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Competitive anxiety and cortisol awakening response in the week leading up to a competition

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ABSTRACT

Objectives: This study investigated the psychological as well as neuroendocrine stress response across one week before an important sport competition, introducing the cortisol awakening response (CAR) to sport psychological research.
Methods: On three days in the week before the German Nationals, martial artists ($N = 17$) reported their competitive state anxiety and collected five samples of salivary cortisol during the first hour after awakening.
Results: Hierarchic-linear models and multiple regressions were conducted. Despite a significant rise in "somatic anxiety" ($p < .05$), the increment of CAR across the week remained non-significant. A moderator function of competitive anxiety on the released amount of cortisol in the morning was not found significant. Results did not show any significant regression of changes in the neuroendocrine response on changes in state anxiety.
Conclusion: Non-significant increments of CAR with a closer proximity to the competition may be interpreted as a possible habituation of basal hypothalamus-pituitary-adrenal activity. Moreover, athletes appear to have a lower CAR than found in norm studies, which points to further investigation of interindividual and situational effects on the temporal pattern of the neuroendocrine response to sport competitions.

Introduction

The neuroendocrine response (i.e. the release of hormones) as part of the physiological stress response has seen a surge in interest in recent years concerning anxiety and stress research in general, and with respect to sport competition in particular (for overviews, see Salvador, 2005; Salvador & Costa, 2009). Neuroendocrine stress markers include catecholamines such as (nor-)epinephrine and dopamine as markers of the sympathetic adrenal medullary system, and cortisol as the primary marker of the hypothalamic pituitary adrenal system (HPA).

Studies have generally found a pronounced hormonal response to a competition. So far, mainly the immediate response has been investigated. Much less is known about the temporal patterning of this hormonal response. For a better understanding of competitive anxiety and related coping processes, research needs to focus on changes over a specific period of time before a competition (Cerin, Szabo, Hunt, & Williams, 2000; Hanton, Thomas, & Maynard, 2004; see also Folkman & Lazarus, 1985). While the psychological response has been investigated as it unfolds over time, the processes of the neuroendocrine response remain understudied. The neuroendocrine response may appear adequate and functional in light of upcoming demands – or it may be dysfunctional, even detrimental to health, for example if it is set-off too early or not at all. Furthermore, for the analysis of coping strategies, the correspondence between psychological and neuroendocrine stress needs to be investigated more closely.

Studies investigating the neuroendocrine response to competitions have also mainly focused on the activity of the HPA. Generally, a rise in cortisol secretion has been found in response to a competition. Filaire and colleagues, for example, found an anticipatory rise in cortisol in female gymnasts during weeks leading up to a competition as compared with levels observed in a control group (Filaire, Michaux, Robert, & Lac, 1999). Similar results were found in judoka (Filaire, Sagnol, Ferrand, Maso, & Lac, 2001; Salvador, Suay, González-Bono, & Serrano, 2003). In several well-designed studies, Rohleder and coworkers also found an anticipatory increase prior to dancing contests

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(Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007). They concluded that sport competitions serve as real life stressor to activate the HPA. Moreover, they discovered similar increases in cortisol across several competitions, which they interpreted as a lack of habituation of the HPA activation to competitions. Also potential moderators have been identified such as the directional interpretation of anxiety symptoms. It has been argued that not the intensity of anxiety perceptions per se but rather their interpretation as being debilitative to performance constitutes the anxiety response (Jones & Swain, 1995). Eubank, Collins, Lovell, Dorling, and Talbot (1997), for example, found more elevated cortisol and competitive anxiety responses in canoeists categorized as "debilitators" before a competition.

Thus, the immediate cortisol response to competition appears to be well explored and established. Although changes in cortisol levels are explained with changes in (pre-) competitive apprehension, the psychological response, however, is rarely assessed as concomitant factor. Also, longitudinal responses to competitive stress have hardly found any attention. With respect to the psychological response to an upcoming competition, Hanton et al. (2004), for example, found an increase in intensity (as well as of frequency) of cognitive, and especially somatic anxiety throughout the week before the actual sport competition. Given that anxiety symptoms increase with proximity to competition, the question arises whether this anticipatory psychological response is accompanied by a similar (early) neuroendocrine stress response. Such associations would be expected according to Ursin and Eriksen's integrational theory (2004) whereby the physiological stress response is proposed to follow cognitive processes of situational appraisal. Gaining insight into longitudinal aspects of the neuroendocrine response and its association with the psychological response would permit addressing questions related to health (e.g., Do competitive athletes habituate to (competitive) stress and what are potential mechanisms?) and performance (e.g., How effective are coping strategies with respect to the physiological response?).

A common possibility to explore longitudinal neuroendocrine reactions to competitive stress with a more precise control of confounds is given by the analysis of the cortisol awakening response (CAR). Within about 30 min after awakening, the diurnal cycle of cortisol release shows a sharp increase of up to 75% compared to awakening levels (Wüst et al., 2000). This increase is superimposed upon the fairly linear trend of increasing cortisol levels in the early morning (for an overview, see Fries, Dettenborn, & Kirschbaum, 2009). The cortisol awakening response (CAR) can be assessed by taking blood or, non-invasively, saliva samples four to five times (usually every 15 min) across the first hour after awakening. Common parameters of the CAR used are not only the increase itself but also the released amount of cortisol, which can be calculated from the area under curve of the measurement time course. The CAR has been proven to be a distinct intra-individual reaction with a relative stability over time ($r_{tt} = .63$ for the areas under curve on two consecutive days; Wüst et al., 2000), and it is well explored in stress and health research (Kudielka & Wüst, 2008, chap. XI). Altered CAR has been found, for example, to be associated with occupational stress (Federenko et al., 2004), with physical health (Steptoe, Wardle, & Marmot, 2005), and mental health (Fries, Hesse, Hellhammer, & Hellhammer, 2005).

Despite its relative stability over time, the CAR can be used as a measure for the acute (re)activity of the HPA axis (Schmidt-Reinwald et al., 1999). On a physiological level, the CAR reflects the (psychological) anticipation of the demands of the respective day – higher anticipated demands leading to a higher CAR (Fries et al., 2009). Thorn, Hucklebridge, Evans, and Clow (2009), for example, report a correlation between day-to-day changes in (state) arousal and CAR. A latent-state-trait model also showed that in addition to its trait characteristic, the CAR also incorporates a high occasion specifity (Hellhammer et al., 2007). In contrast to daytime cortisol assessment, the CAR is not affected by physical stress and – if at all – only slightly by the diurnal cycle of cortisol release. Consequently, the CAR constitutes a valuable measure for the study of the longitudinal cortisol response to real life stress events.

Such research, however, has found equivocal results. In exam situations, Hewig et al. (2008) did not find any changes in the CAR before an upcoming exam. On the other hand, Gaab, Sonderegger, Scherrer, and Ehlert (2006) found increments in the CAR with a closer proximity to an exam only in an experimental group, which had participated in a stress-management training; a control group's CAR remained stable. To date, the CAR has not yet been investigated as a response to a real life stressor in relation to sport competition.

In summary, three objectives for further research become apparent. First of all, the immediate neuroendocrine response to a competition is well investigated. Much less, however, is known about the temporal pattern leading up to a competition. Secondly, the CAR has not yet been investigated in relation to stress before competitions. It appears to be a valuable measure to explore the temporal pattern of the neuroendocrine response and is as such successfully used in clinical and stress research. Thirdly, only few studies have investigated relations between the neuroendocrine stress response and competitive anxiety as measured via psychological self-report.

Purpose and hypotheses

In this study, we intended to explore the neuroendocrine stress response across the week leading up to a competition. Relying on the well explored cortisol response we used the CAR, which is established in stress research but has not found any attention in sport psychology yet. Furthermore, we wanted to explore the relation between the neuroendocrine response and the psychological stress response by assessing self-report competitive state and trait anxiety. The latter (competitive trait anxiety) was seen as a potential moderator in the relation between physiological and psychological response.

First of all, with respect to the anticipatory cortisol response, we expected that the CAR would show increasing levels with closer proximity to a competition. Usually, HPA activity has been found to habituate to the repeated exposure of stressors (Antony & Swinson, 2000; Barlow, 2002). In a sport context, repeated parachute jumps in novices lead to a reduced anticipatory response, indicating habituation of HPA activity (Deinzer, Kirschbaum, Gresele, & Hellhammer, 1997). In contrast, Rohleder et al. (2007) did not find any habituation in their sample of experienced competitive ballroom dancers. They speculated that this might be due to the specificity of a competition as a real life stressor, that threatens more central goals in personal identity (Rohleder et al., 2007). Ballroom dancing contests are an important part of the dancers' life and being successful is part of that. So every contest poses a potential threat to the dancers' identity, whereas one can learn to deal with the dangers of parachuting. Thus, similar to the acute response (e.g. Eubank et al., 1997; Filaire et al., 1999), no habituation was expected (first hypothesis). Secondly, a potential moderator was explored. Recent studies found cortisol reactivity measures to be moderated by traits like cortical activations (Hewig et al., 2008) and trait anxiety (Jezova, Makatsori, Duncko, Moncek, & Jakubek, 2004). It was expected on an explorative level that (second hypothesis) competitive trait anxiety would serve as a moderating personality disposition. Thirdly, it was hypothesized that a positive relation between competitive state anxiety and CAR would be observed (see Mason, 1968). Following the recent study by Thorn et al. (2009) this general expectation was rendered more precisely (third hypothesis): We expected a positive correlation among *changes* in competitive anxiety and *changes* in CAR. Because Thorn et al. (2009) found relations with awakening cortisol for a subjective measure of arousal only but not for other stress