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Nonverbal behavior accompanying challenge and threat states under pressure

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Abstract

Objectives: This study examined if challenge and threat states predicted nonverbal behavior during a pressurized soccer penalty task.

Design: A predictive design was employed.

Method: Forty-two participants (M_{age} = 24 years, SD = 7) completed the task. Before the task, challenge and threat states were assessed via demand resource evaluations and cardiovascular reactivity. During the task, nonverbal behavior was recorded, and later used to rate participants on six scales: (1) submissive–dominant, (2) unconfident–confident, (3) on edge–composed, (4) unfocused–focused, (5) threatened–challenged, and (6) inaccurate–accurate.

Results: Participants who evaluated the task as a challenge (coping resources exceed task demands) were deemed more dominant, confident, composed, challenged, and competent from their nonverbal behavior than those who evaluated it as a threat (task demands exceed coping resources). Cardiovascular reactivity did not predict nonverbal behavior.

Conclusions: Athletes' challenge and threat evaluations might be associated with nonverbal behavior under high-pressure.

Keywords: Psychophysiology; stress; appraisal; body language; impression formation; soccer penalty-kick

Introduction

Competitive sport can hinge on a single pressurized moment, such as the final penalty to win a major soccer tournament. According to the biopsychosocial model of challenge and threat (Blascovich, 2008), performance in these key moments is partly determined by athletes' psychophysiological responses. First, athletes' evaluate the demands of a stressful situation and their coping resources, causing them to evaluate the situation as more of a challenge (resources exceed demands) or threat (demands exceed resources)[1]. Second, these evaluations trigger distinct cardiovascular responses, with a challenge evaluation leading to a cardiovascular response characterized by relatively higher cardiac activity and lower vascular resistance. Thus, challenge and threat states can be measured via cognitive evaluations and/or cardiovascular responses, and both have been shown to predict sports performance (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; Moore, Wilson, Vine, Coussens, & Freeman, 2013; Turner, Jones, Sheffield, Slater, Barker, & Bell, 2013). For example, while Moore et al. (2013) found that evaluating a golf competition as a challenge was linked to lower scores, Turner et al. (2013) found that a challenge-like cardiovascular response was associated with more runs in a cricket task. Despite their effects on performance, challenge and threat states are difficult to assess in real high-pressure situations due to issues associated with both self-report (e.g., social desirability bias) and cardiovascular (e.g., limited portability of equipment) measures. Thus, new and complementary methods are needed to help identify athletes' who are experiencing these states.

Importantly, influential scientists have argued that an individual's response to the perception of stressful environmental demands is characterized by an integrated physiological and nonverbal response (Cannon, 1915; Darwin; 1872). Hence, observers could theoretically be able to detect challenge and threat states from athletes' observable nonverbal behavior (NVB). Indeed, while limited, research in social psychology has partially supported this notion, indicating that challenge and threat states might show in divergent NVB (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007; O'Connor, Arnold, & Maurizio, 2010; Weisbuch, Seery, Ambady, & Blascovich, 2009). For instance, Mendes et al. (2007) found that responding to a social interaction with a threat-like cardiovascular response (lower cardiac activity and

[1] In contrast to the cognitive appraisal theory (Lazarus & Folkman, 1984), which views challenge and threat as two distinct types of primary (stressful) appraisals, challenge and threat are therefore conceptualized as the end result of what corresponds to Lazarus's primary and secondary appraisals (Seery, 2011).

higher vascular resistance) was linked with less positive NVB (smiling, giggling, and positive affirmations) and greater freezing (less feet, hand, and head movement). However, in contrast, Weisbuch et al. (2009) found that participants who responded to a speech with a threat-like cardiovascular response attempted to mask a lack of ability (low vocal confidence) by appearing more confident (high facial confidence). Despite these interesting results, to date, no research has examined the relationship between challenge and threat states and NVB in a pressurized sporting context.

To address this gap in the literature, the context of soccer penalties seems ideally suited due to its highly pressurized, one-on-one nature. In addition, growing research has highlighted the importance of NVB during soccer penalty preparation (e.g., Furley, Dicks, & Memmert, 2012a; Furley, Dicks, Stendtke, & Memmert, 2012b), showing that observers and athletes use NVB to infer internal states of opponents and team-mates. While research has shown that observers of athletes' NVB can make accurate inferences based on this NVB (e.g., current score; Furley & Schweizer, 2016), little research has explored the factors that influence athletes' NVB (e.g., stress appraisals). Thus, this study examined if challenge and threat states predicted NVB during a pressurized soccer penalty task. Specifically, this study tested if untrained observer ratings of NVB corresponded with self-report and cardiovascular measures of challenge and threat states, and if these states were predictive of the impressions formed of the penalty takers. It was predicted that demand resource evaluations (coping resources exceed task demands) and cardiovascular reactivity (higher cardiac activity and lower vascular resistance) associated with a challenge state would be related to more positive impressions of NVB (more dominant, confident, composed, focused, and challenged) and expected performance (greater accuracy).

Materials and Methods

Participants

Given the medium effect size (r = .45) reported by Mendes et al. (2007), a power analysis using G*Power software revealed that 33 participants were required to achieve a power of .80, given an alpha of .05. Thus, 42 participants (35 males, 7 females; M_{age} = 24 years, SD = 7) with at least two years competitive soccer experience ($M_{experience}$ = 12 years, SD = 7) were recruited.

Experimental task

Participants completed a task that required them to kick a standard-size indoor soccer ball (diameter = 20.6 cm) from a penalty spot located 5.0 m from the center of a regulation-size indoor goal (height = 1.2 m, width = 3.0 m; JP Lennard, Ltd., Warwickshire, U.K.). Participants were told to begin with the ball in their hands in front of their stomach, then place the ball on the penalty spot, before returning to a pre-defined mark 1.5 m behind the penalty spot, and initiating their run-up. No time pressure was placed on participants during task execution. The same goalkeeper was used throughout testing, and the positioning, movement, and posture of the goalkeeper was standardized given that these factors have been shown to influence soccer penalty performance (e.g., Van der Kamp & Masters, 2008). Indeed, unbeknown to the participants, the goalkeeper was instructed not to save the penalties, but to stand still in the centre of the goal with their knees bent and arms out to their side.

Measures

Demand resource evaluations. Two items from the cognitive appraisal[2] ratio were used (Tomaka, Blascovich, Kelsey, & Leitten, 1993), one to assess evaluated demands ("How demanding do you expect the upcoming soccer penalty task to be?"), and another to measure evaluated resources ("How able are you to cope with the demands of the upcoming soccer penalty task?"). Both items were rated on a six-point Likert scale anchored between 1 (*not at all*) and 6 (*extremely*). Consistent with previous research (e.g., Moore et al., 2013), evaluated demands were subtracted from resources to calculate a demand resource evaluation score (DRES) ranging from -5 to +5, with a positive score reflecting a challenge state (coping resources exceed task demands) and a negative score indicating a threat state (task demands exceed coping resources).

Cardiovascular data. A noninvasive impedance cardiograph device (Physioflow Enduro, Manatec Biomedical, Paris, France) estimated heart rate (number of heart beats per minute), cardiac output (amount of blood pumped by the heart per minute), and total peripheral resistance (net constriction versus dilation in the arterial system). Following procedures described previously (Moore, Vine, Wilson, & Freeman, 2012), cardiovascular data was recorded during baseline (5 minutes) and post-pressure instructions (1 minute) while participants remained seated, still, and quiet. Reactivity, or the difference between the final minute of baseline and the minute after the instructions, was examined for all cardiovascular variables. While heart rate reactivity was used to assess task engagement (a pre-requisite for challenge and threat states; Blascovich, 2008), cardiac output and total peripheral resistance reactivity

[2] Blascovich and colleagues now tend to use the term 'evaluation' rather than 'appraisal' as they argue it better reflects the predominately subconscious and automatic (rather than conscious and deliberate) nature of psychological responses to stress (Blascovich, 2008).

were used to measure challenge and threat states in response to the instructions. Both heart rate and cardiac output were estimated directly by the Physioflow, while total peripheral resistance was calculated (see Moore et al., 2012). Unfortunately, due to signal problems, cardiovascular data could not be recorded for one participant.

Nonverbal behavior. A tripod-mounted digital video camera (GoPro HERO, California, United States) was used to record NVB before the task. The camera was positioned in line with the left hand goal post (from the goalkeepers' perspective), at a height of 1.6 m and a distance of 3.0 m (Furley et al., 2012a). Two general methods can be used to analyze NVB: behavioural coding of videos by trained or untrained coders (Harrington, Rosenthal, & Scherer, 2008). As behavioural studies using trained coders have mainly focused on the face, and reliable coding of the entire body in real life situations (that do not involve staged basic emotion expressions by actors) has proven difficult (Dael, Mortillaro, & Scherer, 2012a), we decided to measure penalty takers' NVB with a large sample of untrained judges. This method, termed the thin slice approach, has proved useful to achieve reliable global assessments of NVB associated with internal states (Carney, Colvin, & Hall, 2007). Thus, following this approach (Furley & Schweizer, 2016), a short video clip was created of each participant ($M_{duration}$ = 9 seconds, SD = 2). Seventy-one untrained observers (55 males, 17 females; 29 British, 43 German; M_{age} = 25 years, SD = 7) watched the videos of each participant in a randomised order, and assessed NVB and expected performance on six 11-point digital semantic differential scales adapted from previous research (e.g., Furley et al., 2012b): (1) submissive–dominant, (2) unconfident–confident, (3) on edge–composed, (4) unfocused–focused, (5) threatened–challenged, and (6) inaccurate–accurate. A higher rating represented a more positive impression of NVB (more dominant, confident, composed, focused, and challenged) and expected performance (greater accuracy). The Cronbach alpha coefficient for the six scales was excellent (α = .98).

Procedure

This study received institutional ethical approval and participants attended the laboratory individually. First, after providing written informed consent, participants were fitted with the Physioflow. Next, five minutes of baseline cardiovascular data was recorded. Participants then received verbal instructions about the pressurized soccer penalty task. These instructions took ~60 seconds to deliver and were designed to elevate pressure, emphasizing the comparative and evaluative nature of the task

(Baumeister & Showers, 1986). Participants were told that the goalkeeper would try to save their penalty and that their performance would be entered into a competition, with the top five performers awarded prizes and the worst five performers being interviewed at length. Participants were also told that their performance would be published on a leader board, and recorded on a digital video camera so it could be evaluated by a soccer penalty expert. Next, one minute of cardiovascular data was recorded while participants sat still and quietly reflected on these instructions. After reporting demand resource evaluations, all participants performed the single pressurized soccer penalty and NVB was recorded throughout. Finally, the Physioflow was removed and participants were debriefed.

Statistical analyses

Cardiac output and total peripheral resistance reactivity were combined into a single challenge/threat index (CTI) by converting reactivity values into *z*-scores and summing them. Cardiac output was assigned a weight of +1 and total peripheral resistance a weight of -1, such that a higher index corresponded with a cardiovascular response more indicative of a challenge state (i.e., higher cardiac output and/or lower total peripheral resistance reactivity). Data with *z*-scores greater than 2 were removed (one value for unfocused–focused and threatened–challenged NVB, two values for inaccurate–accurate performance, and three values for CTI). Following these outlier analyses, skewness and kurtosis *z*-scores did not exceed 1.96, indicating the data was normally distributed.

A dependent *t*-test was conducted on the heart rate reactivity data to assess task engagement and establish that heart rate increased from baseline (i.e., heart rate reactivity greater than zero) in the whole sample. The results confirmed an average increase in heart rate of 9.49 (SD = 4.78) beats per minute ($t(38) = 15.13$, $p < .001$), confirming task engagement and enabling further examination of challenge and threat states (via DRES and CTI). Next, descriptive statistics and bivariate correlations were calculated (Table 1). Finally, simple linear regression analyses were conducted to assess if challenge and threat states (DRES and/or CTI, analyzed separately) predicted ratings of NVB (submissive–dominant, unconfident–confident, on edge–composed, unfocused–focused, and threatened–challenged) and expected performance (inaccurate–accurate).

Table 1

Means, standard deviations, and correlations for all variables

	Mean	SD	1	2	3	4	5	6	7	8
1. DRES	1.57	2.07		.31	.33*	.38*	.44**	.28	.37*	.32*
2. CTI	-0.34	1.51			.18	.14	.28	-.01	.12	.03
3. Submissive–dominant	6.71	0.99				.98**	.88**	.84**	.96**	.88**
4. Unconfident–confident	6.87	1.11					.90**	.88**	.98**	.93**
5. On edge–composed	6.73	1.07						.90**	.92**	.92**
6. Unfocused–focused	7.12	1.00							.90**	.94**
7. Threatened–challenged	7.04	1.05								.95**
8. Inaccurate–accurate	6.80	1.02								

Results

Notes. * Denotes correlation significant at .05 level (2-tailed), ** Denotes correlation significant at .01 level (2-tailed)

Submissive–Dominant

DRES significantly predicted submissive–dominant NVB (R^2 = .09, β = .33, p = .031, *95% CI* .015 to .305). Participants who evaluated the task as more of a challenge were rated as more dominant than those who evaluated the task as more of a threat. However, CTI did not predict submissive–dominant NVB (R^2 = .00, β = .18, p = .292, *95% CI* -.100 to .323).

Unconfident–Confident

DRES significantly predicted unconfident–confident NVB (R^2 = .13, β = .38, p = .012, *95% CI* .047 to .364). Participants who viewed the task as more of a challenge were rated as more confident than those who viewed the task as more of a threat. However, CTI failed to predict unconfident–confident NVB (R^2 = -.01, β = .14, p = .399, *95% CI* -.138 to .339).

On Edge–Composed

DRES significantly predicted on edge–composed NVB (R^2 = .17, β = .44, p = .004, *95% CI* .076 to .372). Participants who evaluated the task as more of a challenge were rated as more composed than those who evaluated the task as more of a threat. However, CTI did not predict on edge–composed NVB (R^2 = .05, β = .28, p = .085, *95% CI* -.029 to .421).

Unfocused–Focused

Neither DRES (R^2 = .06, β = .28, p = .075, *95% CI* -.015 to .288) nor CTI (R^2 = -.03, β = -.01, p = .941, *95% CI* -.231 to .214) significantly predicted unfocused–focused NVB.

Threatened–Challenged

DRES significantly predicted threatened–challenged NVB (R^2 = .11, β = .37, p = .018, *95% CI* .034 to .342). Participants who evaluated the task as more of a challenge were rated as more challenged than those who evaluated the task as more of a threat. However, CTI did not predict threatened–challenged NVB (R^2 = -.01, β = .12, p = .463, *95% CI* -.145 to .312).

Inaccurate–Accurate

DRES significantly predicted inaccurate–accurate ratings (R^2 = .08, β = .32, p = .045, *95% CI* .004 to .331). Participants who viewed the task as more of a challenge were deemed more likely to take an accurate penalty than those who evaluated the task as more of a threat. However, CTI did not predict inaccurate–accurate ratings (R^2 = -.03, β = .03, p = .843, *95% CI* -.209 to .254).

Additional analyses

Given concerns relating to the inflation of type one error risk with multiple hypotheses testing, and to determine which NVB scale was most robustly related to challenge and threat states, the Holm-Bonferroni technique was used to adjust the *p*-values from the 12 simple linear regression analyses reported above (Holm, 1979). Following this procedure, just one effect remained statistically significant[3], with DRES predicting only on edge–composed NVB (p = .048).

Discussion

This study examined the relationship between challenge and threat states and NVB during a pressurized soccer penalty task. The self-report measure of challenge and threat (i.e., DRES) predicted ratings of NVB and expected performance. Participants who evaluated the task as more of a challenge (coping resources exceeded task demands) were perceived as more dominant, confident, composed, and challenged, and more likely to take an accurate penalty, based on their NVB than participants who evaluated the task as more of a threat (task demands exceeded coping resources). Given the findings of existing research (Furley et al., 2012a, 2012b), it is likely that such favorable perceptions arose from participants displaying more positive NVB (e.g., composed preparation, erect posture, shoulders back, chest out, chin up, and direct eye-contact). These results are the first to highlight that athletes' stress appraisals appear to be related to NVB. In addition, these results support previous social psychology research, and imply that different NVBs might accompany challenge and threat (Mendes et al., 2007; Weisbuch et al., 2009). For example, O'Connor et al. (2010) found that participants who evaluated a negotiation task as a challenge were deemed more competitive and less passive than participants who evaluated the task as a threat. Furthermore, the findings of this study support the *thin slices hypothesis*—which states that untrained observers can infer internal states of other people based on subtle nonverbal cues (Carney et al., 2007)—as untrained observers also rated penalty takers who evaluated the task as more of a challenge as more challenged, and participants who evaluated the task as more of a threat as more threatened. However, these results should be interpreted cautiously as few associations remained

[3] DRES no longer significantly predicted submissive–dominant (p = .279), unconfident–confident (p = .132), and threatened–challenged (p = .180) NVB, or inaccurate–accurate ratings (p = .360).

significant after adjusting for the inflation of type one error rates. Indeed, after such adjustments, challenge and threat evaluations were only significantly related to on edge–composed NVB. In line with Fiedler, Kutzner, and Krueger (2012), it is worth noting that type one and type two errors are linked, and while the Holm-Bonferroni correction reduced the risk of confusing unsystematic variation in our data for systematic variation of our model, it might obscure some systematic variation in NVB that coincides with an athlete's challenge or threat evaluation (see also Fiedler, 2018).

Unlike the self-report measure, the cardiovascular index of challenge and threat (i.e., CTI) did not predict ratings of NVB or expected performance. While surprising, basic physiological responses are often only weakly related to NVB, given that such responses can reflect a variety of underlying psychological processes (e.g., mental effort; Cacioppo & Tassinary, 1990). This null result might also be explained by the conflicting findings of previous research. For instance, Mendes et al. (2007) found that a threat-like cardiovascular response was linked with less positive NVB (smiling, giggling, and positive affirmations) and greater freezing (less feet, hand, and head movement) during a social interaction. In contrast, Weisbuch et al. (2009) found that participants who responded to a speech task with a threat-like cardiovascular response attempted to mask a lack of ability (low vocal confidence) by appearing more confident (high facial confidence). Thus, while NVB might have accurately mirrored underlying cardiovascular responses for some participants, others might have tried to mask a threat response by displaying more positive and confident NVB (an issue that might also have biased responses to self-report measures, and thus contributed to the nonsignificant relationship between DRES and CTI [$r = .31$, $p = .056$]; see Meijen, Jones, Sheffield, & McCarthy, 2014). Indeed, NVB is relatively open to conscious control and is thus susceptible to social desirability bias (Ekman & Friesen, 1969). Alternatively, the pattern of results may be supportive of Fridlund's (1994) theory that NVB functions as a communicative response that does not necessarily depend on underlying autonomic activity. Future research could try to distinguish between autonomous nonverbal cues associated with challenge and threat states, and deliberate nonverbal attempts to mask these states.

Evaluating stressful tasks as a threat is associated with poorer sports performance (e.g., Brown, Arnold, Standage, & Fletcher, 2017; Moore et al., 2013). Thus, to optimize sports performance, practitioners might use NVB (alongside existing self-report measures) to identify athletes who are evaluating stressful situations as more of a threat (those who are deemed less composed and more on edge from their body language; i.e., occupy less space, have a less erect and more collapsed posture, appear more hectic, and have a less stable gaze pattern; Furley et al., 2012a), and would likely benefit from interventions aimed at encouraging them to evaluate such situations as more of a challenge (e.g., arousal reappraisal; Sammy, Anstiss, Moore, Freeman, Wilson, & Vine, 2017). Nevertheless, research needs to identify the precise behaviors and cues (e.g., facial expressions, kinematics, and posture) that observers can use to judge if an athlete is evaluating a situation as a challenge or threat. Therefore, future research might use existing coding schemes from other domains, like the Facial Action Coding System (Ekman & Friesen, 1978) or the Body Action and Posture Coding System (Dael, Mortillaro, & Scherer, 2012b), to identify the (facial) movements and behaviors associated with challenge and threat. However, reliably identifying such subtle NVB will likely be difficult, as the few nonverbal coding studies in sport have only focused on clearly visible behaviors (i.e., gross body movements) associated with pride and shame (e.g., Moesch, Kenttä, & Mattsson, 2015) or high-pressure (e.g., Jordet & Hartmann, 2008). The limitations of this study offer avenues for future research. For example, the predictive design might be considered a limitation. Thus, future research should use experimental designs to offer a more causal understanding of the relationship between challenge and threat states and NVB (as Tomaka, Blascovich, Kibler, & Ernst, 1997). Moreover, the focus on competitive stress could be seen as a limitation. Future research could therefore examine athletes' psychophysiological and nonverbal responses to organizational stress (Fletcher & Wagstaff, 2009).

Conclusion

In conclusion, how participants evaluated the pressurized soccer penalty task was associated with their NVB. Participants who evaluated the task as more of a challenge, rather than a threat, were rated as more dominant, confident, composed, challenged, and competent based on their NVB. However, it is worth noting that only the effect for on edge–composed NVB remained significant after adjusting for type one error risk. Pre-competition NVB might therefore show some promise (alongside existing self-report measures) in helping practitioners identify athletes' challenge and threat evaluations during high-pressure competition, although more research is clearly warranted.

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