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Chapter 18

SALIVARY CORTISOL AND MOOD REDUCTIONS IN AN OLYMPIC ATHLETE USING COGNITIVE-BEHAVIORAL METHODS

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ABSTRACT

Relaxation-enhanced, cognitive-behavioral coping methods (CBM) were taught to an Olympic athlete in mental skills training. In a controlled setting, salivary cortisol and mood were assessed in parallel at 4-minute intervals as the athlete repeatedly viewed a distressing competition video. After a baseline orientation (8-minutes) and mood provocation (12-minutes, immediately following baseline), the athlete was instructed to use CBM (8-minutes). Subjective distress was assessed together with cortisol secretion in a time sequence with eight saliva samples, collected over 28-minutes. Not until the final stage when the subject managed his subjective distress did mood and cortisol covary as commonly reported in the literature: During the CBM phase of the study, as the athlete reported reduced distress, his cortisol levels also reduced. It is suggested that in the case of negative mood, salivary cortisol secretions be assayed as an adjunct to psychometric assessment in multi-dimensional tracking during CBM training.

Key words: cortisol, mood, negative mood, cognitive-behavioral, relaxation

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Relatively few resources have been allocated to psychological, multimodal assessment and treatment of athletes relative to stress and mood. Likewise, clinical psychological research into the methods of managing stress in athletes rarely draws on physiologic measures. Still further, coaches are too often ill-equipped to address emotional issues arising from performance and training while their athletes rarely seek treatment (Ferraro & Rush, 2000). However, as recently reviewed by Johnson, Edmonds, Tenenbaum, and Kamata (2007), mood seen as a multidimensional entity has long been studied as integral to performance. Importantly, although the fundamental aims of CBT and mindfulness-based meditation are quite different (book), recent research using some element of mindfulness-based meditative practice with cognitive-behavioral methods (CBM) has shown efficacy in psychological management of mood among surgery, anxious, and depressive patients, athletes recovering from injury, and athletes seeking to enhance performance (Baer, 2006; Segal, Williams, & Teasdale, 2002; Gould, Greenleaf & Krane, 2002; Perna, Antoni, Baum, Gordon, & Schneiderman, 2003). Although endocrine responses have been known for some time to covary with relaxation, health, and emotional well-being (Davis, 1986) and have more recently been shown to relate to mood elevation following mindfulness-based stress reduction methods (Carlson, Speca, Patel, & Goodey, 2004), clinical sport psychology has been slow to integrate this work within applied settings.

Plasma and salivary levels of cortisol are among the most reliable biomarkers of stress and numerous studies over the past 30 years have examined the role of stress in athletes in a variety of sports using cortisol as a marker. Although the role of endocrine function in live sport performance is still being elucidated and conclusions are premature, there is an emerging literature in which salivary cortisol is monitored during competition and correlations with stress and performance are becoming evident (Doan, Newton, Kraemer, Kwon, & Scheet, 2007; Haneishi, Fry, Moore, Schilling, Li, & Fry, 2007; Hooper, Mackinnon, Howard, 1999). Two principal conclusions are possible: First, in the competitive environment, anxiety (one measure of subjective distress) frequently correlates with cortisol. Second, practitioners in applied, sport physiology settings have found benefit to assessing stress with cortisol measures.

Despite robust individual data sets on optimal mood, mindfulness, cognitive-behavior therapy, and endocrine function in stress, and emerging data on the utility of independently assessing subjective mood with cortisol in athletic settings, there has still been no comprehensive, multidimensional analysis of the psycho-physiologic effects of negative mood and cortisol in athletes in an applied, mental training context. It is widely believed that that hormonal regulation should play an important role in mental preparation for elite performance, covarying with mood during physical activity and sports training, but little is known of the actual interplay between mood and endocrine activity in applied, clinical settings (Kivlighan, Granger, & Booth, 2005; Hedge, Colby, & Goodman, 1987; Michael, Jenaway, Paykel, & Herbert, 2000). As stated, sport physiologists measure subjective mood

and its physiological counterparts in their domain of practice but clinical sport psychology has not followed suit. It is only logical at this time that moment-to-moment mood assessment - in which a sport psychologist tracks mood multidimensionally and in real time, while an individual is task-engaged - (Johnson, Edmonds, Tenenbaum, & Kamata, 2007; Hanin, 2000; Lingjaerde & Foreland, 1998) should now become more standard.

The measurement of salivary cortisol is also standard in high performance labs and endocrine function tests cover the range of estradiol, estrone, estriol, progesterone, dehydroepiandrosterone (DHEA), testosterone and cortisol responses (Raff, Homar, & Skoner, 2003). Salivary cortisol samples are easily collected even on the playing field by coaches, trainers and researchers with little training. Salivary cortisol samples, unlike plasma samples, do not need to centrifuged and are relatively stable for short periods without refrigeration.

The purpose of our present case description is to illustrate the bi-dimensional assessment of mood and endocrine activity while an athlete is engaged in a CBM-based coping training method. We did not set out to demonstrate effects with our CBM; instead, our intention was to assess the utility and feasibility of employing multidimensional monitoring methods during mental training.

METHOD

Subject

The 30-year-old male Olympic athlete with extensive international competitive experience volunteered to participate and gave informed consent according to guidelines of the Helsinki Declaration, meeting also the ethics guidelines of the Canadian Psychological Association. He had failed to reach his goals at the 2002 Winter Olympic Games and, very upset, had returned from the Games before training in both mindfulness meditation, engaging in three, 10-day silent retreats, and 20-weeks of traditional cognitive therapy for depression (Beck et al., 1979).

Study Design

An 8-minute baseline orientation consisted of the athlete simply viewing other athletes from his own sport training at non-competitive venues.

Following baseline, mood provocation proceeded for 12-minutes. The athlete received the mood provocation in this period by watching a specific race video from his own Olympics. He watched critical aspects of the video repeatedly over the course of the case study.

For the last 8-minutes - while engaged in focused breathing and noting his subjective distress - he used cognitive-behavioral methods to re-frame his negative thoughts and to modify his dysfunctional thinking. In treatments which had preceded this case study, the athlete had been taught mindfulness-based meditative breathing (Kabot-Zinn, 2005; Teasdale

et al., 2000) and cognitive-behavioral reframing strategies for facilitating coping in distressed persons (Clark, Beck, Alford, & Hoboken, 1999). Although he was practiced in meditation, we labeled this particular application of breathing as relaxation-based cognitive-behavioral method (CBM).

Mood ratings of subjective distress were taken every four minutes on a 1-7 Likert scale, with 7 indicating the highest distress. Saliva sampling occurred at each of these 4-minute markers.

- Mood provocation: After baseline, negative mood provocation was accomplished over a 12-minute period by having the athlete watch a key race from his Olympics. He had been instructed to "manage breathing while noticing what happens in the race and simultaneously allowing the experience of any feelings that arise." He was instructed further to "Watch the video passively with a focus also on your breathing. Use the meditative breathing that you have practiced." He had learned to identify cognitions that would develop with his feelings. Thus, in the 12-minute provocation phase of the study, as he continued to note his feelings without judgment, he simultaneously identified automatic thoughts corresponding to his mood, also without judgment. While noting this mood and related thoughts he volunteered aloud that he felt "desperate, scared, and alone".
- Active CBM coping: The study athlete was competent in using CBM, as described above. Therefore, for this phase of the study, he used focused breathing together with the cognitive-behavioral reframing strategies as taught. In the final 8-minutes of the study, while still viewing the personal video and attending to his even-paced, meditative breaths, he followed coping instructions: "Now, generate positive thoughts as alternates to your automatic negative ones. For example, to the word "scared" you might intentionally focus on phrases such as "I have nothing to be afraid of. I have done my own best. I am loveable. I am included. I am important to my team. I am happy for my teammates."
- Cortisol assessment: Salivary cortisol was collected eight times via passive drool at 4-minute intervals: 3 times during baseline orientation, 3 times during mood provocation, and 2 times during CBM. Saliva was collected in polystyrene tubes and frozen at -20C until assay. Concentrations were assayed at Rocky Mountain Analytical, Calgary, Alberta, Canada. The method of analysis was enzyme-linked immunosorbent assay (ELISA) using a kit designed for analysis of cortisol directly in saliva (Diagnostic Systems Laboratories, DSL-10-67100, Webster, TX). Samples were analyzed in duplicate. There were no conflicts between scientific and commercial interests. While the assay is not unique to Rocky Mountain Analytical its application in applied sport psychology – the focus of our study – is. The methods used in this study are widely available in both university and commercial labs. Most practitioners interested in pursuing a similar method will find it relatively easy to obtain the same assay in their setting.

RESULTS

The data showed mean salivary cortisol levels of 2.0 ng/ml, 1.7 ng/ml, and 1.2 ng/ml during over three periods: (A) baseline orientation, (B) mood provocation, and (C) active, CBM coping, respectively. The average subjective distress ratings of 2.0, 4.0, and 1.0 recorded for the three periods did not follow the same course as cortisol. Instead, while thinking distressing thoughts but maintaining a focus on relaxed breathing, the subject showed cortisol levels that steadily fell before period (C) when he used CBM coping and attained a level of subjective distress that matched his physiologic status. This mismatch in time course for the two measures identifies the disconnect between two tasks: On one hand, he permitted negative thoughts while, on the other hand, he simultaneously managed his breathing. The changes from (B) mood provocation to (C) active CBM coping were the principal focus for this study. Importantly, after baseline, there was a 30% reduction in average cortisol secretion between B and C that was mirrored by a comparable decline in average subjective distress from 4 to 1. Please see Figure 1.

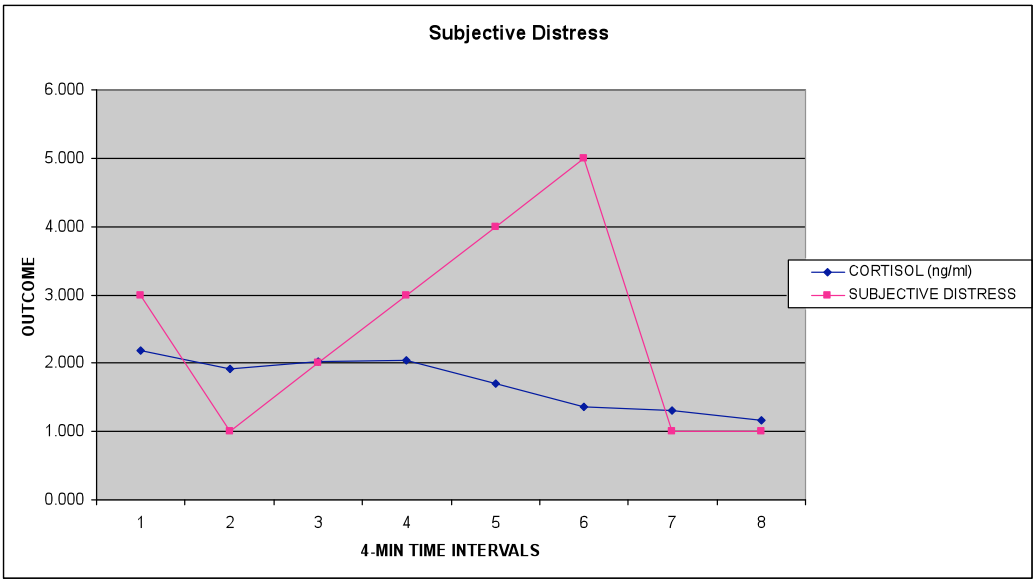

Figure 1. Ratings of subjective distress and cortisol over eight, 4-min periods.

As stated, during period (B), mood provocation, while maintaining focused and relaxed breathing the athlete spontaneously reported feeling "desperate", "scared", and "alone." In contrast, during period (C), active CBM coping, as cortisol levels continued to decline, the athlete spontaneously said, "I don't feel the same now. It would be hard to say that I am upset. I'm less stressed." In other words, during period (B) he did not feel relaxed as he was breathing, perhaps because he was *allowing* and not *managing* his subjective distress.

DISCUSSION

The principal purpose of the case study was to demonstrate the efficacy of multidimensional methods for tracking mood during mental training. In this feasibility

illustration, there was a roughly 30-percent reduction in cortisol level over 28-minutes corresponding to roughly the same period of focused, relaxed breathing. During a period of active coping following mood provocation, using CBM, the cortisol reduction coupled with the corresponding reduction in subjective distress; each occurred within a period of 8-minutes. This suggests a clinically significant aspect of our findings: A response to using CBM methods may be monitored with dual endocrine and psychological parameters while an athlete is engaged in mental training. It is important to note that although this athlete reported greater distress during provocation, his cortisol levels did not elevate beyond the hypervigilant state that was seen at baseline. This argues for using multidimensional methods: An athlete who claims verbally to be "better" and "worse" should simultaneously be evaluated with a biological measure. In this case the athlete's subjective sense of feeling "worse" was not consistently matched by an upregulation of cortisol while his impression of feeling "better" did correlate with the shift in cortisol. This is potentially very important information for the athlete in training.

Our case study was not a test of CBM and this demonstration of the covariation of cortisol with mood (during active coping) cannot be considered evidence for cause or effect. There were no experimental controls and the 8-point sampling procedure was too limited to permit meaningful t-tests or correlational analyses. Instead, the study is valuable for its clinical utility; sport clinicians may draw from two literatures – hormonal and affective - and apply this literature when assessing their applied interventions.

It is important to remember that although the important role of emotional stress in athletic performance is well documented in the extant sports psychology literature, the underlying mechanism by which stress may affect training, and competitive performance, is less well understood. Further, there is little agreement that cortisol levels can be used to predict performance. Finally, the elevation of cortisol has its limitations as a biomarker for stress and any variability in cortisol salivary levels must be considered in light of medical conditions and estrogens which could affect cortisol binding or HPAA activity (Hellhammer, Weist, & Kudielka, 2009).

The overall value of our results lies, therefore, not in the replication of a robust literature showing the covariation of cortisol with mood. Instead, it lies in the demonstration of a method of multidimensional assessment. Showing that a rapid reduction in the primary stress hormone, cortisol, may not mirror change in cognition - if the subject is permitted to feel distress but instructed to manage breathing - appears every bit as important as important as basic replication. Equally, when our subject finally worked to manage his negative mood (during relaxation-based cognitive coping) both mood and endocrine activity paralleled one another. This suggests the importance for measuring both the psychological and biological parameters of stress while tracking the progress of training in a CBM. Clinicians may, for instance, in using the simple assessment tools that we have demonstrated, employ competition videos to intentionally trigger negative mood and provide meaningful exposure to negative stress while tracking the client's coping responses. Undoubtedly, some athletes will not regulate their hormonal response to subjective distress as our own subject did using breathing (in most, subjective distress will likely increase with cortisol). The fact that our subject was essentially able to do these two things at once – allow distress while managing breathing - may be a unique finding, attributable to his unique training and intermediate experience in mindfulness meditation.

The twinning of mood ratings with a salivary cortisol assessment during CBM training will have important implications for practicing sports psychiatrists and psychologists who want ongoing multidimensional evidence for the efficacy of their individualized mental training protocols.

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