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Self-Regulation Training, State Anxiety, and Sport Performance: A Psychophysiological Case Study

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A single-subject research design was used to test the effectiveness of a cognitive-behavioral intervention in reducing state anxiety and improving sport performance. The subject was a small-bore rifle shooter who suffered from high levels of competition-related anxiety. Initially, self-report, physiological, and behavioral measures of baseline state anxiety were obtained during competition. A 6-week intervention program was then implemented. This program included training in relaxation, thought stoppage, refocusing, coping statements, and biofeedback. An opportunity to practice using these procedures in competition was provided. Measures of state anxiety and performance were then obtained in a second competition. Results revealed that cognitive anxiety, somatic anxiety, gun vibration, and urinary catecholamines decreased whereas self-confidence and performance increased from baseline to treatment. The importance of examining multiple dimensions of state anxiety using a multimethod, idiographic approach is discussed.

The ability to produce and maintain the proper emotions before and during competition is universally recognized by athletes, coaches, and sport scientists as one of the most important factors contributing to successful performance. Thus, considerable attention has been given to assessing the impact of specific intervention strategies on modifying or altering emotions and improving subsequent sport performance. A substantial portion of this research has focused on testing the effectiveness of cognitive-behavioral and/or biofeedback intervention techniques in reducing state anxiety.

Results from these treatment studies, however, have been somewhat equivocal. Some studies have found performance improvements when intervention was successful in reducing state anxiety (Dewitt, 1980; Dorsey, 1976; Gravel,

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Lemieux, & Ladouceur, 1980; Griffiths, Steel, Vaccaro, Allen, & Karpman, 1985; Lee & Hewitt, 1987; Mace & Carroll, 1989). Other studies have found no performance improvements when intervention was successful in reducing state anxiety (Bennett & Hall, 1979; Dacaria, 1977; Murphy & Woolfolk, 1987; Weinberg, Seabourne, & Jackson, 1981; Wojcikiewicz & Orlick, 1987). Still other studies have found performance improvements after intervention without concomitant changes in anxiety levels (Crocker, Alderman, & Smith, 1988; Harris, 1981; Wagner, 1984). Thus, it appears that performance-enhancement interventions are sometimes effective in reducing state anxiety but that changes in anxiety do not necessarily result in performance improvements. Moreover, performance enhancement may sometimes occur in the absence of changes in state anxiety.

Reliance on an oversimplified, unidimensional view of state anxiety may be partially responsible for these ambiguous findings. According to numerous researchers, state anxiety is a multidimensional construct containing both cognitive and somatic components (Borkovec, 1976; Davidson & Schwartz, 1976; Landers, 1980; Martens, Burton, Vealey, Bump, & Smith, 1990; Morris, Davis, & Hutchings, 1981). The cognitive component is characterized by negative expectations about success or threats to self-esteem based on negative evaluation; the somatic component is related to physiological and affective responses due to autonomic arousal (Morris et al., 1981). From an intervention perspective, Gould, Petlichkoff, and Weinberg (1984) suggested that it is crucial to identify the predominant type of anxiety response so that the most appropriate intervention strategy can be selected.

The use of single-method approaches to assess state anxiety may be another reason for equivocal findings in this area. Researchers such as Borkovec (1976), Hackfort and Schwenkmezger (1989), Landers (1980), and Weinberg (1990) have advocated a multimethod approach that incorporates cognitive, physiological, and behavioral indices in order to obtain a more complete understanding of the anxiety-performance relationship. Cognitive aspects of state anxiety can be measured by general questionnaires such as Speilberger's State-Trait Anxiety Inventory (STAI; Speilberger, Gorsuch, & Lushene, 1970) or by competition-specific questionnaires such as the Competitive State Anxiety Inventory - 2 (CSAI-2; Martens et al., 1990).

Physiological indicators of state anxiety can be classified into three groups: (a) respiratory and cardiovascular, (b) biochemical, and (c) electrophysiological (Hackfort & Schwenkmezger, 1989). Respiratory and cardiovascular parameters frequently studied with regard to anxiety include heart rate, blood pressure, and rate of respiration (Cox, 1990). Biochemical parameters include catecholamines like adrenaline and noradrenaline (Steptoe, 1987). Typical electrophysiological techniques include electromyography, electrocardiography, and electroencephalography (Cox, 1990). Behaviorally, state anxiety can be related to certain kinds of expressions, avoidances, and task-specific movements (Ekman & Oster, 1979; Hosek, 1983). From an intervention perspective, a consistent pattern of change across multiple measures of anxiety provides more compelling evidence (i.e., construct validity) for the treatment than does change in a single measure of anxiety (Smith, 1988).

The methods used to measure performance are a third limitation in many studies that have examined relationships among interventions, anxiety, and sport performance. Ebbeck and Weiss (1988) have noted that different performance measures (i.e., objective outcomes, subjective ratings, and competitive outcomes) are not equally related to precompetitive state anxiety. Their findings suggest that the nature of the anxiety-performance relationship may depend on the measure of performance used and that there is a need for precision in measuring sport performance. One promising approach to the precise measurement of performance, which also controls for skill level, is the comparison of current performance to seasonal averages or personal bests. This approach has been used effectively with golfers (Krane & Williams, 1987) and swimmers (Burton, 1988).

A final limitation in previous studies of the anxiety-performance relationship is the tendency to ignore individual differences. Researchers have primarily focused on between-subject comparisons and have not adequately considered individual reactions to a given level of anxiety or a specific pattern of anxiety change (Landers, 1980; Weinberg, 1990). To a certain extent, this tendency may reflect the fact that the predominant theories connecting anxiety to performance assume similar responses from most individuals. The inverted-U model, for example, assumes that there is an optimal level of arousal that is applicable to groups of performers (e.g., novices vs. experts) or to types of tasks (simple vs. complex). The quiescence model, which Morgan and Ellickson (1989) have suggested underlies much of the intervention research in sport psychology, makes the similarly general assumption that reductions in anxiety will produce improvements in performance for most people.

Hanin's (1980) zone of optimal function (ZOF) theory is one of the few anxiety models that gives individual differences a central position. According to Hanin, each individual has a preferred zone of arousal, and performance efficiency is maximized when the level of arousal falls within this zone. In other words, ZOF theory predicts that some individuals will have their best performances when arousal levels are low but that others will perform best when they are moderately or highly aroused. Thus, adequate understanding of the anxiety-performance relationship and effective use of performance-enhancement interventions depend on knowledge of how a given anxiety level affects the individual performer.

Single-subject research designs are consistent with the logic of Hanin's (1980) model and may be particularly useful for examining the relationship between state anxiety and sport performance. These designs also have some advantages over the traditional group design when conducting intervention research. First, the researcher does not have to locate a large number of people with the same performance problem (Zaichkowsky, 1980). Second, single-subject designs allow for the detection of small but consistent individual effects that might be masked in a group design (Bryan, 1987). Third, single-subject designs may be more appropriate than group designs when working with highly skilled athletes whose performance is unlikely to change dramatically from pretreatment levels (Wollman, 1986).

The present study utilized a single-subject, A-B, multidimensional, and multimethod design to examine the impact of an intervention program on state anxiety and performance in an elite rifle shooter. The traditional A-B-A withdrawal design was not considered appropriate for this study because discussions with the subject suggested that he was reluctant to undertake procedures that might reverse any gains made as a result of the intervention. Due to the inability of the A-B design to rule out alternative interpretations of treatment effects, steps were taken to control for events occurring between the baseline and postintervention assessments that could threaten the internal validity of the intervention.

Method

Subject Selection

The subject in this study was a 20-year-old male state-level small-bore rifle shooter. He had been competing seriously in his sport for 3 years. He trained 10 months of the year for approximately 10–15 hours per week. The following procedures were used to select this individual for participation in the study.

Initially, the coaching director of the state small-bore rifle association was asked to recommend several shooters of similar skill level and competitive experience whose performances suffered due to excessive anxiety. Anxiety was defined in lay terms as negative thoughts, feelings, or behaviors experienced during competitive shooting, including self-doubt, worry, verbal berating of oneself, tension, nervousness, and physical reactions such as knotted stomach, clammy hands, tense muscles, and accelerated heart rate (cf. Scanlan, Stein, & Ravizza, 1991).

The shooters were contacted individually and asked if they were interested in participating in a training program designed to improve their mental skills. If they expressed interest, they were interviewed. The interviews began with the collection of descriptive data (e.g., age, years competing, skill level, hours per week devoted to training, importance placed on competing well). Each shooter was then asked to rank-order from best to worst six categories of mental skills that were considered important for consistent shooting performance. The mental skills were: (a) maintaining concentration, (b) controlling emotions, (c) controlling nervousness and tension, (d) using mental imagery, (e) maintaining self-confidence, and (f) analyzing performance and planning appropriate courses of action (Grove & Hanrahan, 1988). Each category contained specific sport examples that clearly illustrated the mental skill.

Next, the shooters completed the CSAI-2 (Martens et al., 1990). They were asked to respond in terms of how they would expect to feel during their next important competition. This procedure was followed in order to ascertain each shooter's prospective level of anxiety. Hanin (1980) and Raglin and Morgan (1988) have found significant correlations between prospective and actual anxiety ratings of athletes. This procedure also provided valuable information regarding each shooter's response style. According to Schwartz, Davidson, and Goleman (1978), some people experience the physical symptoms of anxiety to a greater degree than the mental ones whereas others experience the opposite anxiety pattern.

Finally, each shooter completed the graphic body-activity subscale of the Autonomic Perception Questionnaire (Mandler, Mandler, & Uviller, 1958). Research by Borkovec (1976) and Lacey (1967) suggests that individuals tend to be differentially reactive in terms of a dominant response system. For instance, in stressful situations some people may respond primarily with increased heart rate; others may respond primarily with gastrointestinal symptoms. Determining the dominant response mode was considered important in order to evaluate each shooter's needs against the expertise of the research team and in order to plan the content of the intervention.

After considering the information from the interviews, one subject was selected for the study according to the following criteria: (a) controlling nervousness and tension was ranked as the worst mental skill, (b) projected cognitive and somatic state anxiety scores were higher than any other shooter's, (c) projected confidence scores were lower than any other shooter's, (d) cognitive and somatic state anxiety scores were relatively equal in value, and (e) somatic anxiety manifested itself primarily through excessive muscle tension and accelerated heart rate.

Adherence to these criteria ensured selection of a subject whose predominant modes of anxiety response matched the research team's areas of expertise and who possessed other desirable characteristics from a research perspective. Gould et al. (1984) and Martens et al. (1990), for example, have suggested that somatic anxiety may have little effect on performance if it is not high. It was also desirable that the subject experience relatively equal levels of cognitive and somatic anxiety because applied sport psychology research has yet to answer the question of whether certain anxiety-reducing techniques are more appropriate for specific types of anxiety. In other words, we wanted to assess whether the intervention would affect both cognitive and somatic anxiety in a similar fashion.

Dependent Measures

State Anxiety. A multimethod measurement of state anxiety was used based on Borkovec's (1976) suggestion that anxiety can be defined by the measurement of three response components: cognitive, physiological, and behavioral. Cognitively, state anxiety was measured using the Competitive State Anxiety Inventory - 2 (CSAI-2; Martens et al., 1990). The CSAI-2 is a 27-item competition-related, multidimensional scale that measures three components: cognitive anxiety, somatic anxiety, and confidence. Scores on each of the three subscales can range from 9 to 36, with high scores indicating high levels of state anxiety and confidence. Martens et al. (1990) reported acceptable internal consistency and construct validity for the CSAI-2.

Physiologically, three separate indicators of state anxiety were recorded. The first physiological measure was electromyographic responses (EMGs). Electromyograms of a selected muscle were recorded using AgAgCL surface electrodes. The EMG signals were amplified, band-passed filtered (5dB down at 3 Hz and 1 KHz), and relayed to a computer-based data acquisition system sampling at 1000 Hz. Analysis of the EMG data involved calculating the root mean square (RMS) of the recorded signal over a 2-second period prior to the firing of the rifle.

The second physiological measure was electrocardiographic responses (ECGs). Electrocardiograms were obtained from praecordial bipolar ECG leads using a Nihon Kohden Cardiofax Machine. Heart rate was recorded in the 5 seconds immediately prior to trigger release.

The third and final physiological index was biochemical in nature. Urine samples were taken during the competitive period and analyzed for catecholamine (i.e., noradrenaline and adrenaline) concentrations by radioimmunoassay techniques. Because different volumes of urine could be passed from one competition to another, catecholamine concentration was expressed in relation to creatinine excretion as it represents a constant proportion of urinary volume (McGilvery & Goldstein, 1983).

The behavioral component of state anxiety was measured using accelerometry. A lightweight uniaxial accelerometer was secured to the anterior aspect of the rifle stock. The recording axis of the accelerometer was aligned perpendicular to the rifle barrel. Accelerometer signals were amplified 100 times by a strain-gauge amplifier and were relayed to a computer-based data acquisition system sampling at 1000 Hz. The analysis of the accelerometer signals involved calculating the RMS of the recorded signals over a 2-second period prior to shooting.

Performance Index. Performance scores were obtained in actual competitions. These competitions consisted of 3 rounds of 20 business shots. The 20 business shots consisted of 5 shots directed at 4 targets. Performance scores were calculated by measuring the exact distance from the center of the bullet hole to the center of the target for each shot and then averaging these error scores for each round. This measure was considered a more refined and accurate index of performance than ordinal performance measures (i.e., 10, 9, 8, 7, etc.).

Treatment Procedures

Preliminary Sessions. The nature of the study was explained to the subject, and he was asked to sign an informed-consent form. He then reported to the laboratory several times and shot some practice rounds while state anxiety measures were recorded. This procedure was followed because of Nitsch's recommendation (cited in Hackfort & Schwenkmezger, 1989) that repeated exposure to experimental equipment and procedures would minimize the stress sensitivity toward them. This habituation response helped to ensure that we would subsequently be assessing the subject's reaction to competition-related stressors rather than to equipment and/or procedure-related stressors.

These practice rounds also enabled the research team to study the shooter's preshot routine so that the physiological (EMG, ECG) and behavioral (gun vibration) measures could be consistently recorded within seconds of trigger release. The research team determined, through consultation with the subject, that a wrist extensor of the trigger hand was the muscle from which EMG activity would be recorded. Finally, these practice sessions allowed the shooter to become familiar with the demands that would be placed on him during competition and helped the research team learn how to interact with him in an unobtrusive manner.

Baseline Assessment. Following the preliminary sessions, baseline measures of state anxiety and performance were obtained on-site during competition. The subject completed the CSAI-2 at the beginning of every round by responding in terms of how he felt at the present moment. The instructional set recommended by Martens et al. (1990) was used with the CSAI-2 to reduce response bias. EMG, ECG, and gun vibration recordings were obtained during the 5-second period prior to each shot. Twenty measurements were taken in each round, and an average value was calculated for each variable.

The subject was also instructed to void his bladder 1 hour prior to the start of the competition. Any urine subsequently passed was collected in a plastic container treated with hydrochloric acid. Competition usually lasted 2-1/2 hours, and a final urine sample was taken precisely 4 hours after the initial void. Finally, performance measures were taken for each shot fired during the competition. Twenty measures were taken in each round, and an average value was calculated. Point totals were also recorded for each round of competition and compared to the subject's yearly average to ensure the result was not excessively below or above what he normally scored in competition.

Intervention Program. The intervention used in this study was based on Kirschenbaum's (1984) model of self-regulation and Meichenbaum's (1977) multiple-component model of behavior change. Kirschenbaum suggested that athletic performance is a test of the athlete's capabilities in self-directed thinking, feeling, and behaving. In other words, he viewed performance enhancement in sport as a problem in self-regulation. Effective self-regulation of anxiety can be achieved through the use of a multicomponent treatment strategy that includes self-awareness training, mastery of thought-management and relaxation techniques, and simulation of stressful situations (Meichenbaum, 1977).

The intervention program consisted of 12 sessions that took place over a 6-week period. Educational and self-awareness activities occupied the first 2 sessions; the last 10 sessions were devoted to training in specific anxiety-management skills. During the initial sessions, the important cognitive, emotional, and behavioral components of shooting were identified and discussed. Potential sources of anxiety were also identified and discussed. Finally, an overview of the intervention program (length of program, time commitment, general content, etc.) was outlined for the subject.

In the 3rd and 4th sessions, the subject was introduced to Ravizza's (1983) stretch-out procedures. These procedures were described as a strategy for helping various parts of the body (e.g., the lower back) achieve a balanced, centered, and relaxed state through the practice of yoga-like exercises. A personalized tape was made for the subject, and he was asked to practice the stretching exercises every other day.

In Sessions 5 and 6, the subject received instruction in a modified form of Jacobson's (1938) progressive muscular relaxation (Steinmetz, 1980). This procedure was described as a method of listening to your body and distinguishing between muscle tension and muscle relaxation. Once again, a personalized tape was made, and the subject was instructed to practice the procedure every other day.

Thought stoppage (Cautela & Wisocki, 1977) was introduced during Sessions 7 and 8. Common internal and external distractions were identified, and the subject was instructed to mentally rehearse these distractions. He was then shown how to block the distractions with physical (i.e., squeezing his trigger hand into a fist) and mental (i.e., covertly shouting the word *stop*) cues. He was also instructed to breathe from his diaphragm and repeat coping statements designed to handle various distractions. Finally, he was shown how to direct his attention toward the target in a more task-directed manner. A personalized tape was made for him to practice these techniques.

ECG biofeedback training was introduced during Sessions 9 and 10. Biofeedback was used as part of the treatment package based on Zaichkowsky's (1982) recommendation that it can enhance self-regulation and is most effective in combination with other forms of cognitive intervention. ECG training was chosen because the subject felt that developing better awareness and control of his heart rate (HR) was extremely important for optimal performance. During these sessions, HR was monitored using an Ohmeda Pulse Oximeter. The subject was asked to shoot 60 shots in practice and verbally estimate his HR after each shot. He received audio feedback through a pair of Sennheiser HD 424 earphones to indicate the accuracy of his HR estimation. One tone was given if his HR estimation was within five beats per minute of his actual HR, and two tones were given if his HR estimation was in error by more than five beats per minute. The biofeedback training stopped when the subject was able to consistently predict his HR after each shot.

During Session 11, the previous sessions were summarized into two audiotapes. One tape contained an abbreviated version of the stretching and muscle relaxation procedures, and the subject was instructed to listen to this tape approximately 30 minutes prior to competition. The other tape summarized the remaining sessions, and the subject was instructed to listen to it just prior to the start of competition and between each round of shots. This second tape lasted 90 seconds and was designed to trigger a relaxed and focused state.

During Session 12, the subject practiced using his intervention strategies in an actual competition. This "in vivo" training experience helped the subject become comfortable with using the intervention techniques under competition conditions, and it gave the researchers an opportunity to discuss implementation problems with the subject.

Postintervention Assessment. Measures of state anxiety and performance were once again obtained on-site during competition after completion of the 6-week intervention program. Data collection procedures were identical to those used during the baseline assessment. The only additional requirement was that the subject arrived 20 minutes earlier for this competition to allow time for his muscle relaxation and stretching exercises. He also listened to the 90-second tape prior to the start of the competition and between each round of shots.

Controls for Internal Validity. Internal validity concerns whether or not factors unrelated to the treatment can be ruled out as explanations for observed changes in behavior (Smith, 1988). Intervention programs are vulnerable to extraneous factors that threaten their internal validity. One factor is the events in the subject's life that precede or follow the intervention (Cook & Campbell, 1979). For example, if changes occur in diet, sleep patterns, general well-being, training habits, or fitness during the period of the intervention, then these changes constitute potential explanations for differences observed in the baseline and postintervention assessments. Similarly, physiological processes and the instruments used to assess them can be affected by changes in climate, fitness, circadian rhythms, and/or the demands of the sporting activity (Hackfort & Schwenkmezger, 1989). State anxiety during riflery could also be influenced by changes in competition-related factors such as the importance of the contest or the environmental conditions (e.g., wind conditions).

Several of these potentially confounding factors were monitored in this investigation so that they could be evaluated as plausible alternative explanations for treatment effects. Monitoring was accomplished by asking the subject to keep a diary related to his diet, sleep patterns, training habits, and general health. He also underwent a PWC-170 submaximal fitness test at the beginning and end of the study. In addition, care was taken to ensure that both baseline and postintervention competitions took place on the same day of the week and at the same time. Temperature and wind readings were recorded for both competitions, and the subject was asked to rate their perceived importance on a 4-point bipolar scale. Finally, to minimize the potential for changes in body position to affect the outcome measures, data was collected only while the subject was shooting from the prone position.

Results and Discussion

Means (and standard deviations where applicable) for the baseline and postintervention competitions are presented in Table 1. Graphic representations of treatment effects for the self-report, physiological, and performance variables appear in Figures 1, 2, and 3, respectively.

Table 1

Self-Report, Physiological, and Behavioral Indices of State Anxiety and Performance for Baseline and Treatment Competitions

	Baseline competition						Treatment competition					
	Round 1		Round 2		Round 3		Round 1		Round 2		Round 3	
Variables	*M*	*SD*[b]	*M*	*SD*[b]	*M*	*SD*[b]	*M*	*SD*[b]	*M*	*SD*[b]	*M*	*SD*[b]
Cognitive anxiety	26.000		24.000		21.000		20.000		19.000		17.000	
Somatic anxiety	20.000		18.000		15.000		13.000		11.000		11.000	
State confidence	19.000		21.000		24.000		24.000		26.000		29.000	
Urinary noradrenaline[a]	.027						.005					
Urinary adrenaline[a]	.016						.001					
Accelerometry (gun vibration)	3.850	.660	3.790	.550	3.460	.470	3.650	.560	3.410	.480	3.380	.410
Heart rate	90.750	1.320	87.750	3.740	80.250	1.800	96.250	4.000	85.500	2.450	83.750	1.070
EMG (forearm)	.073	.040	.062	.030	.048	.020	.075	.040	.074	.050	.078	.050
Performance error (mm)	46.750	5.890	44.000	6.780	34.000	6.740	38.250	9.440	36.250	16.910	24.500	4.060

[a]Measured over a 4-hour period during competition.
[b]*SD* cannot be computed for some variables because they are single observations.

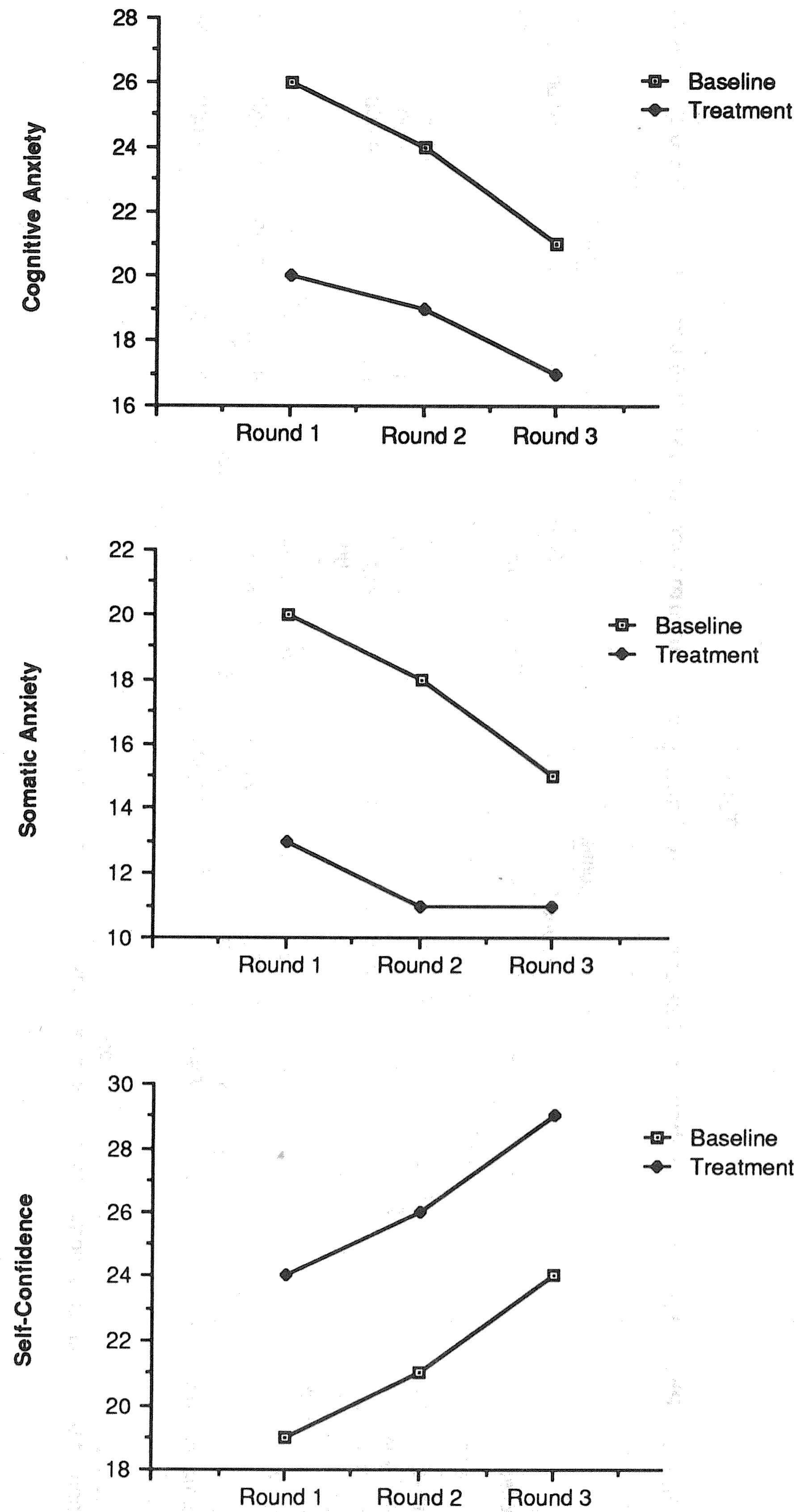

Figure 1 — Self-reported levels of cognitive anxiety, somatic anxiety, and self-confidence for the baseline and postintervention competitions.

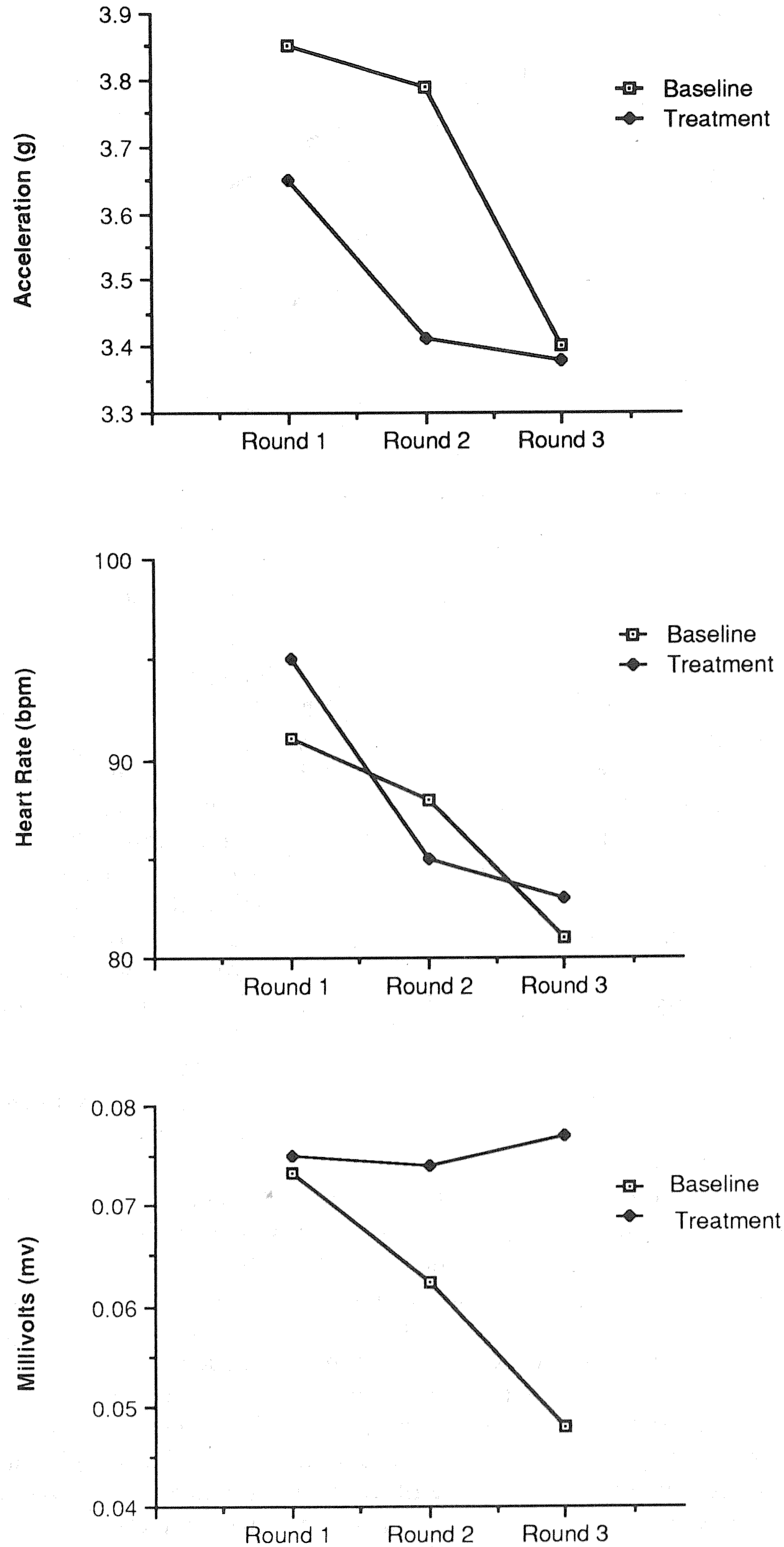

Figure 2 — Gun vibration, heart rate, and forearm EMG readings for the baseline and postintervention competitions.

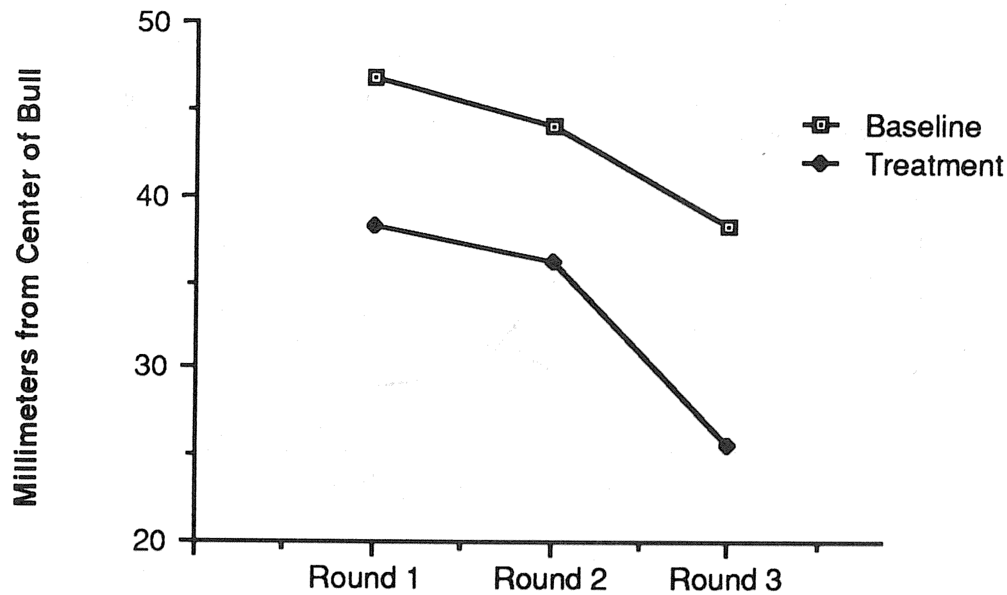

Figure 3 — Performance error in the baseline and postintervention competitions.

With respect to within-competition effects for state anxiety, the general pattern was a gradual decrease across rounds. This pattern held for cognitive and somatic anxiety (Figure 1, top and middle panels), gun vibration (Figure 2, top panel), heart rate (Figure 2, middle panel), and EMG activity during the baseline competition (Figure 2, bottom panel). EMG activity in the postintervention competition was the only anxiety measure that did not exhibit this pattern. Within-competition changes in self-confidence and performance were generally positive, with increases in confidence (Figure 1, bottom panel) and decreases in performance error (Figure 3) occurring across rounds in both competitions. Thus, the data suggest that the various indices of anxiety were, with the possible exception of EMG, positively related to each other but negatively related to self-confidence and performance.

The data also suggest that the intervention used in this study was effective in reducing state anxiety and improving shooting performance. Examination of Table 1 and Figures 1, 2, and 3 reveals that cognitive anxiety, somatic anxiety, and gun vibration were lower for each round of the postintervention competition than for the corresponding round of the baseline competition. At the same time, self-confidence was higher and performance error was lower during the postintervention shoot than during the baseline shoot. In addition, Table 1 and Figure 4 reveal that urinary adrenaline and noradrenaline levels were well below baseline during the postintervention competition. Thus, consistent patterns of change in an expected direction were observed across multiple measures of state anxiety and performance, suggesting that the intervention was responsible for these changes (Smith, 1988). Anecdotal evidence for the effectiveness of the intervention was provided by the subject and his coach. Both individuals read a summary of the findings, agreed with the nature of the changes, and expressed the opinion that the intervention was primarily responsible for these effects.

Table 2 presents a comparison of personal and environmental factors associated with the baseline and postintervention competitions. Potentially confounding

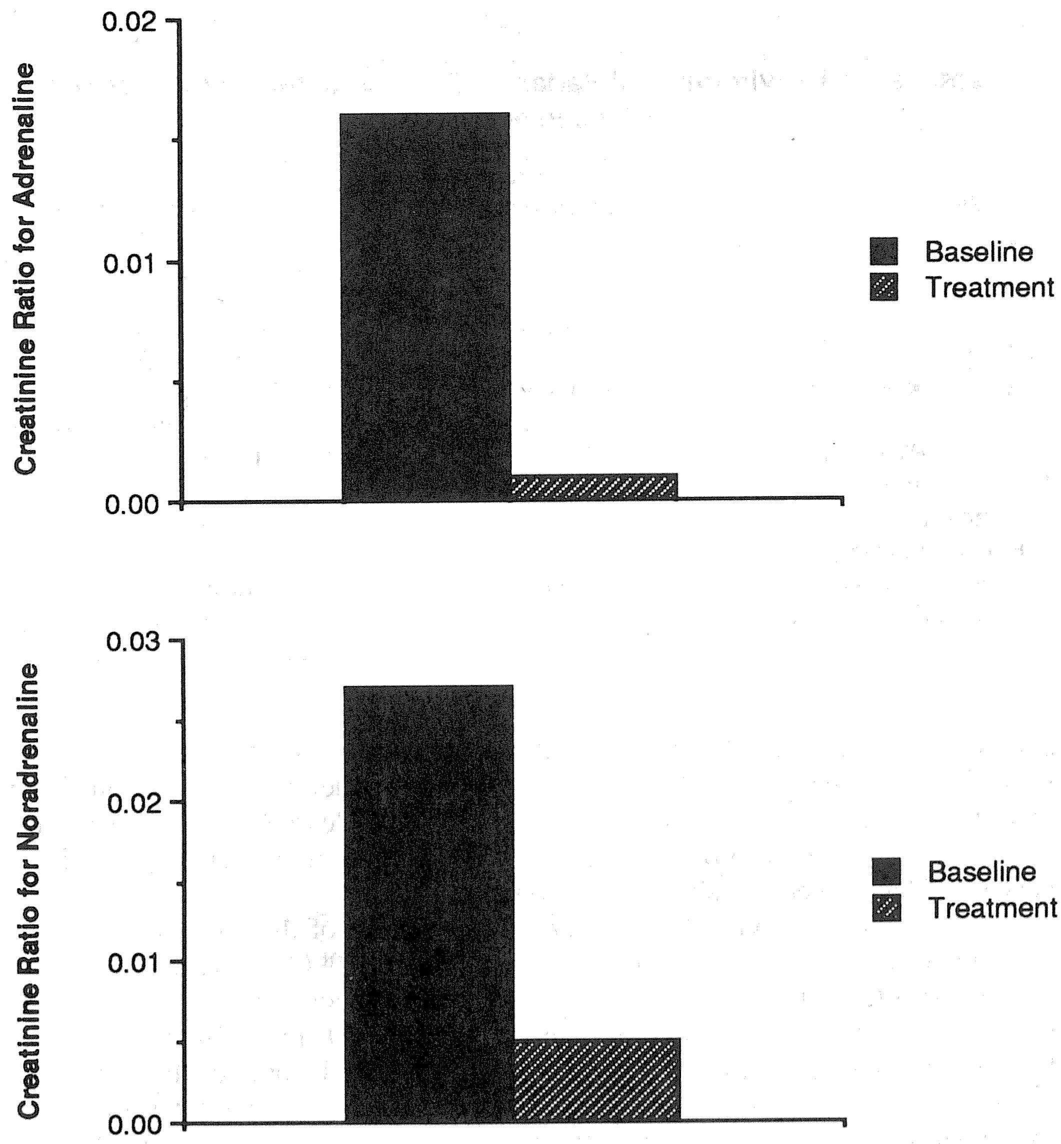

Figure 4 — Urinary adrenaline and noradrenaline levels during the baseline and postintervention competitions.

personal variables were almost identical across the two competitions. Diet, sleep patterns, general health, training habits, and physical fitness changed very little from baseline to postintervention assessment and are unlikely to have produced the changes shown in Figures 1–4. A similar conclusion can be made regarding several potentially influential environmental variables. Both competitions were perceived as equally important by the subject, and only minor differences existed in temperature, relative humidity, and wind conditions.

Although no formal evaluation was made of the relative merits of the interventions, the subject did make some noteworthy comments along these lines. He viewed the "in vivo" simulation to be particularly beneficial: "I felt I had learned the program, but I wasn't sure whether I could actually implement it when it really counted. The opportunity to test these new skills under competitive

Table 2

Personal and Environmental Variables Related to the Internal Validity of the Intervention

Variables	Baseline competition	Treatment competition
Personal		
Diet	No restrictions	No restrictions
Sleep	9 hours per night	9 hours per night
General well-being	No major illness	No major illness
Training	10–15 hours per week	10–15 hours per week
Fitness (PWC_{170})	116 watts	126 watts
Environmental		
Temperature	18 °C	21 °C
Relative humidity	82%	75%
Wind conditions	Gusting 2–10 mph	Gusting 0–8 mph
Importance of competition	3	3

conditions gave me a great deal of confidence.'' Learning how to refocus attention following a distraction was also mentioned as a very beneficial intervention: ''We identified the things that distract me the most, and I learned how to deal with them. I learned how to properly regain my concentration, especially when I get nervous. That helped me shoot more consistently.''

Our interaction with this shooter and the results of this investigation lead us to agree with several observations made by Mace (1990) in a recent review of anxiety-oriented intervention research. First, the subject(s) used in anxiety research must demonstrate symptoms of anxiety that are detrimental to performance. Even though athletes may experience anxiety symptoms, some of them may not perceive these symptoms to be negative or debilitative to their performance. Implementing appropriate interventions requires that the scientist/practitioner have a thorough understanding of the intensity, frequency, and pattern of individual anxiety reactions. Second, it appears that the effectiveness of interventions is enhanced if a considerable amount of time is devoted to the specific needs of individual athletes. Interventions are less likely to be effective if they use the same procedures for large groups of athletes or if they do not allow time for specific target behaviors to be well-learned. Finally, training and testing conditions should, as much as possible, simulate the conditions under which the athlete must perform. Effective transfer of mental skills to the competitive environment and accurate evaluation of treatment effects will be facilitated by an ecologically valid training environment.

In summary, findings from this study suggest that a multimethod cognitive-behavioral intervention program reduced state anxiety and improved performance for an elite rifle shooter. Consideration must be given, however, to the fact that we could not control for the athlete's expectation for improvement due to intervention. In addition, the single-subject design restricts generalizations to other athletes, therapists, and sports. Thus, there is a need to test the reliability of our findings by conducting both idiographic and nomothetic research with athletes in a variety of sports. In the process, we may achieve a more thorough understanding of the complex relationships among anxiety, interventions, and sport performance.

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