow breathing (Zaccaro et al., 2018). However, while the respiration frequency of the comparative control and control groups suggested that they adhered to their breathing instructions (i.e., ~12 and 17 breaths per minute, respectively), overall, the experimental group failed to lower their respiration frequency to six breaths per minute as instructed. This may have been due to a lack of sufficient practice with the breathing technique prior to the intervention period, or because some participants had difficulties complying with the breathing technique during the five-minute intervention period. Indeed, recent research has shown that it may be useful for participants to practice at different frequencies to demonstrate paced-breathing competence prior to an intervention (e.g., 14 vs. six breaths per minute; Gholamrezaei et al., 2021).

Despite between-group differences in respiration frequency, the slow diaphragmatic breathing intervention had little effect on performance during the pressurized pistol shooting task. Specifically, the experimental group displayed similar accuracy to the comparative control and control groups during the pressure test. This unexpected result, which is inconsistent with the results of previous research (e.g., Morgan & Ma, 2017), suggested that the benefits of slow diaphragmatic breathing on the performance of cognitive tasks reported previously may not transfer to specific sporting skills (e.g., De Couck et al., 2019; Ma et al., 2017). The skill of shooting was selected in the present study as it could be conducted in a laboratory environment with relative ease, thus affording a high degree of internal control, and because it has been used in previous research to assess psychophysiological responses to (e.g., heart rate variability), and performance under, pressure (e.g., Mosley et al., 2018). However, the task was novel to participants, and this could have contributed to the large variance in accuracy displayed during the baseline and pressure tests. Indeed, despite including some brief technical training, and setting an initial goal during familiarisation (i.e., hitting the target eight times), this variability might have contributed to the null effects. Another possible explanation for the null effects could be the timing and duration of the slow diaphragmatic breathing intervention, with previous research finding that breathing techniques benefitted sports performance when used during task execution (e.g., archery; Mohamed et al., 2014), and taught over multiple sessions (e.g., shooting; Solanky, 2010). Thus, the fact that the slow diaphragmatic breathing intervention in the present study was delivered prior to the task, and over a single session, might explain the null effects.
This study also examined whether slow diaphragmatic breathing affected psychological responses to stress. Overall, the results suggested that the pressure manipulation instructions were successful, with all groups reporting greater cognitive anxiety and perceived stress, more debilitative interpretations of cognitive anxiety, and more maladaptive stress appraisals (i.e., threat appraisals), following these instructions. However, as predicted, both the experimental and comparative control groups reported less cognitive anxiety and perceived stress, and more facilitative interpretations of cognitive anxiety, after the intervention period. These results are consistent with previous research (e.g., Hopper et al., 2019), and imply that both the slow diaphragmatic and paced breathing interventions benefitted psychological stress responses. It is possible that by focusing on breathing, participants from both groups might have been distracted from worrisome task-related thoughts, resulting in them reporting lower cognitive anxiety, more facilitative interpretations of cognitive anxiety, and less perceived stress (Goldin & Gross, 2010). However, the control group also experienced reduced cognitive anxiety following the intervention period. While surprising, previous research using similar control tasks (e.g., TV documentary; Laborde et al., 2019) have observed similar stress-reducing effects, which may be because the videos evoke a sense of relaxation (Conway & Rubin, 1991). Unexpectedly, all groups reported more of a threat appraisal (i.e., task demands outweigh coping resources) following the intervention period. This result might be explained by the non-contingent feedback element of the pressure manipulation instructions, which could have reduced self-efficacy and thus triggered threat appraisals among participants (Jones et al., 2009). While focusing on controlling breathing could have enhanced perceptions of control, this might not have been sufficient to promote challenge appraisals (Jones et al., 2009).

Beyond psychological stress responses, this study also examined whether slow diaphragmatic breathing benefitted physiological responses to stress. Overall, all groups displayed no differences in HR or measures of HRV (i.e., RMSSD, pNN50, and HF-HRV) following the pressure manipulation instructions, suggesting that these instructions were not successful at eliciting a physiological stress-response (e.g., elevations in HR). In addition, despite the experimental and comparative control groups both lowering respiration frequency during the intervention period, HR was higher for all groups during the intervention period and at post-intervention than at the other timepoints. Although
these findings were in contrast to the results of previous research (e.g., Zaccaro et al., 2018), a systematic review by Conlon et al (under review), found that slow breathing techniques had a less consistent effect on physiological markers of stress than psychological indices. Furthermore, similar task-based studies have also found limited effects on HR following slow breathing (e.g., Anderson et al. 2018; Hornsby et al. 2021). No effects were observed for HRV at any timepoint, suggesting that the slow diaphragmatic breathing intervention did not increase vagal tone more than paced breathing (or the control task). This result is incongruent with previous research (e.g., You et al., 2021), and might be explained by the experimental group’s respiration frequency sitting above the intended rate (i.e., ~ eight breaths per minute), or the relatively short breathing interventions, which may have been insufficient to elicit increases in vagal tone (McCraty et al., 2009; Schwerdtfeger et al., 2020).

Further, as increases in vagal tone are associated with improved executive function (e.g., attentional control; Thayer & Lane, 2009), this might also explain why no effects were observed on performance. Consequently, considering no differences were observed in either vagal tone measures (e.g., RMSSD) or the performance of the pressurized shooting task (i.e., accuracy), this study did not provide evidence to support the neurovisceral integration model (Thayer & Lane, 2009). Thus, future research is required to further test the predictions of this model in relation to the effects of slow breathing interventions in individuals operating in highly pressurized contexts (e.g., sport, medicine, military).

**Strengths, limitations, and future research directions**

Although this study failed to offer conclusive evidence regarding the benefits of slow diaphragmatic breathing, particularly for pressurized performance, some strengths should be noted. First, this study was conducted in a laboratory setting with a high degree of internal control, which enabled a relatively robust and comprehensive test of the effects of the five-minute slow diaphragmatic breathing intervention on performance under pressure as well as a vast array of psychophysiological markers (e.g., state anxiety, stress appraisals, HR, HRV). Second, unlike previous research (e.g., Hunt et al., 2018), this study included a comparative control group (i.e., paced breathing), which enabled potential biases to be controlled that might have led to erroneous conclusions regarding the benefits of the slow diaphragmatic breathing intervention (e.g., Hawthorne and placebo effects; Adair, 1984). Finally, this study addressed some of the methodological concerns
levelled at previous research (Conlon et al, under review), including a clear description of how participants were randomly assigned to groups and the researcher being blind to group allocation when assessing performance.

Despite the aforementioned strengths, this study is not without its limitations. First, the relatively limited amount of time spent practicing the breathing techniques could be considered a limitation. Indeed, while the duration of single-session breathing interventions has varied from two to 30 minutes in previous research (e.g., De Couck et al., 2019; Yadav & Mutha, 2016), it is possible that the five minute intervention period used in this study was insufficient to benefit task performance and psychophysiological stress responses. Thus, future research is encouraged to assess longer periods of practicing breathing techniques (e.g., 10 minutes; Prinsloo et al., 2013). Second, the inhale to exhale ratio of four to six could be viewed as a limitation. While the optimal inhale to exhale ratio to elicit maximal vagal tone is currently debated, with a range of ratios used in prior research (e.g., 5 to 7 in DeCouck et al. [2019]; 4.5 to 5.5 in You et al. [2021]), the four to six ratio used in this study might have been inadequate to increase vagal tone. Thus, future research should explore whether different inhale to exhale ratios moderate the effects of slow breathing interventions on outcomes (e.g., performance; Röttger et al., 2021).

Third, this study failed to provide evidence that slow diaphragmatic breathing is beneficial for pressurized performance. For athletes, performing under pressure typically involves the optimal execution of a previously demonstrated skill (e.g., taking a penalty in soccer), rather than the performance of a novel task (Moran et al., 2019). As such, the fact that participants were inexperienced with the shooting task could be seen as a potential limitation. Thus, future research is encouraged to evaluate the effects of a slow diaphragmatic breathing intervention with a sample of athletes on a task with which they have experience (e.g., golfers performing a golf putting task). Indeed, with task experience relatively consistent, any benefits of the breathing technique on pressurized performance might be more likely to emerge (e.g., Lagos et al., 2011). Finally, although a paced breathing comparative control group was included to control for biases such as placebo and Hawthorne effects, future research evaluating slow diaphragmatic breathing may wish to include a distraction-based control group instead. Indeed, evidence for the physiological benefits following
slow breathing is limited (see Conlon et al., under review), therefore, any potential benefits of slow diaphragmatic breathing may be down to more psychological mechanisms such as the controlling of attention (e.g., directing attention away from stressors). In addition, the inclusion of a distraction-based control group (e.g., asked to perform a mental arithmetic or problem-solving task) could better elucidate the mechanisms underpinning the effects of slow diaphragmatic breathing.

**Conclusion**

This study aimed to examine whether a five-minute slow diaphragmatic breathing intervention benefitted psychophysiological stress responses and pistol shooting performance under pressure. The results suggested that the diaphragmatic breathing intervention benefitted some psychological stress responses (i.e., cognitive anxiety intensity and direction, perceived stress), but not to a greater extent than the paced-breathing intervention or control task (i.e., watching an educational video about the respiratory system). Furthermore, the diaphragmatic breathing intervention had little effect on other psychophysiological stress responses (i.e., somatic anxiety, stress appraisals, HR, HRV), and did not benefit pistol shooting performance under pressure. These mixed results could be attributed to the relatively short amount of time spent practicing the diaphragmatic breathing technique. Thus, future research is encouraged to examine whether slow diaphragmatic breathing is more effective when continually practiced over a sustained period (e.g., 10 minutes daily for six weeks).
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Table 1. Mean (SD) demographic and confounding factor data for the entire sample and experimental, comparative control, and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>N (Female)</th>
<th>Age</th>
<th>Hours training per week</th>
<th>Years of experience</th>
<th>Depression (0 to 21) $a = .80$</th>
<th>Anxiety (0 to 21) $a = .74$</th>
<th>Stress (0 to 21) $a = .81$</th>
<th>Sleep quality (0 to 14) $a = .81$</th>
<th>Trait anxiety (15 to 60) $a = .88$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire sample</td>
<td>67 (40)</td>
<td>20.17 (2.77)</td>
<td>7.94 (5.42)</td>
<td>6.36 (4.44)</td>
<td>1.94 (2.19)</td>
<td>2.36 (2.24)</td>
<td>4.71 (3.14)</td>
<td>2.59 (2.33)</td>
<td>28.42 (6.85)</td>
</tr>
<tr>
<td>Experimental</td>
<td>23 (14)</td>
<td>20.39 (3.19)</td>
<td>8.04 (5.72)</td>
<td>6.13 (4.63)</td>
<td>2.13 (2.48)</td>
<td>2.27 (2.19)</td>
<td>4.52 (2.31)</td>
<td>1.87 (1.49)</td>
<td>28.35 (5.79)</td>
</tr>
<tr>
<td>Comparative control</td>
<td>23 (14)</td>
<td>20.04 (3.01)</td>
<td>7.00 (4.16)</td>
<td>6.69 (4.18)</td>
<td>1.22 (1.48)</td>
<td>2.05 (1.95)</td>
<td>4.49 (2.31)</td>
<td>3.18 (2.85)</td>
<td>29.13 (8.31)</td>
</tr>
<tr>
<td>Control</td>
<td>21 (12)</td>
<td>20.09 (1.95)</td>
<td>8.86 (6.33)</td>
<td>6.24 (4.72)</td>
<td>2.53 (2.37)</td>
<td>2.82 (2.59)</td>
<td>5.16 (4.52)</td>
<td>2.76 (2.34)</td>
<td>27.71 (6.39)</td>
</tr>
</tbody>
</table>

Notes. $a = Cronbach’s alpha.$
Table 2. Mean (SD) respiration frequency and task performance data for the experimental, comparative control, and control groups. Respiration frequency was recorded during the intervention period, while task performance was assessed during the baseline and pressure tests.

<table>
<thead>
<tr>
<th>Group</th>
<th>Respiration frequency (EDR)</th>
<th>Baseline test performance (0 to 80)</th>
<th>Pressure test performance (0 to 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (23)</td>
<td>8.32 (1.98)</td>
<td>31.61 (17.92)</td>
<td>32.30 (20.27)</td>
</tr>
<tr>
<td>Comparative control (23)</td>
<td>11.92 (0.22)</td>
<td>31.61 (17.92)</td>
<td>35.91 (16.21)</td>
</tr>
<tr>
<td>Control (21)</td>
<td>16.78 (2.28)</td>
<td>36.52 (14.00)</td>
<td>39.43 (11.98)</td>
</tr>
</tbody>
</table>

Notes: EDR = ECG derived respiration.
Table 3. Mean (SD) psychological stress response data (i.e., state anxiety, stress appraisal, and perceived stress) for the experimental (Exp), comparative control (CC), and control (C) groups pre-pressure instructions, post-pressure instructions, and post-intervention.

<table>
<thead>
<tr>
<th></th>
<th>Pre-pressure instructions</th>
<th>Post-pressure instructions</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
<td>Exp</td>
<td>CC</td>
</tr>
<tr>
<td>Cognitiv e anxiety intensity (1 to 7)</td>
<td>Exp</td>
<td>2.30 (1.11)</td>
<td>2.30 (0.82)</td>
</tr>
<tr>
<td>Cognitiv e anxiety direction (-3 to +3)</td>
<td>Exp</td>
<td>-0.09 (1.35)</td>
<td>-0.26 (1.09)</td>
</tr>
<tr>
<td>Somatic anxiety intensity (1 to 7)</td>
<td>Exp</td>
<td>2.30 (1.11)</td>
<td>2.61 (0.84)</td>
</tr>
<tr>
<td>Somatic anxiety direction (-3 to +3)</td>
<td>Exp</td>
<td>-0.35 (1.34)</td>
<td>-0.39 (0.94)</td>
</tr>
<tr>
<td>Stress appraisal (-5 to +5)</td>
<td>Exp</td>
<td>0.91 (2.02)</td>
<td>2.00 (1.95)</td>
</tr>
</tbody>
</table>
Table 4. Mean (SD) physiological stress response data (i.e., HR, RMSDD, pNN50, and HF-HRV) for the experimental (Exp), comparative control (CC), and control (C) groups at baseline, pre-pressure instructions, post-pressure instructions, intervention, and post-intervention.

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>Pre-pressure instructions</th>
<th>Post-pressure instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Exp</td>
<td>CC</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>71.91</td>
<td>70.33</td>
<td>72.12</td>
</tr>
<tr>
<td></td>
<td>(10.64)</td>
<td>(11.21)</td>
<td>(12.02)</td>
</tr>
<tr>
<td>RMSSD (ms)</td>
<td>62.49</td>
<td>52.77</td>
<td>53.94</td>
</tr>
<tr>
<td></td>
<td>(39.07)</td>
<td>(26.18)</td>
<td>(25.07)</td>
</tr>
<tr>
<td>pNN50 (%)</td>
<td>34.36</td>
<td>30.86</td>
<td>31.27</td>
</tr>
<tr>
<td>HF-HRV (ms²)</td>
<td>2103.32</td>
<td>1116.14</td>
<td>1465.67</td>
</tr>
<tr>
<td></td>
<td>(2247.37)</td>
<td>(1001.86)</td>
<td>(1054.03)</td>
</tr>
</tbody>
</table>
Table 4. Mean (SD) physiological stress response data for the experimental, comparative control, and control groups at baseline, pre-pressure instructions, post-pressure instructions, intervention, and post-intervention. (continued)

<table>
<thead>
<tr>
<th>Group</th>
<th>Intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exp</td>
<td>CC</td>
</tr>
<tr>
<td>HR</td>
<td>72.93</td>
<td>72.58</td>
</tr>
<tr>
<td>(bpm)</td>
<td>(11.19)</td>
<td>(12.56)</td>
</tr>
<tr>
<td>RMSSD</td>
<td>81.04</td>
<td>53.35</td>
</tr>
<tr>
<td>(ms)</td>
<td>(32.78)</td>
<td>(26.15)</td>
</tr>
<tr>
<td>pNN50</td>
<td>38.86</td>
<td>31.25</td>
</tr>
<tr>
<td>(%)</td>
<td>(14.75)</td>
<td>(24.61)</td>
</tr>
<tr>
<td>HF-HRV</td>
<td>2213.09</td>
<td>1948.77</td>
</tr>
<tr>
<td>(ms²)</td>
<td>(1846.61)</td>
<td>(1605.23)</td>
</tr>
</tbody>
</table>
Distance from participant to target: 4 metres

One metre long tape positioned 4 metres from target

Target diameter: 14cm
Target centre diameter: 14mm

Distance from target centre to ground: 1.4 metres

Figure 1. Test setup.
<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-intervention</strong></td>
<td></td>
</tr>
<tr>
<td>00.00</td>
<td>Demographic information taken</td>
</tr>
</tbody>
</table>
| 00.05-00.10 | *ECG time stamp*  
Five minutes of Baseline HRV measures recorded |
| 00.10-00.11 | Task 1 instruction (no pressure) |
| 00.11-00.12 | One minute of HRV reactivity recorded following no pressure task-instruction |
| 00.12 | *ECG time stamp*  
State anxiety and cognitive appraisal questionnaire |
| 00.15 | **Perform baseline test** |
| 00.20 | Task 2 instruction (pressurised) |
| 00.21-00.22 | One minute of HRV reactivity recorded following pressurised task-instruction |
| 00.22 | *ECG time stamp*  
State anxiety and cognitive appraisal questionnaire |
| **Intervention** | |
| 00.25-00.30 | Experimental  
Comparative Control  
Control  
Technical instruction of breathing technique followed by breathing to pacer instruction.  
10 minutes non-demanding video |
| 00.30-00.35 | Five minute individual practice. |
| 00.35 | *ECG time stamp*  
Five minutes of Baseline HRV measures recorded |
| **Post-intervention** | |
| 00.36 | **Task 2 instruction (pressurised)** |
| 00.36-00.37 | One minute of HRV reactivity recorded following pressurised task-instruction |
| 00.37 | *ECG time stamp*  
State anxiety and cognitive appraisal questionnaire |
| 00.40 | **Perform pressure test** |
| 00.45 | Debrief |