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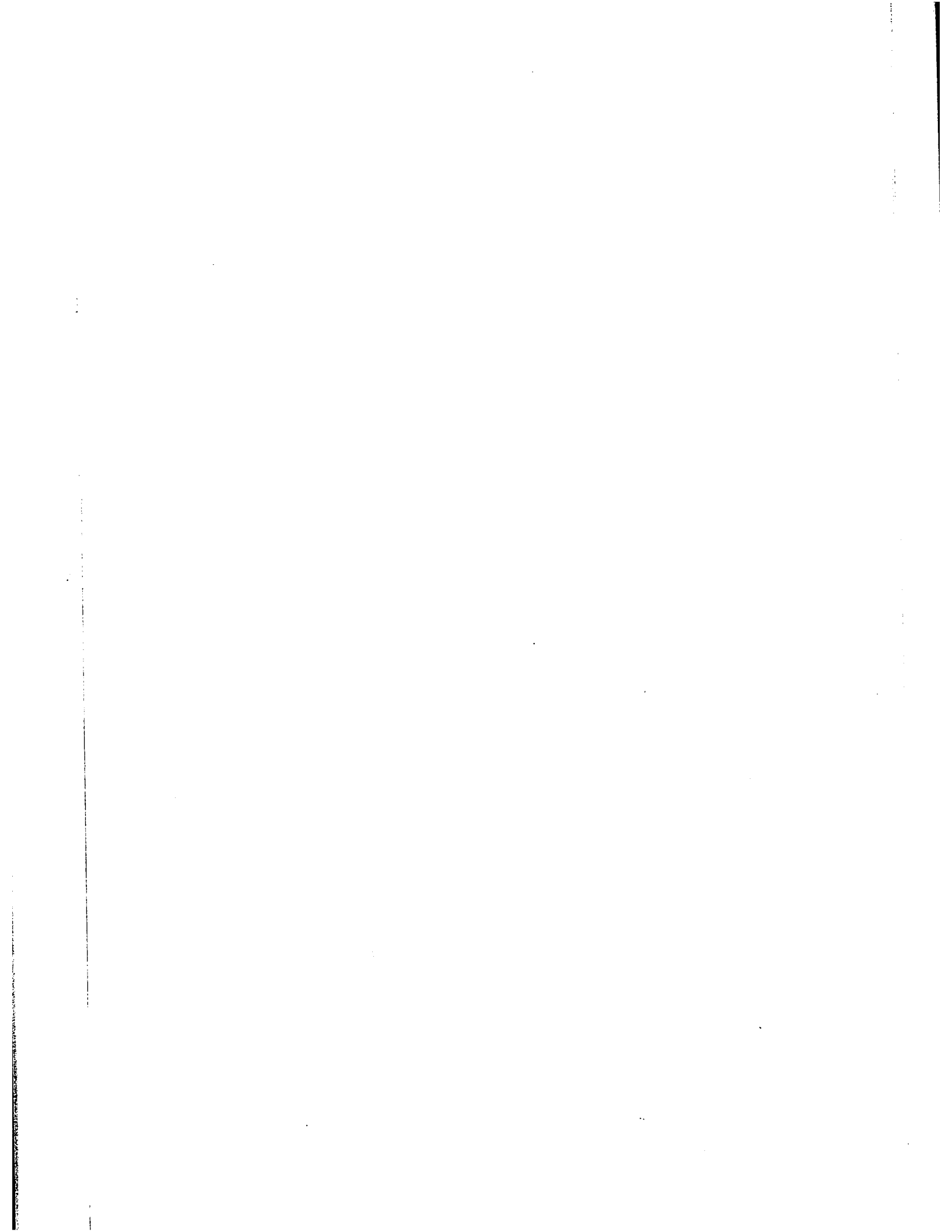
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EMG BIOFEEDBACK FOR CONTROL  
OVER PRE-COMPETITIVE ANXIETY  
WITHIN A LABORATORY CONTROLLED ENVIRONMENT

By

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B.E.P. (spec.), University of Ottawa, 1976

A thesis

submitted to the school of Graduate Studies  
in partial fulfilment of the requirements for the degree of  
Master of Science in Kinanthropology

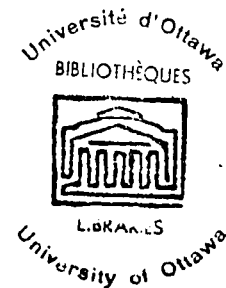
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## ABSTRACT

The purpose of this study was to investigate the effects of frontalis electromyographic (EMG) biofeedback (BF) training on sport pre-competitive anxiety variables and on motor performance, within a laboratory controlled environment with high trait anxious boys from 10 to 13 years of age.

From 261 tested subjects (Ss), 80 Ss scored in the upper quartile of the Sport Competition Anxiety Test (SCAT) and from this latter sample, 20 Ss were randomly selected and randomly assigned to either a group having frontalis EMG BF (n = 10) or to a group receiving a placebo condition. The Ss were yoked for contingent positive verbal qualitative feedback (CPVQF).

The Ss participated in a bogus sport competitive tournament. An elaborate bogus setting was presented to the Ss in order to control for variables such as opponents, audience and success-failure. The objective of the game was to beat an opponent two out of three times to win a match and to achieve first place in a pyramidal tournament that consisted of five matches. The opponent was a bogus character who was purportedly in a different location and represented by a timer in the S's room. The task consisted of keeping a stability platform in horizontal balance for as long as possible within a 30 second trial. The six laboratory sessions consisted of a practice session and five

matches. Each session was comprised of an adaptation period, three games separated by three rest periods, then post measurements. During rest periods, the BF Ss (n = 10) were given frontalis EMG auditory and visual feedback while the placebo Ss (n = 10) listened to white noise. During this period, the placebo Ss were given the same instructions as the BF Ss but modified so as to describe the treatment procedures pertinent to each group. The BF group also received CPVQF from the experimenter (E) at the end of the rest period when warranted. The placebo group received the same CPVQF as their respective yoked BF S.

General trait anxiety (STAIC FORM C-2) and sports specific trait anxiety (SCAT) were administered before and after the laboratory sessions. Frontalis EMG mean peak-to-peak microvoltage was recorded continuously during the 20 minutes rest periods of every session. Frontalis EMG, heart rate, and respiratory rate were recorded within every session: after adaptation, before every game (except during the practice), at the end of every rest period and at the end of every session. State-anxiety (STAIC FORM C-1) and subjective perception of optimal tension level to perform were recorded before every game. Time performance and error performance were recorded three times per session. A taped interview concluded the last session. The data for all the variables (except for trait anxiety and the post interview) was treated by a three way ANCOVA with repeated measures using the baseline measure of the practice session

as the covariate. The data for the trait anxiety variables was treated by a two way ANOVA with repeated measures. The post interview data was kept descriptive.

Significant group differences were found only on the EMG variable in the general competitive setting and in the rest periods, thus, supporting the notion of specificity of frontalis EMG BF. However, the results did suggest the potential use of the frontalis EMG BF to transfer its specific effect from rest to general competitive setting. The high variability during the rest periods recorded by the placebo Ss on the EMG data also suggested the possibility that BF may have strong potential for children where the BF modality seems valuable so as to maintain the child's attention and may also be valuable to his understanding of relaxation.

The study showed significant increases in all of the anxiety parameters assessed in this study except for trait anxiety thus, providing some support for Martens' (1977) model of competitive stress. Trait anxiety was assessed differently from the former variables (pre-post design). A significant decrease in sport specific trait anxiety (SCAT) was found for both groups and could be attributed to the highly successful outcomes experienced during the tournament. The success-failure variable may have also influenced variations in state anxiety across the sessions and trials. Results on the motor performance variables as expressed by time and error showed a positive learning curve

with regard to time, thus remaining in balance for longer periods of time across sessions. However, motor performance as assessed by error, increased across sessions. Results from the post interview suggest a placebo effect on subjective measures. This study does not provide support for a cross modality effect or performance enhancement under competitive stress that may be attributed to frontalis EMG BF.

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## CHAPTER I

### THE PROBLEM

There are numerous millions of children involved in competitive sports (Scanlan, 1976). According to Scanlan's estimate (1976), more than half of these children's leisure time would be occupied by competitive activities. Recent studies by Martens, Gill, Simon and Scanlan (1975), and Wine (1974) demonstrated that the competitive environment increases situational anxiety. Also, high trait anxious individuals tend to be more influenced by the competitive situation (Wine, 1974). Their state anxiety in a competitive situation is generally higher than the lower trait anxious Ss and thus, they tend to be more negatively self-oriented (Wine, 1974) and perform more poorly. In short, sport competitive anxiety may lead to detrimental effects on such aspects as psychological and physiological well-being, motor learning, self-concept, and sport participation (Orlick, 1978).

The numerous young athletes facing sport competitive stress have the choice to either "fight or flight" the process. How positive is their experience in this sporting environment? If the athletes could learn how to cope with competitive stress, they would probably be better able to have a more positive experience in the sporting environment. Different techniques have been proposed to cope with stress. Among them, the relatively new BF methods have demonstrated

positive results for control over various physiological processes and emotional states such as anxiety and relaxation (Blais and Orlick, 1977). From the different parameters of biofeedback, electromyographic (EMG) biofeedback (BF) seems to be the "soundest" for clinical applications to induce relaxation and reduce anxiety (Blanchard and Young, 1974).

#### PURPOSE

The purpose of this study was to investigate the effects of frontalis EMG BF training on sport pre-competitive anxiety variables and on motor performance, within a laboratory controlled environment with high trait anxious boys from 10 to 13 years of age.

#### SUB-PROBLEMS

The sub-problems that this study investigated could be grouped into three components. The first component assessed was that of the effects of EMG BF on physiological responses namely, frontalis EMG, heart rate and respiratory rate during the general competitive setting, the rest periods and the competitive stress periods. The second parameter assessed the effects of EMG BF on psychological variables such as state anxiety and subjective perception of optimal tension level to perform during the competitive stress periods. The psychological parameter also included specific and general trait anxiety assessed before and after the

experimental procedures. Finally, the third parameter assessed the effects of EMG BF on motor performance as revealed by time and error, during the competitive stress periods.

#### DEFINITIONS

Electromyographic biofeedback. Electromyographic biofeedback (EMG BF) was operationally defined as constant auditory clicks and needle deflection (analog meter) varying in frequency (clicks) or deflection (analog meter) proportionately to the average mean peak-to-peak microvoltage (wave amplitude) of the frontalis muscle. When peak-to-peak value increased, the clicks' frequency increased and the needle deflected towards the right side of the meter. Contingent positive verbal qualitative feedback was also considered as part of the EMG BF condition. This latter element of the EMG BF condition was given by the experimenter (E) to the BF subject (S) after the rest period if the S had a lower EMG reading than at the beginning of the respective rest period.

Placebo condition. The placebo condition was operationally defined as giving the same basic instructions as that of the EMG BF condition but modified so as to describe the treatment's procedures pertinent to each condition. The placebo condition consisted of listening to auditory white noise and having positive verbal qualitative feedback according to the yoke procedure.

Yoke Procedure. The yoke procedure was defined as the pairing of a BF S to a placebo S, whereby the latter received the same positive verbal qualitative feedback at the same moment of the experimental procedure as did his paired BF S.

Pre-Competition. This was the period before the S engaged actively in the task or event. Pre-competitive measurements were taken (approximately) three minutes before competition.

Pre-Competitive Anxiety. This was defined as a specific situational anxiety manifested through physiological and psychological responses to a pre-competitive laboratory setting. Physiological responses were measured on EMG mean microvoltage, heart rate and respiratory rate. Psychological responses were evaluated by Spielberger's STAIC FORM C-1 for state anxiety and by subjective self-report of optimal tension level to perform.

Competitive Stress Period. The competitive stress period was operationally defined as the measurements taken at the third minute after the bogus technician announced that: "we will start the game in three minutes from now! ". The Ss were not receiving any EMG BF or placebo condition during this period.

Rest Period. The rest period was operationally defined as the recordings taken at the last minute of treatment or placebo conditions. Therefore, the recordings were taken while the Ss were having either EMG BF or listening to white

noise.

General Competitive Setting. The general competitive setting was operationally defined as the combination of both the competitive stress periods and the rest periods recordings.

General Trait Anxiety. This was operationally defined as the score from Spielberger's STAIC FORM C-2 questionnaire.

Specific Trait Anxiety. This was operationally defined as the score from Martens' Sport Competition Anxiety Test (SCAT) questionnaire.

State Anxiety. State anxiety was operationally defined as the score on Spielberger's STAIC FORM C-1.

Motor Performance. This was defined as the Ss' performance on a stabilometer for a period of thirty seconds. Performance was assessed by two variables: 1) time in horizontal balance and 2) number of errors.

Practice. The practice was defined as the first experimental session which consisted of the same procedures as for the matches except that no competitive element was presented to the S

Matches. The matches were defined as the five experimental sessions following the practice. The five matches were characterized by their sport competitive element.

### DELIMITATIONS

The population for this study was limited to males between the ages of 10 to 13 years and who scored in the upper quartile of the trait anxiety distribution of tested Ss. Only those meeting the above criteria, who obtained authorized permission and agreed to go through the entire experiment were used.

The study was limited to three physiological variables, four psychological variables and two motor performance variables. In the broad field of anxiety control, many treatments have been presented; for the purpose of this research, one treatment was investigated: EMG BF.

To assess motor performance this research was limited to the task of maintaining a horizontal balance on a stabilometer.

### HYPOTHESES

1. It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak microvoltage than that of the placebo group during the general competitive setting.

2. It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak microvoltage than that of the placebo group during the rest periods.

3. It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak

microvoltage than that of the placebo group during the competitive stress periods.

4. It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rates than that of the placebo group during the general competitive setting.

5. It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rate than that of the placebo group during the rest periods.

6. It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rates than that of the placebo group during the competitive stress periods.

7. The EMG BF group would show lower pre-competitive respiratory rate than that of the placebo group during the general competitive setting.

8. The EMG BF group would show lower pre-competitive respiratory rate than that of the placebo group during the rest periods.

9. The EMG BF group would show lower pre-competitive respiratory rate than that of the placebo group during the competitive stress periods.

10. It was hypothesized that the EMG BF group would perceive significantly lower levels of tension than that of the placebo group during the general competitive setting.

11. It was hypothesized that the EMG BF group would have significantly lower levels of state anxiety than that of the placebo group.

12. It was hypothesized that the EMG BF group, would

improve their performance (higher times) on the stabilometer significantly more than that of the placebo group.

13. It was hypothesized that the EMG BF group, would improve their performance (lower errors) on the stabilometer significantly more than that of the placebo group.

14. It was hypothesized that the EMG BF group would have significantly lower levels of specific trait anxiety (SCAT) than that of the placebo group.

15. It was hypothesized that the EMG BF group would have significantly lower levels of general trait anxiety (STAIC FORM C-2) than that of the placebo group.

#### Significance of the Study.

Research on BF treatment in the sport competitive environment is still unexplored. Advertisements of BF instruments are becoming more prevalent and salesmen are solicitating different amateur and professional athletic teams. Hence, a need for systematic studies exists to assess the effects of BF in the sporting environment. The main significance of this study would be to initiate an investigation of the potential effects of EMG BF on situational sport pre-competitive anxiety variables within physiological, psychological and motor performance parameters.

Very few studies have dealt with the use of EMG BF with children on control of their frontalis muscle and assessed on three different parameters: physiological, psychological,

and motor performance. This study will have the additional value of observing the effects of muscular control of the frontalis on the learning of a gross motor task within a competitive stress situation.

In summary, the main contribution of this research is to initiate systematic investigations to evaluate EMG BF's potential as a possible means to control sport pre-competitive anxiety for youngsters involved in sport competitive structures.

## CHAPTER II

### REVIEW OF THE LITERATURE

A variety of concepts are involved in studying the effects of EMG BF on pre-competitive anxiety in a controlled situation. Therefore, it was felt that for the purpose of this review, certain anxiety related concepts should be briefly discussed before presenting the literature concerning the major problem.

The basic problem investigated in this study has been the various effects of an EMG BF treatment on various physiological, psychological and motor performance variables. Therefore, the review of literature will focus mainly on previous studies involving EMG BF as a possible means of relaxation and anxiety reduction. Finally, an attempt will be made to summarize and relate the major problems and contributions relevant to this study.

#### Stress and Anxiety.

Stress and anxiety are subject to confusing interpretation (Appley and Trumbell, 1967; Lazarus, 1966). However, Spielberger (1970) grouped these two latter variables together and spoke of anxiety as having a personality characteristic (trait anxiety) and a situational component (state anxiety). Spielberger conceptually defines state anxiety as:

"a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension, and heightened autonomic nervous system activity." (Spielberger, 1970, p. 3)

and trait anxiety as

"relatively stable individual differences in anxiety proneness, that is, to differences between people in the tendency to respond to situations perceived as threatening with elevations in A-State intensity." (Spielberger, 1970, p. 3).

Through Spielberger's definition of state anxiety, two important variables are worthy of consideration: feelings and heightened autonomic nervous system activity.

Human reaction to stress can be detected by both psychological and physiological means (Spielberger, 1970; Martens, 1974). Psychological reactions to stress can be evaluated by subjective measurement (e.g., self-evaluation questionnaire of state and trait anxiety) or by objective observable actions such as differences in performance or by direct observational systems of behavior analysis. In regard to subjective psychological assessment of anxiety (self-evaluation scales), Martens (1971) has presented a comprehensive review of research in the domain of anxiety and motor performance. He mentioned the general weakness in anxiety measurements particularly regarding the popular use

of Taylor's Manifest Anxiety Scale (MAS) with motor behavior research. Martens commented on this latter scale:

"(MAS) has proven to be an inadequate operational definition when testing drive theory notions extended to motor behavior." (Martens, 1971, p. 172)

Furthermore, he suggested (based on McReynold's review, 1968) that Spielberger's State-Trait Inventory (STAI) bears impressive credentials and uniqueness for evaluating state and trait anxiety with separate scales (Martens, 1971, p. 172).

Spielberger's A-State and A-Trait has high reliability, concurrent and construct validity (Spielberger, 1970). The child form (STAIC FORM C-1) for A-State showed test retest reliability from a Florida sample ( $n = 456$ ) of children in the fourth, fifth and sixth grade of .82 for males and .78 for females. From the same sample, Spielberger showed evidence of construct validity, where the scale showed significant differences between normal conditions and the pre-examination condition in the classroom. Spielberger's STAIC FORM C-2 for A-Trait showed test retest reliability of a .65 coefficient for boys and .71 for girls, both from the Florida sample. From this latter sample, Spielberger reported that the STAIC FORM C-2 correlated with the Children's Manifest Anxiety Scale (.75) and with the General Manifest Anxiety Scale (.63).

The A-State construct was recommended for the evaluation of situational anxiety in the sport competitive

process (Martens, 1971). However, Martens notes the problem of specificity of situational anxiety where sport competitive anxiety is an example of specific situational anxiety. It was therefore recommended that in order to assess competitive anxiety, specific scales should have higher predictability value.

Physiological responses to stress are measured in a more objective manner by means of various physiological processes. Among the responses commonly studied are: hormonal secretion, muscle action potential, oxygen consumption, respiratory and heart rate, electroencephalographic brain waves, blood pressure and skin conductance (Martin, 1961).

Earlier, Martin (1961) in a review of assessment of anxiety by physiological and behavioral measures, noted a general problem of low intercorrelations among physiological indicators of arousal. Krause and Sarason (from Martens, 1974) came to the same conclusion in their reviews of the literature. What may account for this problem is the specificity of the individual and the situation to which he is submitted.

#### Anxiety and Performance.

Inconsistency of research results in the domain of anxiety and motor performance has been reported by Duffy (1962) and Martens (1971). After reviewing more recent literature on this issue, Martens (1974) confirmed the

conclusions made by Duffy in 1961:

"It appears, then, that it is impossible to state what particular level of activation is most conducive to good performance. The answer might be considered to depend upon the requirements of the task at the moment, and certain characteristics of the individual, some of which may be temporary and others more or less permanent. If the assumptions made up to this point are tenable, it seems certain that there is an "optimal" level of activation for a given task to be performed by a given individual at a given time. It would appear also that for most individuals and for most tasks the optimal level is a moderate degree of activation, high enough to assure reasonable speed and alertness, and low enough not to present a hazard to the organization of responses." (from Martens, 1974, p: 185).

Therefore, specificity of the task, situation and of the individual may be important elements to consider.

Field studies by Fenz (1973, 1974), Fenz and Epstein (1967) and Fenz and Jones (1972) with sport parachutists reported consistent patterns of arousal autonomic responses, (galvanic skin response, heart rate and respiratory rate) and cognitive responses with the subjects' experience and performance in jumping. They recorded the reactions of parachutists throughout a sequence of events leading to a jump. Their studies demonstrated that while novice jumpers produced a sharp increase in physiological activity and reported an increase in anxiety and fear, up to the moment of the jump, experienced parachutists produced (on dependent variables) an inverted "v" shaped curve, i.e. an initial

increase well before the jump was followed by a decrease (Fenz and Epstein, 1967, p. 251). It is suggested that the inverted "V" shaped curve of the good performers is characteristic of a more adaptive response to the situation. Also, they have demonstrated that when novices and expert jumpers made good jumps, both groups experienced a reduction of arousal before jumping (Fenz and Epstein, 1967). Later, Fenz (1974) replicated the field study with the addition of a reaction time task in a mobile laboratory at the airport. The same pattern of results occurred in the mobile laboratory as in the field situation, and some interesting similarities were depicted between the time reaction task and the jumping situation. For instance, before both tasks the "good" performers had evidently lower heart rates than the "poor" performers. Significant differences were reported between performers in the jumping situation ( $p < .01$ ) while in the reaction time task, differences were almost significant ( $p < .06$ ) for heart rate. Significant differences were reported in groups' performance on the reaction time task ( $p < .05$ ). Fenz commented on his results concerning the jumping situation:

"These results point out that experience by itself does not make for skill, and that skill is directly related to the way in which a person has learned to control his autonomic responding." (Fenz, 1974, p.253).

### COMPETITIVE ANXIETY

Within organized sports, the competitive structure is eminent throughout our North American society (Scanlan, in press). Competition may be viewed as a 4 stage process (Martens, 1977) that intergrates the objective competitive situation, the subjective competitive situation, the responses and consequences of engaging in the competitive process (Martens, 1977).

The objective competitive situation may be operationally defined as:

"a situation in which the comparison of an individual's performance is made with some standard in the presence of at least one other person who is aware of the criterion for comparison and can evaluate the comparison process." (Martens et. al., 1975, p. 289)

The subjective competitive situation could be defined as "How the person perceives, accepts, and appraises the objective competitive situation..." (Martens et.al., 1975, p. 289). The responses and the consequences of engaging in the competitive process is often determined by the subjective competitive situation (i.e. state anxiety).

Among the different subjective and response variables that the objective competitive situation may interact with, anxiety may well be a common denominator. Wine (1974) showed that high test anxious individuals are more self-focused with self-comparison, negative self-statements and concern about their autonomic reactions, especially under any

evaluative situation such as competitive sports. She also concluded that performance was affected by these concerns. This report seems to coincide with Fenz et.al. studies with the parachute jumpers under real life stress. In this regard, the evaluative situation was similar to real life stress where both studies reported that high anxious Ss tend to have more self-oriented negative statements than the low anxious Ss. Furthermore, it seems that the performance had a direct relationship with these behaviors under evaluative and real life stress situations (Fenz, 1974; Wine, 1974).

Martens et. al. (1975) were also concerned with the two elements of anxiety and competition and their possible relationship. In this regard, they formulated a theory of competitive stress as "to predict the levels of state anxiety (A-State) among different people in varying competitive situations" (Martens et. al., 1977). Briefly summarized, this theory indicates that state anxiety (A-State) is a function of threat (T), where threat may be a function of the uncertainty (U) of the outcome and the importance (I) of the outcome. This latter theory can be expressed as:

$$A\text{-State} = f(T) = (U \times I)$$

The theory is based on Martens' competitive process, Spielberger's trait-state theory of anxiety and McGraths conceptual model of stress (Martens et.al., 1975, p. 589).

The theory predicts that high trait anxiety Ss will

have a higher state anxiety:

"The theory of competitive stress predicts that persons higher in competitive A-Trait perceive more competitive situations as threatening and/or are more threatened in a competitive situation than persons with lower levels of competitive A-Trait." (Martens et. al., 1975, p.289)

In this regard they have developed a Sport Competition Anxiety Test (SCAT) to assess competitive A-Trait. To validate the SCAT instrument, a series of experiments were done involving boys between 10 and 12 years of age. These experiments were characterized by a simulated competitive environment in a mobile van:

"Subjects competed on a complex motor maze task for 20 contests via a purported computer hookup with a bogus opponent at another school in a similar van. Success-failure was manipulated by the experimenter and evaluation potential was maximized through instructions, knowledge of results, and emphasis on the Ss ability as the primary determinant of the outcome." (Martens et.al., 1975, p.290).

Results from these studies showed (among other points) that the high SCAT Ss had higher A-State than the low SCAT Ss in a stress competitive situation, but no significant differences was found in non-competitive situations. Furthermore, Scanlan (1975) in the same experiment showed significant results suggesting that success-failure is a powerful element influencing state anxiety; where failure could significantly promote anxiety and success experiences could significantly reduce anxiety. Unfortunately, due to

technical problems, no physiological data was reported in those studies from Martens et. al..

Thus, it could be safe to say that a competitive environment (as previously defined by Martens) increases state anxiety compared to a non-competitive and/or non-stressful situation. Also, high anxious individuals may tend to be more self-oriented with negative statements and to perform poorer (Fenz, 1974; Wine, 1974). Consequently, sport competitive structures, which heighten anxiety may promote detrimental values (especially with young participants) on aspects such as self-concept, motor learning and even participation (Orlick, 1978).

Furthermore, in the psychophysiology of stress, some known scholars postulated:

"Individuals forced frequently to mobilize themselves to meet stresses are likely to lose their ability to execute the opposite response, i.e., to shift into parasympathetic mode in which bodily recuperation occurs." (Stoyva and Budzynski, 1975, p. 265)

This postulate is supported by research from Charvat (1964), Cannon (1932), Wolf (1968), Lader (1968), and Matthews (1966; from Stoyva and Budzynski, 1975). Therefore, applying this latter statement to what has been previously discussed regarding anxiety and the competitive environment leaves some important points for serious considerations.

Concerning the problem of anxiety and competitive structure, two main alternatives may be proposed:

"Structural changes can be made with respects to the rules of the games and the distribution of rewards so that the environment is rendered less distressful... The athlete can learn self-control skills of his thoughts and emotions so that his reality is rendered less distressful." (O'Hara and Orlick, 1976, p.1)

For the purpose of this study, attention was drawn to self-control and sport competitive anxiety. In this regard, relaxation may be an important element to consider as a means for reducing anxiety.

#### EMG Biofeedback for Relaxation and Anxiety Control.

In treating anxiety, relaxation is worthy of consideration (Benson, Beary and Carol, 1975; Stoyva, 1976). Gellhorn and Kiely (1972) proposed an interesting model to study the effects of muscular relaxation on different physiological processes. Their model is based on Hess's concepts of the ergotropic and trophotropic systems. Briefly, the ergotropic system is activated by increasing skeletal muscle tone and by EEG excitation (sympathetic activation). In contrast, parasympathetic activation exemplifies the trophotropic system with muscle relaxation and lower cortical activation.

Gellhorn and Kiely proposed two methods to activate the ergotropic and trophotropic systems. They suggested either direct stimulation of their neurological "centers" (the hypothalamus) or indirect methods that could alter these

"systems" such as by changing the intensity of the input sources from the cerebral cortex or from the afferent input of the reticular formation and the hypothalamus. Muscle activity was then suggested as an efficient proprioceptive input. Gellhorn (1952) previously demonstrated that animals under curarized like drugs had a loss of muscle activity and shifted from ergotropic responsiveness towards trophotropic activity (decrease in the hypothalamic-cortical discharges).

Skeletal muscle tonus can and usually does influence the central nervous system and the autonomic nervous system (Budzynski, 1977). Furthermore, the striated musculature accounts for approximately 50 percent of the total body mass and plays an integral role in behavior and/or movement. This may therefore explain why many relaxation techniques focus on skeletal muscle relaxation (Stoyva, 1976). Decreased muscle tension also qualifies as one of the main elements for Benson's "relaxation response" (1974).

Some BF studies also reported the existence of a relaxation response and a reduction of anxiety (Blais and Orlick, 1977). In comparison with the "cognitive" relaxation techniques, BF has the unique property of giving to the S simultaneous information of his physiological responses. Furthermore, recent BF researchers are referring to skill acquisition models (Schwartz, Young and Volger, 1976) in regard to the BF process. Motor skill acquisition models stress the importance of feedback for learning (Robb, 1972).

Recent studies investigating the effects of BF on

anxiety control are concerned with whether single system BF is prone to produce specificity of the locus of control or whether it has a generalization effect within its own parameter and/or other parameters. Other studies (Schwartz, 1972; Hasset and Schwartz, 1975) suggest that BF procedures should be applied on a multiple system training basis. This would involve simultaneous feedback training of different parameters (e.g., blood pressure and heart rate).

Unlike the multiple system suggesting various BF parameters, Stoyva and Budzynski (1974) contend that frontalis muscle action potential feedback may be sufficient to produce a generalized lowering of arousal.

According to a comparative EMG study by Balshan (1962), the frontalis muscle is one of the most difficult muscles to "deeply" relax. Later, Smith (1973) reported positive rank correlations between resting frontalis EMG level and trait anxiety ( $r = .529$ ,  $p < .02$ ,  $n = 20$ ), covert/overt anxiety ( $r = .497$ ,  $p = .05$ ,  $n = 20$ ), neuroticism ( $r = .384$ ,  $p < .05$ ,  $n = 20$ ) and external locus of control ( $r = .412$ ,  $p < .05$ ,  $n = 20$ ). Stoyva and Budzynski (1974) have reported that frontalis EMG BF may be accompanied by lowered forearm tension, lowered heart rate and decreased cortical activation. These latter researchers postulated that the frontalis EMG BF treatment should be efficient for shaping a low arousal condition before working with more stress specific responses.

Studies have already been done on the postulate that

EMG BF may decrease anxiety or increase the "relaxation response" on subjective and/or objective measurements. For example, Wickramasekara (1972) has used EMG BF with systematic desensitization to reduce EMG level and situational test anxiety. There was only one S in this study. The latter had to initially reduce contraction level of her frontalis muscle with EMG BF. She was then presented hierarchical scenes on slides that were controlled by her EMG levels. Wickramasekara reports that she learned to lower her EMG and passed an exam that she had avoided several times due to high anxiety levels.

Garret and Silver (1972), used a controlled group outcome study involving 36 Ss to study the effects of EMG and EEG Alpha BF on test anxiety. The treatment ranged from 6 to 8 sessions of 40 minutes, 3 to 4 sessions on EMG reduction and 3 to 4 sessions on Alpha production. Results indicated that the BF group showed significantly lower physiological effects due to BF training. This latter group decreased EMG baseline by 40% and increased percentage of Alpha time baseline by 21%. On the post test measurement, the BF group showed lower test anxiety than the control group ( $p < .01$ ). Unfortunately, this design cannot assess what parameter (between EMG and Alpha) was more efficient. However, the design showed a positive main effect of EMG and Alpha BF treatment to reduce test anxiety.

Raskin, Johnson and Rondestvelt (1973), achieved "deep frontalis muscle relaxation" (below 2.5 microvolts) with 10

chronically anxious patients using EMG BF, cognitive relaxation (at home) and minor tranquilizers (compared to previous usage). Group average showed a reduction of EMG from 14.1 microvolts to a criterion level of 2.5 microvolts (or lower). Results of clinical responses showed: 4 out of 10 Ss reported moderate or better improvement in anxiety symptoms, 5 out of 6 Ss reported improvement on insomnia and 4 out of 4 Ss improved their tension headache. Furthermore, the authors note that once the Ss had been trained (EMG BF), they were generally successful in relaxing at home when they were very anxious. The results of this study are interesting but as far as design is concerned (one group pre-test post-test design) no conclusive statement can be made regarding specific treatment's validity such as the effects of EMG BF on main symptoms.

These later studies suggest a certain potential in regard to the use of EMG BF as either an intermediary aid to other therapeutic procedures or as a treatment by itself for relaxation or reduction of anxiety. However, due to deficiencies of designs in adequate controls and in comparisons between different techniques, it was impossible to make a substantial judgement regarding the value of EMG BF on anxiety reduction. Consequently, contemporary researchers (1975) attempted to resolve this issue.

Cox, Freundlinch and Meyer (1975) have studied the differential effectiveness of EMG BF, verbal relaxation instructions and medication placebo. The authors have

reported significant improvement ( $p < .05$ ) in the EMG BF group compared to the placebo group on: self-reports of headache activity, frontalis EMG and on items on a Psychosomatic Checklist. No significant differences were reported between the EMG BF group and the verbal relaxation group. However, the verbal relaxation group failed to demonstrate significant differences from the placebo control group.

Similarly, Haynes Moseley, and McGowen (1975) also used three groups but had a control group rather than a placebo group. They took 21 volunteers randomly assigned to : a relaxation group ( $n = 8$ ), an EMG BF group ( $n = 8$ ) and a control group ( $n = 5$ ). Their results showed no significant differences between the two experimental groups. However, they were both significantly ( $p < .01$ ) more efficient than the control group on overall headache activity reduction and on EMG reduction ( $p < .05$ ).

During the period of 1975-1976, specific studies were done that dealt with EMG BF and the problem of increasing relaxation or decreasing anxiety symptoms using a comparative approach between the different relaxation techniques.

Haynes, Griffin, Mooney and Parise (1975) studied the differential effects of EMG BF, with more commonly used verbal relaxation instructions, on EMG reduction and trait anxiety. From a sample of 101 volunteer university students; five random samples were formed in the following

manner: 1) one group (n = 22) received EMG BF, 2) a second group (n = 18) were submitted to passive relaxation (PR), 3) a third group (n = 22) were submitted to active relaxation (AR), 4) a fourth group (n = 22) received false feedback (FF) and 5) a fifth group (n = 17) in a control situation (C) were instructed to relax as much as possible. Results showed that the EMG BF group was more efficient than the AR, FF and C groups ( $p < .05$ ) in EMG reduction. However, the data failed to support any significant differences between the EMG BF and the PR groups. Regarding the trait anxiety dependent variable assessed by the Taylor Manifest Anxiety Test (MAS), no significant differences were reported between any groups. Finally, the study showed that for the situation and limited population, EMG BF was more effective in reducing EMG level than the AR and the two control groups. The authors reported that: "Not only did the BF produce lower level of frontalis EMG activity, it lowered EMG activity faster than the other methods of relaxation." (Haynes et. al., 1975, p.192).

Coursey (1975) took a random sample of 30 university students and studied the effects of EMG BF on the Mooney Problem Checklist, the MAS, the Nowlis Mood Adjective Checklist and the EMG level. A comparative analysis was made between 3 groups of 10 selected Ss in every group. One group had EMG BF, the other had a cognitive relaxation technique and a third group had the control procedures. The session distribution had one pre and one post session for

assessment. Between these sessions, there was 6 training sessions of approximately 16 minutes within a 2 weeks period. Results of the study showed that the EMG BF group reduced their EMG level more significantly than the cognitive relaxation group and the control group ( $p < .05$ ). Also interesting, the cognitive relaxation group did not differ from the control group on the EMG level. On subjective mood problems the EMG BF group increased significantly more ( $p < .01$ ) on the Item of "peacefulness". On measures from the MAS and Nowlis Mood Adjective Checklist, no significant differences were reported. The design and setting appear to be adequate for a controlled study.

Alexander (1975) also attempted to verify EMG BF's validity as a relaxation procedure. He divided a population of 28 volunteers and made 2 random samples (that became accidental samples) of 19 Ss having EMG BF and 9 Ss in the control situation. Experimental group training time and sessions were less than in Coursey's (1975) study having a total training time of 54 minutes compared to Coursey's 96 minutes training. The Ss had pre and post test measurements and 3 sessions of approximately 18 minutes each for training. Dependant variables were different from Coursey's and Haynes et.al. (1975,1975) studies, where he was not only interested on the target response (frontalis EMG) but also on the generalization effects to other muscles such as the forearm and the leg (left forearm extensor muscles and left

lower leg extensor muscles). Subjective assessment of physical feelings and mental feelings regarding relaxation were also reported by Ss at the end of every block in a session which included four blocks of training. No significant differences between groups on subjective assessments were reported. Regarding EMG level variable, the EMG BF group was significantly more effective ( $p < .05$ ) than the control group in EMG relaxation. However, results failed to show any significant differences with respect to the generalization effects in the forearm and the lower leg. The actual training time was very limited compared to other relevant studies. Experimental Ss in this study were having 2 blocks of feedback training and 2 blocks of non-feedback training, thus giving total experimental feedback training time of 27 minutes.

Reinking and Kohl's study (1975), as compared with the previous mentioned studies, seems to handle previously dealt problems in a more efficient manner. The purpose of their study was to examine the relative effectiveness of four types of relaxation techniques on EMG frontalis level and subjective self-reports of level of "tension". The sample consisted of 50 Ss who were selected at random from a population of psychology undergraduate students. The Ss were then randomly assigned to one of the following five groups:

- 1) cognitive relaxation based on Jacobson and Wolpe technique (JWR),
- 2) EMG BF,
- 3) both previous treatment together (JWR + EMG BF),
- 4) EMG BF with monetary reward (EMG

BF + MR) and 5) a control group told to relax. Experimental sessions were longer than those used in previously mentioned studies and accounted for an adaptation period to the laboratory environment. Every session lasted one hour. The 3 first sessions were used for baseline measurements, and actual feedback training was given in the 12 other sessions.

Results were analyzed on a 5 X 5 ANOVA with repeated measures. They showed that the EMG BF groups were significantly more effective than the JWR group and control group in decreasing frontalis EMG level. JWR group was also more effective than the control. This latter group showed no significant change in EMG level. Self-reports did not demonstrate any significant differences between groups. The authors reported that the EMG BF groups were not significantly better than the other groups on self-report but showed a slight superiority. The analysis also revealed a significant difference ( $p < .001$ ) across trials that may suggest that practice did influence subjective reports of relaxation. Correlations (type is not specified) were made between EMG and self-report data, showing low correlations of .38 in early sessions, but improved to .57 during the last three sessions. This might suggest that Ss were evaluating at the beginning situational variables, but, with treatment, would later tend to focus on internal cues in evaluating anxiety. Furthermore, no significant differences were found between EMG BF groups and it was suggested that other additional procedures to EMG BF had little additive

effects.

This research gives good support to the notion that EMG BF is more efficient than a JWR group in decreasing frontalis EMG level. No clear conclusion can be emitted concerning self-reports measures. The authors have suggested "that future studies using population with higher initial baseline levels may be able to resolve this question" (Reinking and Kohl, 1975, p.221).

Garret and Silver (1976) took 23 high test anxious volunteer students and did a comparative study on the effects of EMG BF and Alpha BF, and desensitization on test anxiety. The sample was randomly divided in two groups: 11 Ss in the experimental group were given EMG BF and Alpha BF and 9 other Ss received desensitization treatment on test situation. The Ss had 10 training sessions of approximately 40 minutes for every session. There were 2 sessions every 2 weeks, thus a time span of 10 alternate weeks. Through instructions, Ss were encouraged to practice at home. The dependent variables assessed for both groups were on test anxiety. Physiological assessment was made only with the BF group on EMG reduction and on percentage of time of EEG occipital Alpha.

Test anxiety assessment after every session consisted of subjective reports on six items on a five point scale. The items dealt with the degree of relaxation during actual BF training and after the training while outside the laboratory. They also dealt with the ability to perform

tasks involving skill and concentration and the ability to relax during stressful situations. Results showed that the BF group decreased their EMG level from their baseline by 54.39% and increased Alpha level by 5.7%. The slight increase in alpha level was attributed to a high baseline level. Regarding test anxiety on post measures, the desensitization group had significantly ( $p < .05$ ) better scores than the BF group on post measurement. However, differences are reported to be small. Looking at group means, the desensitization group had an average of 22.75 and the BF group had a score of 21.12. Also, the BF group significantly ( $p < .001$ ) decreased their subjective anxiety from pre to post measurements. Similarly, the desensitization group showed a significant decrease but at a lower level of probability ( $p < .01$ ). In the test anxiety reduction (pre to post measures), the desensitization group did not differ significantly from the BF group.

Results showed that the EMG and alpha BF can reduce test anxiety. The authors (Garret and Silver, 1976) have suggested that EMG and alpha BF is an effective means for desensitization in this kind of situation. Unfortunately, no physiological assessment of anxiety was studied between the two groups.

Garret and Silver's works (1972, 1976a, 1976b) suggest that BF should be focused on and assessed by situational anxiety variables. However, no significant improvement was reported on test performance.

It has been argued that behavioral changes may be the most critical test for assessing true anxiety reduction. In this respect, very few controlled studies have so far demonstrated such potential in BF. Lawrence (1975) from the Advanced Research Project Agency summarized a series of results of research contracts done for the U.S. Department of Defense that involved investigating the use of BF for performance enhancement: "on the basis of the EMG and the brain wave work, it is clear at least that there is no easy and powerful key available in BF for significant enhancement of performance" (Lawrence, 1975, p. 81)

Several studies support the notion that frontalis EMG BF is a very efficient technique for reducing its own target response (frontalis). However, there is still an issue concerning the validity of a generalization effect to other muscles, other physiological parameters and also with respect to it's potential to transfer its effects from the laboratory to the real life environment.

Alexander's study (1975) showed no support for a generalization effect to the forearm and the leg extensors. Shedivy and Kleinman (1977) also negated Stoyva and Budzynski's postulate of generalization (1974). Shedivy and Kleinman (1977) showed a lack of correlation between frontalis EMG and either neck EMG (sternomastoid, semispinalis and splenius capitus) or verbal ratings of tension. However, Shedivy and Kleinman's study was limited to a very small sample of volunteered Ss (n = 4).

In contrast, Schandler and Grings (1976) reported evidence for a generalization and a cross modality effect of frontalis EMG BF during short term laboratory sessions. The general design of this study was a pre-post control 4 X 2 (condition X trials) design. There were 20 Ss assigned to a progressive relaxation condition, visual feedback, tactile feedback and control condition. The dependent variables were: heart rate, dominant forearm extensor EMG, frontalis EMG, skin conductance, systolic blood pressure, respiratory rate and anxiety as assessed by the Anxiety Differential test. ANOVA's supported the assumption of equivalence of groups at the pre-tests. Significant treatment effects were reported on the heart rate variable, where the feedback group had a significant reduction but not the control group or the progressive relaxation group. No significant differences among the feedback groups were reported.

The authors found that the tactile frontalis BF groups significantly reduced ( $p < .05$ ) all response measures from the pre treatment to the post treatment periods. The auditory feedback group significantly reduced all responses except for skin conductance. Control groups had significantly smaller effects on all variables than those demonstrated by the other treatment groups. Their results supported a generalization effect of muscle relaxation (to the forearm extensor) to other physiological parameters and to subjective states of anxiety. They further noted that the role of various feedback modalities is still unclear and

that systematic investigations on this issue is needed. One may infer from these results only with respect to a short term response to BF training.

Glaus and Kotses (1976) and Kotses and Glaus (1977) found a relationship between frontalis muscle tension and airway resistance, showing that frontalis muscle relaxation effects increases in peak expiratory flow rate in asthmatic children.

Degood and Chisolm (1977a), interested in the problem of cross modality effects compared EEG BF and EMG BF. In the first part of their study they found that both frontalis EMG feedback and parietal alpha feedback with short-term training led to a significant increase ( $p < .01$ ,  $n = 10$ ) in EEG alpha time, where the EMG group was slightly better than the alpha group. With respect to the EMG variable, only the EMG group had a significant EMG decrease ( $p < .05$ ). The Ss in the alpha group found the task significantly more difficult to control than the EMG group and this latter group reported more alpha like experiences as measured by an "Alpha Experience Scale".

The second section of their study (Degood and Chisolm, 1977a) consisted of training eight Ss for two feedback sessions separated by a week interval. One training session was conducted with eyes open and the following session was conducted with eyes closed. Every session consisted of a baseline period (6 minutes) followed by 4 blocks of 10 minutes of different feedback contingencies: parietal alpha

increase, parietal alpha decrease, frontalis EMG decrease and finally frontalis EMG increase. The dependent variables were parietal alpha, frontalis EMG, heart rate, pulse volume and respiratory rate. Results demonstrated that in the "eyes open" session, alpha increased significantly during "EMG down condition" while no significant alpha enhancement was reported during the actual "alpha up condition".

General results showed that the frontalis EMG feedback appears to have a cross modality effect at least on parietal alpha EEG, frontalis EMG, heart rate, and respiratory rate. Later, the same authors (Degood and Chisolm, 1977b) showed evidence that the frontalis BF training may have an effect on plasma cortisol with above average baseline cortisol Ss.

#### Conclusion.

Anxiety was defined as having a state and a trait characteristic. Spielberger's definition of state anxiety implies physiological, psychological and behavioral measurements to assess state anxiety.

Studies reviewed in both physiological and psychological assessments of anxiety showed inconsistent correlates with arousal or performance. This problem may be due to specificity of response. However, recent field studies on parachute jumping by Fenz and his colleagues (1967, 1972, 1973, 1974) found consistent relationships between the various parameters of anxiety. High anxious Ss were

found to have more negative self-statements in an evaluative situation (Wine, 1971,1974) and during real life stress (Fenz et. al. 1974). Martens and his colleagues (1975), also concerned with anxiety and competition as a process, presented a theory of competitive stress and developed the SCAT instrument to assess sport competitive trait anxiety. Through their research, they have shown that the competitive situation, enhances state anxiety particularly with high trait anxious Ss. They also mentioned that success-failure is an important factor influencing anxiety level.

Cognitive and physiological responses of relaxation have been documented in different studies using different relaxation techniques. The relatively new applications of BF seems to be promising, particularly with respect to its unique value of instant feedback and possible implications for clinical therapy. Among the different parameters of BF, EMG BF seems to be the most sound (Blanchard and Young,1974; Stoyva and Budzynski,1975) and may be one of the best single correlates of autonomic arousal. In EMG BF studies on relaxation and anxiety, EMG was consistently used as an independent and dependent variable. From these studies, it seems safe to conclude that EMG BF can be very efficient to relax frontalis EMG (Alexander, 1975; Coursey,1975; Cox, 1975; Haynes, Griffin, Mooney and Parise, 1975; Haynes, Moseley and McGowen, 1975; Reinking and Kohl, 1975). In some of the better controlled studies (Haynes, Griffin, Mooney and Parise, 1975; Reinking and Kohl, 1975), EMG BF

proved to be the most efficient means for reducing EMG level and thus promoted better results than cognitive relaxation in the reduction of EMG level. Unfortunately, this refers to specific muscle responses (frontalis EMG) and its value for generalization is still not consistent (Alexander, 1975; Shedivy and Kleinman, 1977). Recent studies (Schandler and Grings, 1976; Degood and Chisolm, 1977) evaluating the effects of frontalis EMG feedback provided evidence for generalization and a cross modality effect. EMG BF effects on subjective self-reports are still unclear probably due to inconsistent use of scales. Evaluating trait anxiety rather than state anxiety may also account for the problem. However Garrett and Silver (1976), and Schandler and Grings (1976) reported positive results regarding the use of frontalis EMG feedback on self-reports of test anxiety. With respect to the behavioral parameter, there is presently very little evidence supporting the position that BF may enhance performance.

Finally, from the present review of the literature on the problem of controlling anxiety it seems clear that the effects of EMG BF is still unexplored in the domain of sport competitive stress.

O'Hara and Orlick (1976) suggested two main alternatives to deal with the possible detrimental effects of competitive stress: structural game modifications and completely new games or techniques that can elicit self-control and better adaptation to the process. Results

issued from related studies, indicate that EMG BF is worthy of consideration and investigation. Therefore, a study oriented towards EMG BF as a means of control for sport competitive anxiety was conducted.

## CHAPTER III

### METHODOLOGY

The purpose of this study was to investigate the effects of frontalis EMG BF training on sport pre-competitive anxiety variables and on motor performance, within a laboratory controlled environment with high trait anxious boys from 10 to 13 years of age.

To induce pre-competitive anxiety the experimental setting was designed so as to replicate a sport competitive environment. To this effect the cover story and actual setting were designed in accordance with Martens (1977) construct of competitive stress. Within this environment, the effects of EMG BF training was evaluated on physiological, psychological and motor performance responses.

#### Subjects.

The SCAT and the STAIC FORM C-2 were administered to 261 boys ranging from 10 to 13 years of age. The results of the SCAT indicated, that of this group (n = 261) 80 Ss scored 22 or higher on the SCAT. This score corresponded to the upper quartile. These potential Ss were randomly assigned to either a BF sample (n = 40) or to a placebo sample (n = 40). From each of these samples, 10 Ss were randomly selected for the study. To become a participant,

the randomly selected Ss had to agree to complete the entire tournament and to have completed the parental consent and release of responsibility forms by one of the parents or a recognized guardian. The E also verified verbally with the parents that the child was not taking any drugs that may affect his arousal level, and that he did not have any apparent physical or psychological problems or disorders. If one or all of the above conditions were not met by a S, he was eliminated from the experiment and replaced by another willing S randomly selected from the non-selected boys who scored themselves in the upper quartile of the SCAT. The replacing S was then added to the respective sample and assigned the number of the eliminated S.

A yoking technique was used for controlling varying contingent positive verbal qualitative feedback given to the BF Ss. The technique consisted of pairing a BF S to a placebo S, where this latter, received the same qualitative feedback at the same moment of the experimental procedure as his paired experimental S who received it contingent to his performance. When the 10 Ss were assigned to a group, they were also assigned a number according to the order of selection (i.e., first S selected had number '1' and so on). The Ss were then paired to their corresponding number from the other sample (i.e., number '1' experimental was paired with number '1' control).

### Laboratory Setting.

The laboratory had two rooms : The control room and the tournament room (see Figure 1, p. 43). Access to the control room was limited to the E and the technician only. This room contained all the instruments necessary to record data, to control the cameras, the bogus opponent's timer and dialogue on tape. The room had a one-way mirror and three TV monitors which were used to observe and control experimental procedures. The room also had an audio-visual communication system.

The tournament room was maintained at a constant temperature of 22 degrees celsius throughout the experiment. The room was equipped with two remote controlled cameras located at ceiling level, a microphone hanging from the ceiling and a loud speaker. These instruments were operated from the control room.

The tournament room also contained an armchair with two speakers for the S. On the left hand side of the armchair was the EMG BF unit on a rotating chair. A stabilometer was situated three meters in front of the armchair. One meter in front of the stabilometer was a table, on top of which was the S's timer and error counter module and the opponent's timer. In addition, there was 1) the tournament board (see Appendix I, p. 193), 2) The tournament poster (see Appendix H, p. 191) and 3) the score board (see Appendix J, p. 195) which were placed on the wall (from left to right respectively) behind the timers. Beside the table

with the timers, was a 19 inch (48 cm) TV monitor on a stand. The monitor was connected to the monitors control board located in the control room. A clock timer was located on the middle shelf of the stand below the TV monitor. Electrodes, paste, abrasive, adhesives, electrode's junction cable, pneumograph, STAIC FORM C-1 questionnaires and the tension scale were also part of the material in the tournament room.

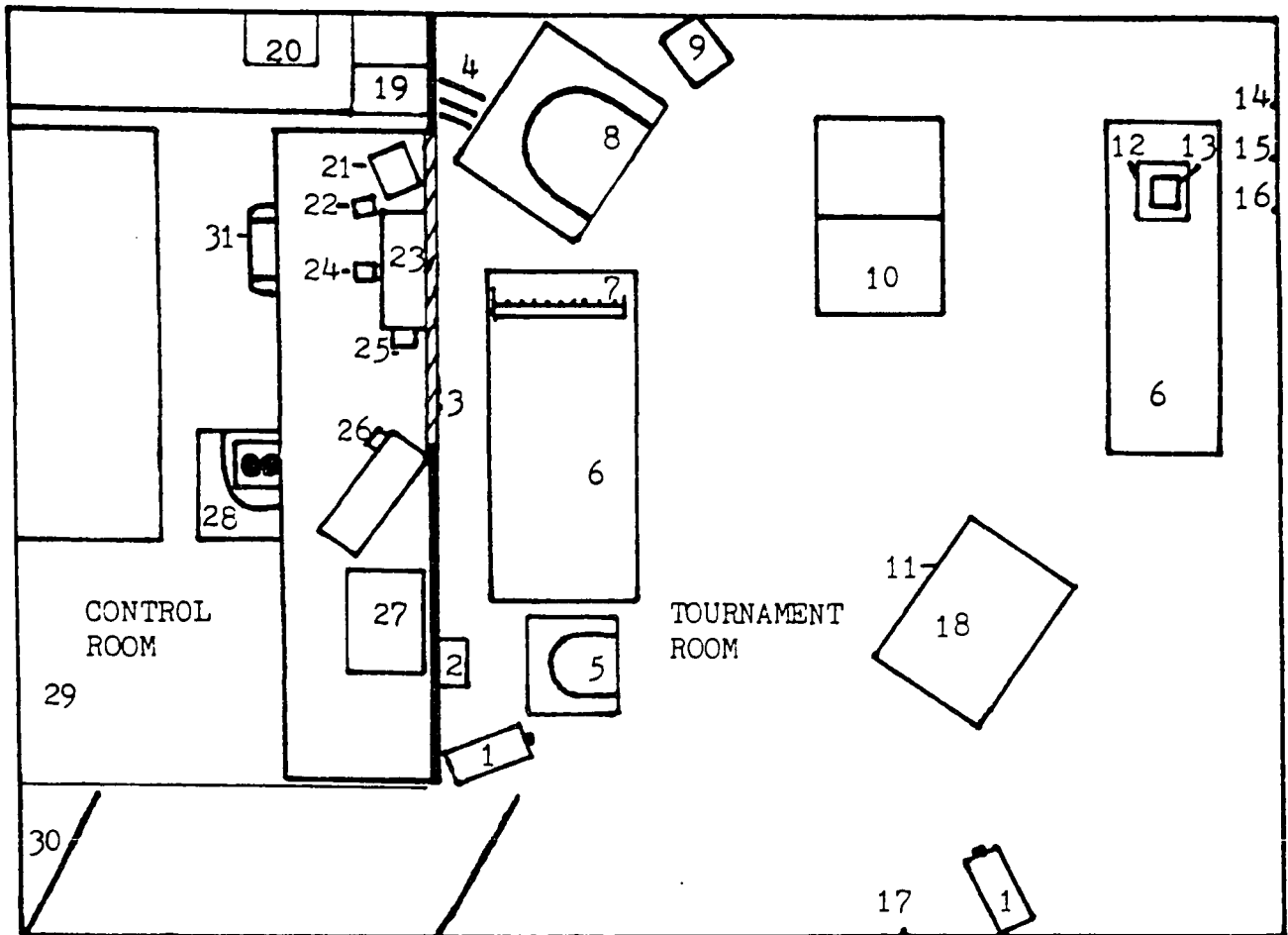


Figure 1 Laboratory setting

TOURNAMENT ROOM:

1. Remote controlled camera
2. Loud speaker
3. One way mirror
4. Junction cables
5. Chair
6. Tables
7. "Tension slide rule"
8. Arm chair
9. EMG Feedback Unit
10. Stabilometer
11. Clock Timer
12. Timer and error counter for stability platform
13. Controlled timer
14. "Tournament board"
15. "Tournament poster"
16. "Score board"
17. "Tournament poster"
18. T.V. Monitor

CONTROL ROOM:

19. EMG "Time period integrator"
20. Polygraph for heart rate and respiratory rate
21. White noise generator
22. Closure Timer
23. Controls for cameras
24. Control box for performance timers
25. PA amplifier for microphone or tape recorder
26. TV monitors
27. Video tape recorder
28. Tape recorder
29. Curtain
30. "Tournament poster"

### Instruments.

A white noise generator model 15012 from Lafayette was used to generate 22 decibels of white noise to the control Ss during the rest periods.

Silver/silver chloride reusable surface electrodes of 1.7 cm in diameter were used for EMG purposes. The EMG BF unit model BFT 401 C from Bio-Feedback Technology was used for frontalis EMG BF treatment for the BF group. The BFT 401 C had a "shorted test" function to verify for "free air" artifact. The feedback mode used was a click modulation (rising-falling click frequency). Visual BF was available by means of the EMG BF unit's analog meter. The feedback myograph was also used for recording purposes of the frontalis EMG (as a dependent variable). For this purpose, the Time Period Integrator model BFT 215C from Bio-Feedback Technology was connected conjunctively to the myograph to relate directly to the average peak-to-peak values from this latter myograph in digital readouts. The Time Period Integrator averaged peak-to-peak values of the feedback myograph for determined sample times and displayed the value in digital readout. The Feedback Myograph was battery operated, while the Time Period Integrator had a 60 hz electrical source. In this regard, the Time Period Integrator included a built-in optical isolater for the S's protection.

A pneumograph model P 907 E/M was used for measuring

respiratory rate. Recordings for both heart rate and respiratory rate were made on a physiograph model DMP-4B by NARCO Bio-Systems.

The audio output of the white noise generator and the EMG BF unit was connected to an armchair with intergrated speakers. The armchair was made by Electrohome (model 704) and housed two 8 ohms speakers on each side.

The task instrument was a stability platform, model 3-15 A made by Marietta Apparatus Company, Marietta, Ohio and calibrated for a one degree error on each side of the platform.

The S's digital timer and error counter that was connected to the stabilometer was manufactured by the Marietta Apparatus Company. The timer had readouts up to one thousandth of a second and was activated by an extension switch in the control room.

The opponent's timer was a Lafayette digital timer/counter model 54519. The timer was left on the "timer" function and its readout capability was the same as the S's timer. The opponent's timer had an extension control switch to start, stop and reset the timer from the control room.

A closure timer was used to activate and stop simultaneously the two timers after 30 seconds.

Two remote control cameras at ceiling level were used to follow and focus on the S during specific moments of the matches. The cameras were used to produce a controlled and

thus consistent audience for every S.

One score board was used to inform the S, of the number of games that were won by the S and by his opponent for a specific match (see Appendix J, p. 195).

One tournament board was used to indicate the S's position and his opponent's position throughout the tournament (see Appendix I, p. 193). The board represented the pyramidal competition structure as illustrated in Beeman and Humphrey (1960).

One Sony reel-to-reel tape recorder, model 837, was used for all the recorded material presented during the experimental sessions.

Three closed circuit monitors with the remote control panels were used to control the cameras' focus on the S and to give a zoom readout of S's time and errors, as well as the bogus opponent's time to the technician in the control room.

#### Experimental Procedures.

The procedures consisted of three main components: the first part was the trait anxiety pre testing. Secondly, there was the practice session for the Ss' adaptation to the laboratory setting. Also, this session was used for baseline measurements. Finally, the third component was the "tournament setting". This setting consisted of five matches that occurred twice daily for three days where each match included three games. Post assessment of trait anxiety and

an interview was made after the last match. This is illustrated in Figure 2 (p.48).

Upon the arrival of the S (game period one), the electrodes were placed accordingly. He then sat quietly alone for five minutes to account for laboratory adaptation (see box "PRE" in Figure 2, p. 48). Measurements were then taken before playing each game (G) and during each rest period (R). The distribution of the dependent variable recordings across the practice and a match is presented in Figure 2 (p. 48). The rest periods were of five minutes after each first and second game. After every third game, the rest period lasted for 10 minutes. The latter consisted of BF training for the BF group and "white noise" listening for the placebo group.

	PRACTICE			MATCH *										
	..PRE	R1	R2	R3	POST	..	PRE	G1	R1	G2	R2	G3	R3	POST
EMG FRONTALIS	X													
HEART RATE	X													
RESPIRATORY RATE	X													
STATE ANXIETY STAIG C-1	X	X	X				X	X	X	X				X
SUBJECTIVE TENSION	X	X	X				X	X	X	X				X
PERFORMANCE TIME	X	X	X				X	X	X	X				X
PERFORMANCE ERROR	X	X	X				X	X	X	X				X
TRAIT ANXIETY:SCAT STAIG C-2							(+)							(+)
INTERVIEW														(+)

Figure 2 Distribution of dependent variables' recordings throughout the Practice and a Match; within each session in an Adaptation period (PRE), a Rest period (R) and/or a Competitive Stress period (G) and Post assessment (POST).

\* N.B. The experimental design is comprised of one Practice and five Matches (six sessions). In the practice session, no "Competitive Stress" (G) was induced.

(+) Trait Anxiety was assessed before the experiment and at the end of the last Match. The interview was conducted at the end of the last Match.

### Trait Anxiety Measurements.

Before the trait anxiety tests were administered, the E met with the people who were responsible for the sports program from which the Ss were drawn, such as the coordinator, the coach and the instructor. It was explained to them that the objective of the study was to assess the effects of relaxation methods to reduce pre-competitive anxiety. They were also told that the objective of the research should remain confidential to the Ss so as to prevent any biased results. When the trait anxiety tests were administered, instructions were read aloud by the E after the Ss' received a copy of the questionnaires. The Ss then answered the items on the STAIC FORM C-2 (Spielberger's children form for trait anxiety). Following this, the instructions were read for the SCAT child form questionnaire (Marten's trait anxiety questionnaire related to sport competition), and the questions were completed by the Ss.

The Ss were told that the E was from the University of Ottawa and that he was conducting a survey to determine how they felt in life "in general" and how they generally felt before they competed or played games. They were also told to be as honest as possible. As well, this questionnaire was to remain confidential and that under no circumstances would it be used for any team selection.

The randomly selected Ss (n = 10) from the upper quartile of the SCAT were contacted by telephone and were

told that their name had been selected among others to represent the downtown Ottawa region in a motor ability competition. The E added that he would coach the S and study a new way to help athletes relax before playing (see Appendix C, p. 196).

#### Laboratory Procedures.

Exact procedures and verbatim instructions are presented in Appendix A (p. 153) for the practice session and in Appendix B (p. 165) for the tournament sessions.

Within the same week as the first match, the Ss were required to come to a practice session. This session served as an adaptation period. Also, baseline measurements were taken and the experimental Ss received initial BF training of frontalis EMG. The E drove the Ss from their home to the laboratory and back every session.

#### Practice Session.

For the practice session, the Ss were first shown the control room, then moved into the tournament room and remained there for the entire session. The objective for introducing the S to the control room was to elaborate progressively a rationale to increase the credibility of what the S may conceive as an "unfamiliar" tournament setting. In the control room, the E described the main apparatus and features of the room and their relative functions with respect to the rationale of competing against

someone at another location. The dialogue and time spent in the control room was brief. The S and the E then moved to the tournament room where basic tournament procedures were respected except for the competitive element.

In this latter room the E proceeded to place the electrodes on the S. The electrodes for the electrocardiogram (EKG) were placed in the position "V-4" (Cambridge, 1971). The ground electrode was located on the xyphoid process while the active and reference electrodes were placed on the fifth intercostal space to the left mid-clavicular line and on the manubrium respectively. The active and reference electrodes for EMG were placed on either side of the forehead (frontalis) at 2 centimeters above the eyelid. The ground electrode was placed at equidistance from the two latter electrodes which corresponded approximately to 2 centimeters above the nasion process.

Once the S had sat in the armchair, the pneumograph (bellow belt) was attached around his chest between the ground and reference EKG electrodes (Huizinya, 1962).

The skin resistance was verified and the acceptable limit was established at less than 10,000K in Ohm count (for EMG readings). The EMG BF unit was set on the 95-600 Hz bandpass in order to have a signal relatively free of artifact such as the EEG and the EKG. A "shorted test" showed a respectable level of "free air" artifact in both rooms. The latter test showed readings lower than 1

microvolt.

The S was then left alone in the armchair and was asked to relax as much as possible for five minutes. The physiological measurements that were then taken included: frontalis EMG, heart rate and respiratory rate. The EMG frontalis reading was a 60 seconds average taken at the last minute of the adaptation period. Heart rate and respiratory rate readings were taken in the last 30 seconds of the 60 seconds sample of the EMG readings. Therefore, all physiological measurements were taken within the same minute period.

The E then entered the tournament room and explained to the S that during the tournament, after the adaptation period, the technician would give him a "three minutes before playing" warning. He also mentioned that following this warning, he (the S) will be asked to complete the STAIC FORM C-1. The STAIC FORM C-1's instructions were read aloud by the E and he then emphasized the importance of answering the questionnaire very honestly as to how he (the S) felt at that specific moment. The S then proceeded to complete the questionnaire that was given to him by the E. Then the electrodes were disconnected from the junction cable and the S was asked to set the marker on the tension scale. The scale varied from +10 to -10 where "0" was explained to be "the perfect feeling to compete". The positive numbers reflected the level of "nervousness" to perform where +1 reflected being "slightly nervous" to perform and as the

numbers increased (by an increment of 4 dotted lines between each number) the state of nervousness increased where +10 reflected being "extremely nervous". The negative numbers reflected the opposite reaction where -1 reflected being "slightly lazy" to perform and as the numbers increased (by an increment of 4 dotted lines between each number) the state of "lazyness" increased whereas -10 reflected the state of being "extremely lazy" to perform.

Following these procedures, the S listened to recorded instructions given by the director of the "First Annual Motor Performance Tournament" (a bogus character). The voice of the director was that of a male professional television announcer. This recorded information in its original form as heard by the S, may be found in the Appendix A (p. 153). In summary, the information given to the S included at the outset, the rationale underlying the purpose and the rules of the tournament.

The director then informed the S that this tournament would also permit the experimentation of a new communication method. This latter objective was given to the S to provide a rationale for the particular setting.

The E explained the important role of the S as a representative of his region. The rationale given to the S underlying the selection of representatives was explained as being made by random selection and that, this process was very important to select the proper representatives for the study.

The S was told that he was competing against contestants of his own age. This information was given to the S so that he could perceive a certain equality among his future opponents. Then he was told that there would be different groups in the tournament. This procedure was used to reinforce the much needed credibility associated with the experimental situation.

Before presenting the rules and procedures, the S was told to consider seriously his participation throughout the entire tournament. The S's attention was then drawn to the stabilometer and he was provided with instructions relevant to the apparatus.

The S was informed of the objective of the game by being referred to the tournament board (see Appendix I, p. 193) which illustrated a pyramidal tournament. The numbers found at each level represented the contestants. For the purpose of this study, the S was constantly referred to as contestant number 1.

The rules of the tournament were identical to the procedures suggested by Beeman and Humphrey (1960) for the pyramidal tournament. This particular tournament was selected among others for its high competitive value in its structure, and its clear perceptive value of the S's placement. The contestant had to reach level I (or first place) by the end of the last match in order to win the tournament. Level I represented first place; and at this level the contestant competed to keep his position or defend

his title. If he was beaten, he took the place of his opponent. He then had to accept another challenger from a lower level. If he was not beaten, he had to win against everyone in his level before "challenging" the contestant in the next upper level. The S was told that the initial positions of the contestants would be done at random by the computer.

After the bogus director explained the technical features of the tournament, the bogus presence of evaluators was again emitted by mentioning that the judges would officiate through closed circuit television monitors. Also, with respect to the closed circuit transmission (bogus element), the S was told that the cameras would be turned off during the rest periods. Consequently, during the tournament, the TV monitor located in the tournament room was turned off by the E before every rest period of the five matches. Again, these procedures were used to increase the S's belief in the competition.

Before the end of the tape the S was told that if he did not understand all or parts of the information given, that he could ask his coach (i.e., the E) or re-play parts of the tape. The S was then asked to confirm his participation throughout the entire tournament. This question was asked by the director so as to emphasize its importance. If the S refused to participate, he was asked to explain his reasons, and was requested not to talk about the tournament to others. He was then excused and randomly

replaced by another S in the upper quartile of specific trait anxiety. If the S accepted, he and the E proceeded with the practice session.

The starting procedures were then explained to the S. The command to begin was given and the S performed on the stabilometer for the required time period of 30 seconds.

During the practice session there were no readouts on the opponent's timer and no evaluative comments were made by the E.

After the first practice game, the S had a five minutes rest period. In every match there were two five minutes rest periods, one after the first game and the other following the second game. There was a ten minutes rest period after every third game.

The placebo S was told before the rest period to relax in the armchair as much as he was able to. He was also told that the sound he heard (in the form of white-noise) was his forehead muscle tension and that listening to it would help him to relax. For the placebo group, the EMG unit was facing away from the S so that he would not see the analog meter. For the BF Ss, the instructions were the same but additional instructions were given for frontalis EMG BF training. The instructions were short and simple so that the Ss would understand the process. The EMG BF unit was facing the BF S so that he could see the analog meter during rest periods.

The BF S was told to listen to the clicks or to look at

the analog meter in order to get feedback on his frontalis 'tension' level. It was explained to him that as he hardened his forehead muscle, the clicks would come faster and the needle would move towards the right side. He was also told that when he relaxed his muscle, the clicks would become slower and the needle would fall to the left side of the meter towards the "0" reading. Meanwhile the S was told to practice to contract and relax his muscle while listening to the clicks or looking at the needle. The S was left free to choose the feedback modality he preferred. The technician set the threshold level on the feedback myograph to a relatively higher threshold (0-150 microvolts) than that of the actual practice so it would be easier for the S to hear the difference in click frequencies to the extent of almost having no more clicks. Following this, the S was told that, as he learned to control his muscle, the machine would become more sensitive and that he would have to relax much more in order to reduce the clicks or to lower the needle's reading. The S was then left alone in the tournament room, and he practiced lowering the clicks or the needle. Meanwhile, the E was in the control room.

Both BF and placebo Ss were told not to concentrate too hard on the task. During the BF training sessions, EMG readings were taken at every minute of the session.

When the BF S's last reading was lower than his first reading, the E, after re-entering the tournament room, said to the S that he was "doing good!". This qualitative

feedback was recorded on the yoked placebo S's data sheet. This latter S then received the identical feedback as his paired BF S and at the same stage of the experimental procedure. After every rest period was over, the E also closed the auditory feedback and turned the EMG BF unit away from the S.

Following this procedure, the S completed the STAIC FORM C-1, and the tension scale (i.e., -10 +10). The S then performed the second practice game and the same procedures were repeated (as after the first game).

At the end of the third practice game, the S had a ten minute rest period. He was informed that this ten minutes rest period was important "because it is easier to learn how to relax because you know that there is no more games left."

After every last rest period, the E entered the tournament room and asked the S the following: "O.K., now I would like to see how well you can relax without the help of the instrument for only one minute". The E turned the EMG BF unit away for the BF S, closed the respective auditory feedback then left the room. The measurements were taken on: frontalis EMG, heart rate and respiratory rate. The E came back after the one minute post readings were recorded and removed the electrodes from the S. The S was asked to confirm his next appointment. Confirmations were also made by telephone the night before every match. Before leaving, the S was asked to promise not to mention anything about the

tournament to any of his friends except to his parents.

#### Tournament Sessions.

The tournament sessions were technically characterized by tape recorded dialogue between bogus characters and the E. The recorded material, the purported opponent's performance and the cameras actions were controlled by the technician in the control room and were presented to the S and the coach (i.e., the E) in the tournament room, to recreate a tournament and competitive environment.

Before every match, the E met with the S at the door of the laboratory. The former greeted the latter and directed him to the tournament room. On the laboratory door, there was a specially made poster for the "Annual Motor Performance Tournament". The poster was a 45 centimeters by 60 centimeters print illustrating a picture of a boy on a stabilometer. On top of the picture was the title of the tournament: "Annual Motor Performance Tournament". Below the picture was written "first closed circuit transmitted tournament between competitors from the Ontario and Quebec regions". The poster print was made in order to promote an official setting so as to increase the credibility of the situation (see Appendix H, p. 191).

In the tournament room, the E placed the electrodes and verified for the acceptable level of skin resistance for the EMG electrodes. Then he directed the S to the armchair and told him to try to relax as best as he could for five

minutes. The physiological measurements were then taken at the last minute of this adaptation period.

During all of the experimental sessions, the technician was in the control room from which he could see the tournament room by means of 1) the one-way mirror and 2) the closed circuit monitors. The technician manipulated all the recording instruments, the remote control cameras, the tape recorded instructions, the BF instruments and the bogus opponent's timer.

After this five minutes adaptation and baseline recording, the technician started a tape recorded dialogue between bogus characters. On occasion, they would demand a reply from the E. Blank spaces on the tape were made for this purpose. The bogus characters involved were: 1) a technician 2) a judge and 3) the opponent's coach, all located at Carleton University (purported situation). The voices on tape were recorded by three professional radio announcers from the campus radio station.

The dialogue in the first match reflected more technical interactions to elaborate initial credibility of the bogus technical procedures. These procedures were mainly focusing on a purported testing state for sound, then for the opponent's performance "reception" in the S's tournament room on the designated timer, and for visual reception.

After the purported technical aspects were verified, the judge's voice came on the "air" and he announced the positions of the six contestants. Their position was

indicated by numbers. The S's starting position was in level I, so he had number one and was starting in the first position.

The judge introduced the contestants by their respective number and the location where they were playing. Meanwhile, the E turned on the TV monitor in the tournament room then left the room. The bogus technician proceeded to say (on tape recorder) that the game would start in about three minutes. The technician stopped the tape, made a 'zoom in' focus of the S with one of the cameras which appeared on the S's monitor. The S appeared in this latter monitor for 30 seconds. The technician then switched to the other camera's display focusing on the stabilometer. The technician proceeded to record the physiological variables at the third minute. These recordings are later referred to as the data of the competitive stress periods. The E then entered the tournament room and asked the S to answer the STAIC FORM C-1 questionnaire.

Upon completion of the questionnaire, the tape was turned on again and the judge announced the "one minute before the game". An auditory tone signalled the start of the minute. The S was then asked to stand up and set the marker of the tension scale to his perceived level of optimal tension to perform.

After the minute was over, the tape was started and the judge asked the contestants to stand on the stabilometer. The judge asked the coach at Carleton if they were ready and

then asked the coach (i.e., the E) at the University of Ottawa if they were ready. Again, a blank space on the tape was reserved so the E could answer affirmatively.

The judge proceeded to give the starting command: "O.K. Ready...5,4,3,2,1,go!". At the starting signal, the two timers were activated by the technician. Meanwhile, the E activated the clock timer in front of the S so that he could see the elapsed time for playing. The timers were automatically stopped after 30 seconds when a red light and a buzzer indicated the end of the game.

During the game, the opponent's timer readout was controlled by the technician with an "on-off" switch. The technician reset the two timers by means of an extension switch after the readings were made.

Win-loss ratios were pre-determined (see Figure 3, p. 67) and differences of performance and final results were kept at a "+1" or "-1" difference from the S's performance.

At the end of every performance, the E made an encouraging comment towards the S's performance (i.e. "Good try!"). With respect to his results, the S was given quantitative feedback from his digital timer. The results and comments made by the E are presented in the Appendix B (p. 165).

The judge (on tape) then gave the final results by making known the contestant number that won. The scores were then indicated by the E on the score board. The judge was consistently reminding the S of the game's result and

commenting on the importance of the following game or match. He also congratulated the winner of every match.

The S was then asked to relax in the armchair with the help of the instrument (EMG BF unit for the BF S and white noise for the placebo S) throughout the rest periods. He was also told to remain calm even after the rest period. After connecting the electrodes to their junction cable, the E turned off the TV monitor and left the room. The procedures were the same as those followed during the practice for all rest periods for both groups of Ss. The recordings taken at the end of the rest periods are later referred to as the data from the rest periods.

After the rest period recordings were taken, the E entered the tournament room, turned on the TV monitor, gave qualitative feedback (if necessary), withdrew from all Ss all sources of available feedback and returned to the control room. For the placebo Ss the white-noise generator situated in the control room, was turned off by the technician. The judge proceeded to say that the game would start in about three minutes. The technician stopped the tape, made a 'zoom in' focus of the S with one of the cameras which appeared on the S's monitor. The S appeared in this latter monitor for 30 seconds. The technician then switched to the other camera's display focusing on the stabilometer.

The following procedures were repeated for all the other games. However, the results and comments made by the

E and those of the judge differed throughout the tournament but were consistent for every S.

Figure 3 (p. 67) indicates the corresponding level of competition with the S's bogus opponents and controlled win-loss ratios according to game and match results. Generally, following a game and/or a match, the E reacted sympathetically towards the S and encouraged him to pursue the objective to win the tournament.

The win-loss ratios were pre-determined so as to keep a high level of competition within the matches and within the tournament itself. For this reason, before every last game there was a one to one tie and the S was told by the E that it was important to win the following game to win the match. Importance of winning was a repetitive element in the design as to promote the element of the importance of the outcome (Martens, 1977). Uncertainty of the outcome was elicited by presenting to the S, new contestants at every match (except for match 4) and by controlling the game scores where the Ss had a one to one tie before the last game. However, due to the credibility factor, a variation of results had to be presented. Also, to maintain the S's motivation to pursue the entire tournament the element of success of match results was considered. For this reason the S lost only the second match and won four other matches including the tournament's title.

In the first match, the S was playing against bogus opponent number 2. The S won the first game and the E

responded enthusiastically (i.e., "Good start!"). Then the S lost the second game and the E responded sympathetically (i.e., "we still have a third game"). Then, finally the S won the third game and consequently the first match. The E reacted happily (i.e., "Great!"). The judge also responded with additional comments. The S's win of the first match was to increase his interest to compete.

In the second match, the S was still in level I and competed against contestant number 3. The S lost the first game. The S won the second game and lost the last game and thus the second match. The Ss' loss in the second match was to give a certain credibility to the tournament, and to promote an element of uncertainty of the outcome.

To this situation, the E responded sympathetically and explained how he would have to win every other match to win the tournament. These comments made by the E, were to increase the importance of winning future matches. Therefore, throughout each game and match leading toward the end of the tournament, importance of the outcome was progressively increased in order to elevate gradually the level of competitive stress. At the end of every match, the judge congratulated the winner.

In the third match, the S was in level II and had to accept a "challenge" from contestant number 4 in level III. The S won the first game and the E responded happily. Then the S lost the second game and won the last game and thus the third match.

In the fourth match, the S was still in level II and competed against contestant number 3 ranked in the same level. The S lost the first game and won the second game. He also won the last game and consequently the fourth match.

The final match was against contestant number 6 who was in first place. Comments on the importance of this match were given by the judge before the start of this match. The S lost the first game but won the second game. Finally the S won the third game and the tournament.

After the congratulations, the Ss had a last rest period followed by a one minute post assessment without feedback after which the electrodes were removed. The E then proceeded to interview the S so as to assess if he believed in the bogus competitive situation and to obtain his subjective interpretation of the effects of EMG BF (see Appendix K, p. 197). The S was then asked to promise not to mention anything about the experiment to any of his friends. Throughout the experiment, the S was requested to talk only to his parents about the experiment.

	Match 1	Match 2	Match 3	Match 4	Match 5
Opponents #	2	3	4	3	6
Level #	I	I	II	II	II
Game 1 Win-Loss	W	L	W	L	L
Game 2 Win-Loss	L	W	L	W	W
Game 3 Win-Loss	W	L	W	W	W
Match result Win-Loss	W	L	W	W	W

Figure 3 Corresponding level of competition with subject's bogus opponents and controlled win-loss ratios according to Game and Match results.

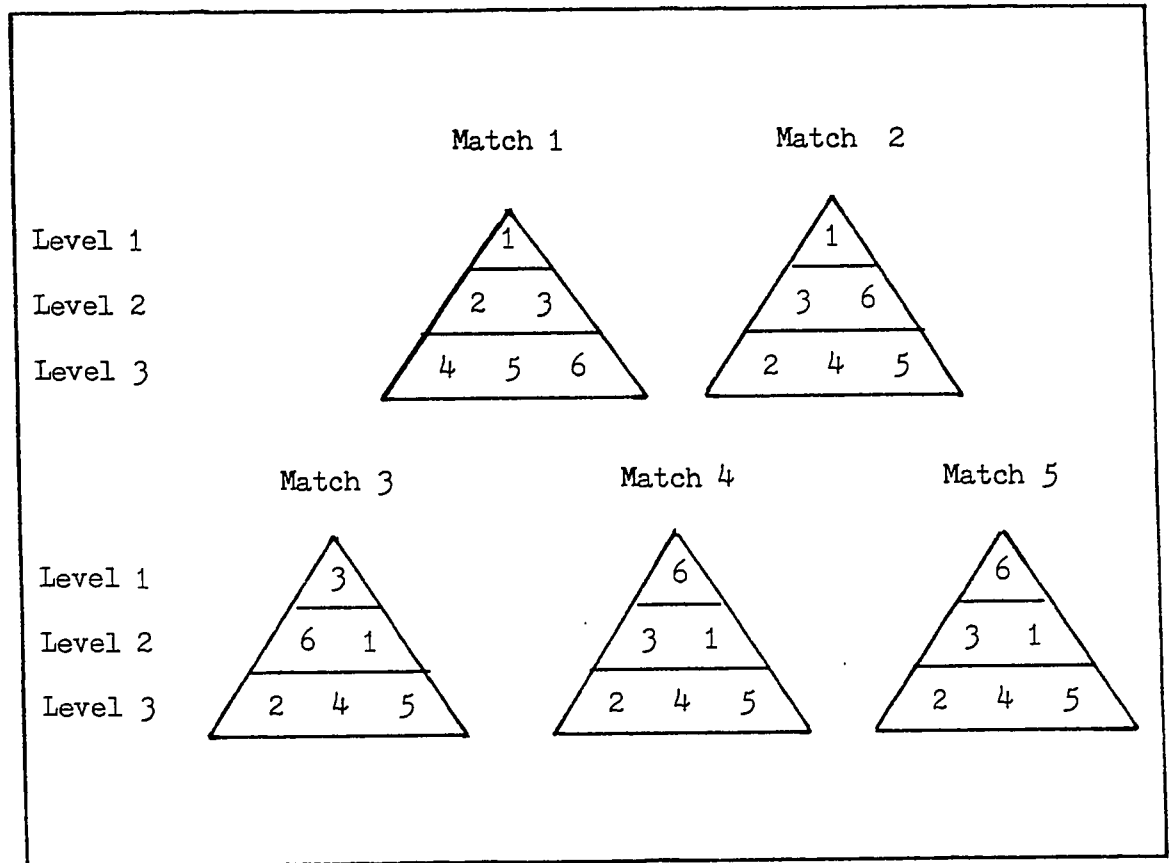


Figure 4 Pyramidal structure of the bogus tournament with corresponding participants' position before every Match. The subject is number "1".

### General Design.

The general design was a "pretest-posttest control group design" according to Campbell and Stanley (1966).

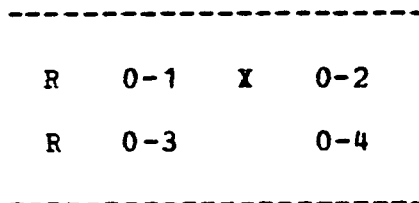


Figure 5. Pretest-Posttest control group design  
(Campbell and Stanley, 1966).

In Figure 5, R indicates a random assignment of Ss, O refers to the process of measurement and X represents the treatment that a specific group receives (Campbell and Stanley, 1966, p.6).

### Statistical Analysis.

The statistical analyses to verify the hypotheses of the present study are briefly presented in this section. For all variables except that of trait anxiety and the post interview data, a three way Analysis of Covariance (ANCOVA) with repeated measures on the last two factors was used to analyze the data in order to verify the hypotheses 1 to 13. The computer program was taken from the BMDP 2V computer program (Jennrich and Sampson, 1977).

A constant covariate was used in order to account for baseline variations on the dependent variables. The

baseline reading taken during the practice (first session) was therefore used as a constant covariate. Its function was to adjust the subsequent repeated measures.

A changing covariate was considered where the baseline of every session would adjust the means. However, it was felt that the data, being possibly dependent across sessions, would lose value, with regard to the hypotheses by being adjusted at every consecutive session. A Full Rank Multivariate Linear Model (Carlson and Timm, 1974) statistical analysis revealed that the variables were dependent. A three-way univariate analysis of covariance with repeated measures on the last two factors was used to verify the seven hypothesis relevant to the effects of EMG BF on (1) frontalis EMG, (2) heart rate, (3) respiratory rate, (4) state anxiety, (5) subjective perception of optimal tension (6) performance as expressed by time and (7) performance as expressed by error. The general design was a 2 X 5 X 3 (groups X sessions X trials). The last factor varied according to the nature of the dependent variable. State anxiety, subjective perception of optimal tension level and performance as assessed by time and error were recorded three times during every session. However, physiological variables such as EMG, heart rate and respiratory rate were measured eight times during each session excluding the practice session during which they were measured five times. The level of significance was fixed at .05 for all analyses.

### Physiological Variables.

A constant covariate was used to adjust the means of every dependent variable. Three basic clusters of repeated measures were obtained to evaluate the effects of EMG BF. The first cluster of data was relevant to the general competitive setting and, therefore, included the data recorded during the rest periods and the competitive stress periods. Two additional repeated measures were included which consisted of one minute pre-post recordings taken at the beginning and at the end of every session where the Ss were asked to relax as much as they could without the help of the instrument. The factorial design for this latter analysis was therefore a 2 X 5 X 8 (groups X sessions X trials).

The second analysis was relevant to the rest periods. This latter cluster of data was taken from the last minute of the three rest periods of each match, while the S was having BF or the placebo treatment. The factorial design was therefore a 2 X 5 X 3 (groups X sessions X trials).

A third analysis was done using the data recorded during the competitive stress periods while the Ss were not having BF or placebo conditions (white noise). These readings were taken after the third minute following the judge's announcement of "three minutes before the game starts". The statistical design that treated the stress periods data was a 2 X 5 X 3 (groups X trials X sessions).

Psychological and Performance Variables.

The psychological and motor performance data were subjected to a 2 X 5 X 3 (groups X matches X games) ANCOVA using the baseline measurement of the practice session as the covariate. This design applied to state anxiety and subjective perception of optimal tension level. The third factor (games) of the latter factorial design consisted of recordings taken before every game. Hence, these variables were taken during the competitive stress periods. The actual performance on the stabilometer expressed through time and error, was also treated through the same statistical design.

The Ss' specific and general trait anxiety was assessed on a pretest posttest design. The data was treated by a 2 X 2 (groups X sessions) ANOVA with repeated measures on the last factor (Cooper, 1977). Finally, the data from the post interview was descriptive.

## CHAPTER IV

### RESULTS AND DISCUSSION

The results of the effects of frontalis EMG BF on boys from 10 to 13 years of age involved in a simulated sport competitive environment are reported in this section. The effects of EMG BF were assessed on physiological variables, psychological variables and motor performance variables. The physiological variables were that of 1) frontalis EMG, 2) heart rate and 3) respiratory rate. For each of these latter variables, three ANCOVAs with repeated measures were used to analyze the data relevant to 1) the general competitive setting 2) the rest periods and 3) the competitive stress periods. The psychological variables were that of 1) state anxiety (STAIC FORM C-1), 2) subjective optimal tension level 3) specific trait anxiety (SCAT) and 4) general trait anxiety (STAIC FORM C-2). The two former variables were each tested by an ANCOVA with repeated measures and the two latter variables by an ANOVA with repeated measures. The effects of EMG BF were also assessed on the behavioral parameter through motor performance as expressed by 1) time and 2) error. Each of these latter two variables were analyzed under an ANCOVA with repeated measures.

All of the ANCOVAs in this study verified the main effects of the groups, the sessions and the trials, and the

interactions between the latter three factors. The ANOVA with repeated measures assessing trait anxiety verified for main effects of groups and sessions (pre-post) and the interaction between the latter two factors.

The results, divided according to each of the parameters included in this study are presented below and have been subdivided according to their respective variables. In the second part of this chapter is a discussion of the results and their possible implications.

## RESULTS

### Physiological Variables.

#### Frontalis EMG During the General Competitive Situation.

It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak microvoltage than that of the placebo group during the general competitive setting.

The groups mean EMG data presented in Table 1 (p. 76) and in Figures 7 to 11 (pp. 79-83) illustrates the superiority of the EMG BF group in reducing frontalis EMG microvoltage. Results from the ANCOVA supported the hypothesis. The summary table of this latter analysis (see Table 2, p. 77) shows a significant group effect,  $F(1, 17) = 6.64, p < .02$ . A significant trials effect  $F(7, 126) = 5.36, p < .000$  was also found. These results suggest that

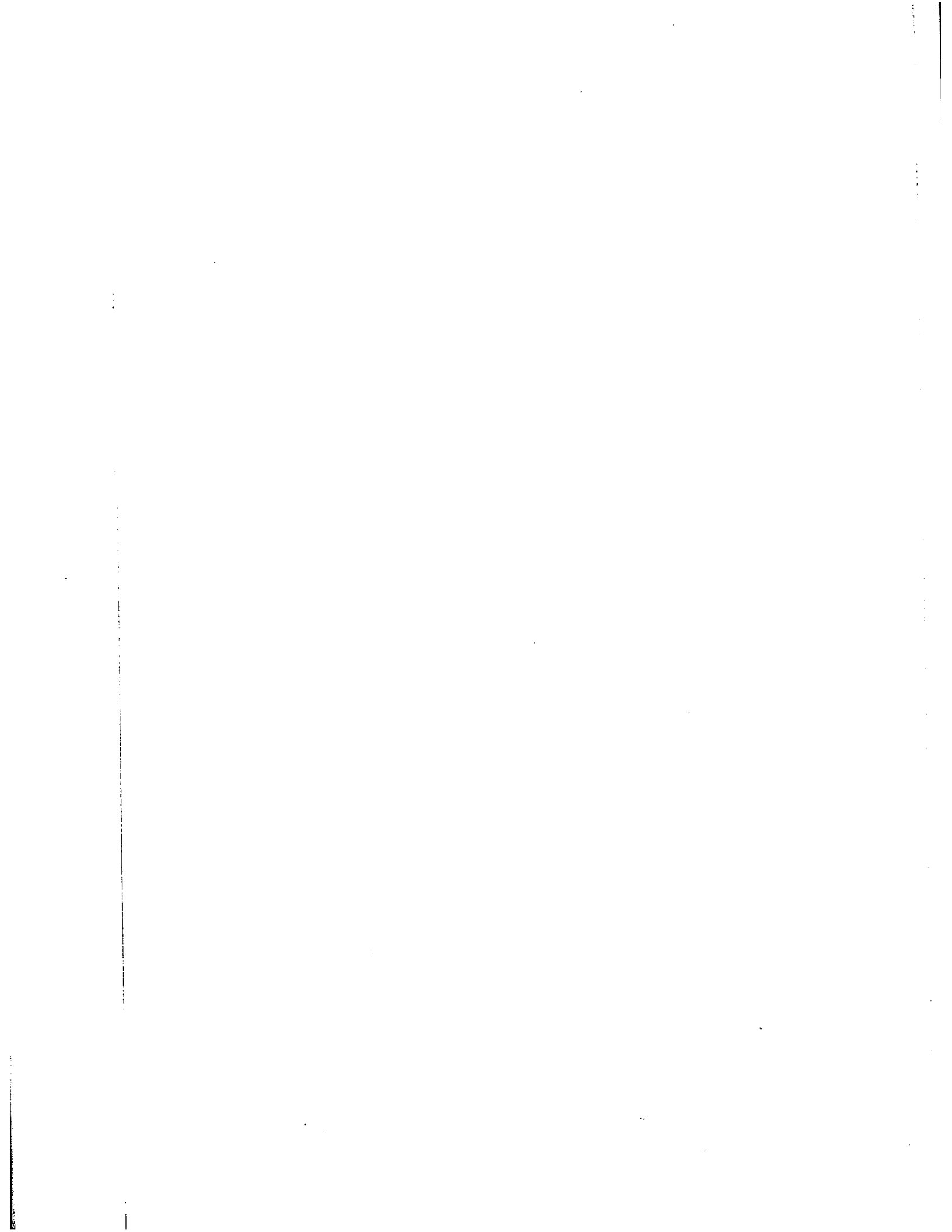
the BF Ss reduced their frontalis EMG level more than did the placebo Ss. However, both groups varied significantly in EMG values across trials. Figure 7 (p. 79) illustrates clearly this latter trials effect, showing variations in EMG across games and rests for both groups.

Means and Standard Deviations of Frontalis EMG for Biofeedback and Placebo Groups (n = 10) Across the Practice and The Five Matches

Table 1

	PRACTICE					MATCH 1					MATCH 2					MATCH 3					P																	
	PRE	RI	RE	RJ	POST	PRE	GI	RI	RE	RE	GI	RJ	POST	PRE	GI	RI	RE	RE	GI	RJ	POST	PRE	GI	RI	RE													
BIOFEEDBACK	$\bar{X}$	25.3	11.9	9.9	12.6	12.4		21.5	27.7	9.4	31.4	8.1	22.6	14.0	9.2		16.6	24.2	10.6	14.6	14.9	20.0	9.8	11.5		13.1	14.2	12.9	13.3	12.1	18.4	15.9	10.5		9.3	15.7	17.2	20.9
	$\sigma$	17.4	10.6	5.7	14.4	8.9		21.1	17.8	5.4	24.1	4.3	12.3	10.8	6.5		21.1	17.8	5.4	24.1	4.3	12.3	10.8	6.5		13.1	18.2	10.1	10.6	11.5	13.3	7.6	11.1		5.9	15.4	9.1	20.6
PLACEBO	$\bar{X}$	31.6	22.2	42.2	31.7	15.9		21.9	29.5	24.3	35.2	22.1	28.6	30.8	13.6		23.6	31.0	17.9	27.7	25.1	33.5	31.8	15.2		23.6	24.8	27.7	28.7	28.0	26.3	25.8	21.3		27.2	26.8	24.5	23.7
	$\sigma$	41.2	22.6	56.6	26.4	8.8		13.8	16.4	15.2	25.0	29.6	25.7	27.7	4.8		18.8	24.9	12.3	16.8	19.0	41.9	28.0	8.2		14.9	12.0	17.3	24.3	22.4	11.4	20.0	24.3		28.0	20.0	15.7	15.0

R - Rest  
G - Game



Means and Standard Deviations of Frontalis EMG for Biofeedback and Placebo Groups (n = 10) Across the Practice and The Five Matches

Table 1

MATCH	PRACTICE										MATCH 1										MATCH 2										MATCH 3										MATCH 4										MATCH 5									
	PRE	GL	RI	RE	GS	RS	POST	PRE	GL	RI	RE	GS	RS	POST	PRE	GL	RI	RE	GS	RS	POST	PRE	GL	RI	RE	GS	RS	POST	PRE	GL	RI	RE	GS	RS	POST	PRE	GL	RI	RE	GS	RS	POST																		
1	14.4	8.9	21.1	17.8	5.4	24.1	4.3	12.3	10.8	6.5	21.1	17.8	5.4	24.1	4.3	12.3	10.8	6.5	13.1	18.2	10.1	10.6	11.5	13.3	7.6	11.1	5.9	15.4	9.1	24.6	2.5	8.2	13.5	2.5	4.9	5.5	13.8	24.1	4.7	10.7	4.1	4.1																		
2	12.6	12.4	22.5	27.7	9.4	31.4	8.1	22.6	14.0	9.2	16.6	24.2	10.6	14.6	14.9	20.0	9.8	11.5	13.1	14.2	12.9	13.3	12.1	18.4	15.9	10.5	9.3	15.7	17.2	24.9	6.9	14.8	12.6	7.4	11.0	13.2	10.1	24.0	9.0	17.1	9.4	9.4																		
3	11.7	15.9	21.9	24.5	24.3	35.2	32.1	38.6	30.8	13.6	23.6	31.0	17.9	22.7	25.1	33.5	31.8	15.2	23.6	24.8	22.7	28.7	28.0	26.3	25.8	21.3	27.2	26.8	24.5	23.7	20.0	24.4	21.7	16.0	17.6	35.6	15.9	23.1	23.2	28.4	27.7	15.2																		
4	26.4	8.8	13.8	16.4	15.2	25.0	29.6	25.7	27.7	4.8	18.8	24.9	12.3	16.8	19.0	41.9	38.0	8.2	14.9	12.0	17.3	24.3	32.4	11.4	20.0	24.3	18.0	10.0	15.7	15.0	12.1	17.7	15.9	9.3	9.8	18.7	7.0	14.6	12.5	20.4	21.9	8.0																		



Table 2

ANCOVA Summary Table of Frontalis EMG During General  
Competitive Setting

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	16775.2	6.64	0.020 <sup>*</sup>
Error	17	2525.9		
Sessions	4	664.3	1.80	0.139
Sessions X Groups	4	13.6	0.04	0.997
Error	72	369.4		
Trials	7	1774.0	5.36	0.000 <sup>*</sup>
Trials X Groups	7	339.7	1.03	0.416
Error	126	331.0		
Sessions X Trials	28	178.9	1.31	0.136
Sessions X Trials X Groups	28	164.3	1.20	0.222
Error	504	136.8		

\* Significant F value

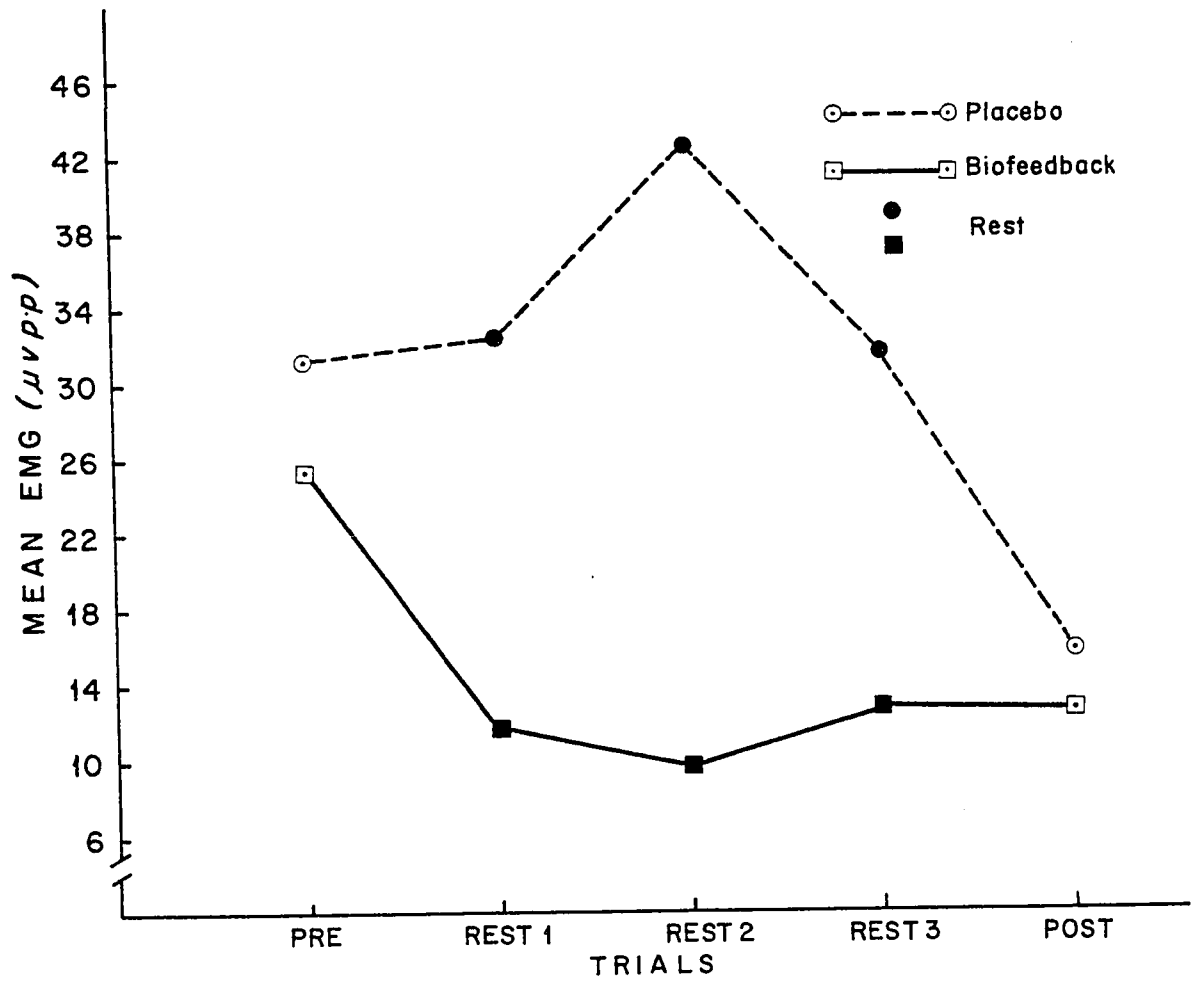


Figure 6. Frontalis EMG mean peak-to-peak microvoltage of Placebo and Biofeedback groups (n=10) for the Practice session.

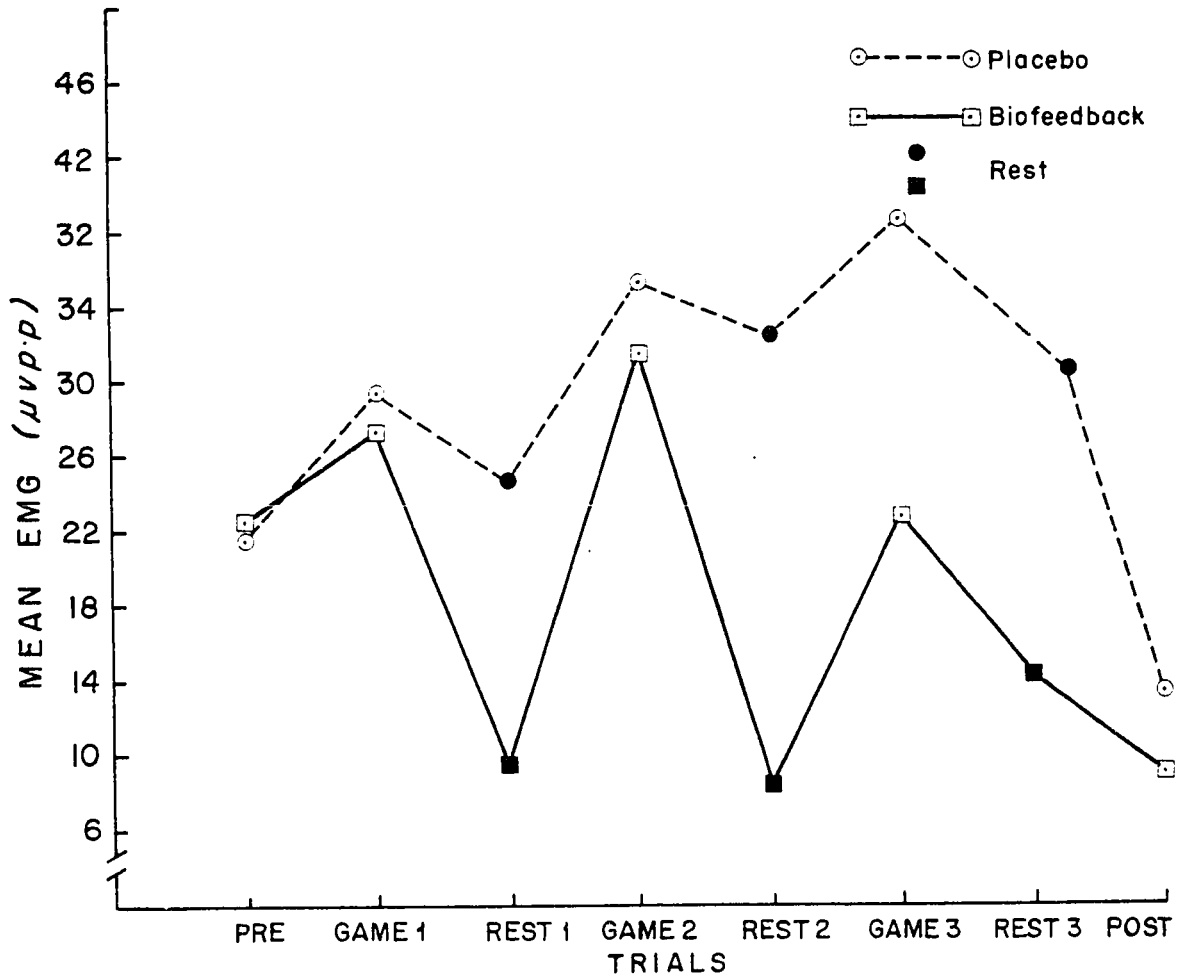


Figure 7. Frontalis EMG mean peak-to-peak microvoltage of Placebo and Biofeedback groups (n=10) for Match 1 (session# 2)

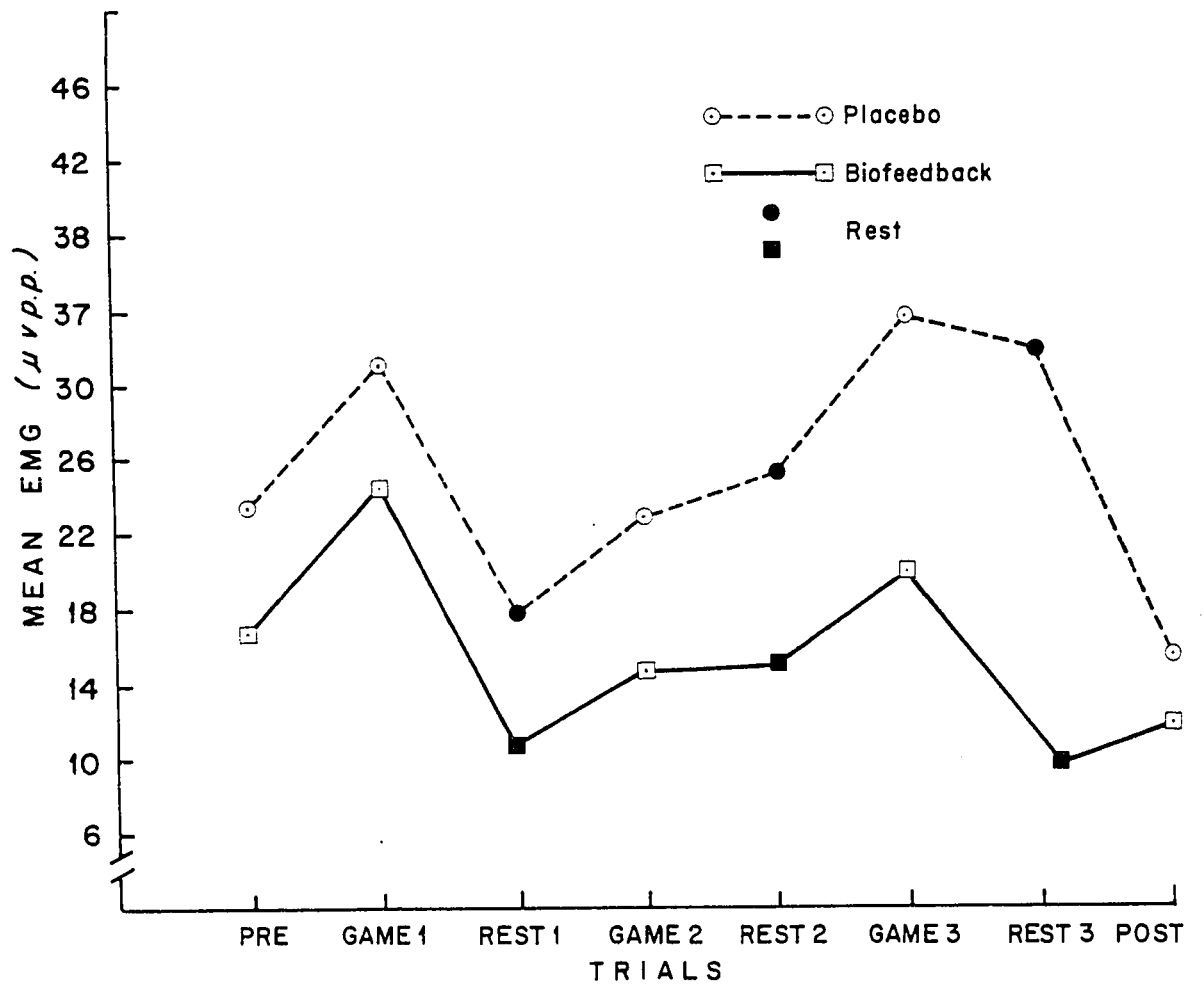


Figure 8. Frontalis EMG mean peak-to-peak microvoltage of Placebo and Biofeedback groups (n=10) for Match 2 (session #3)

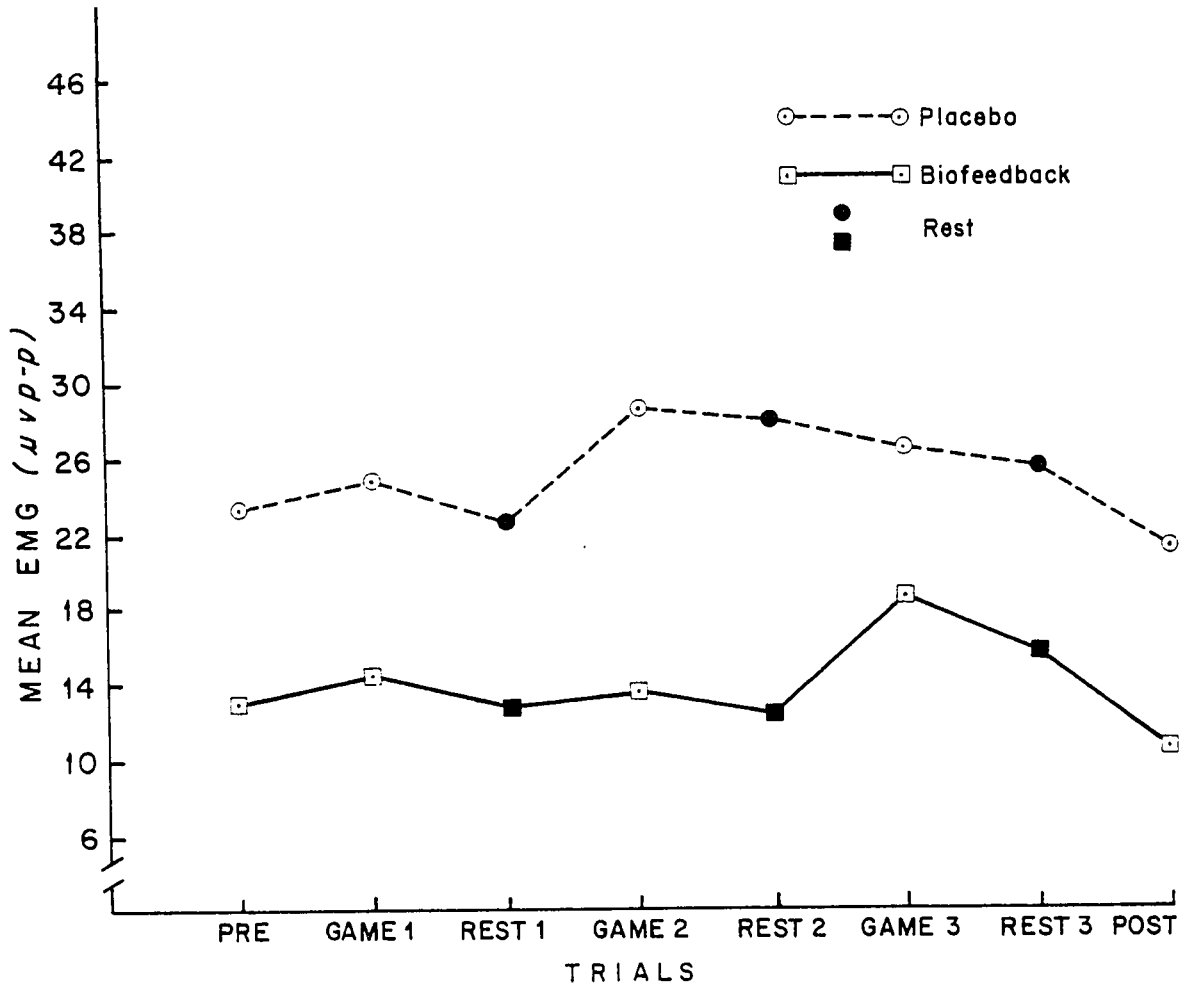


Figure 9. Frontalis EMG mean peak-to-peak microvoltage of Placebo and Biofeedback groups (n=10) for Match 3 (session #4)

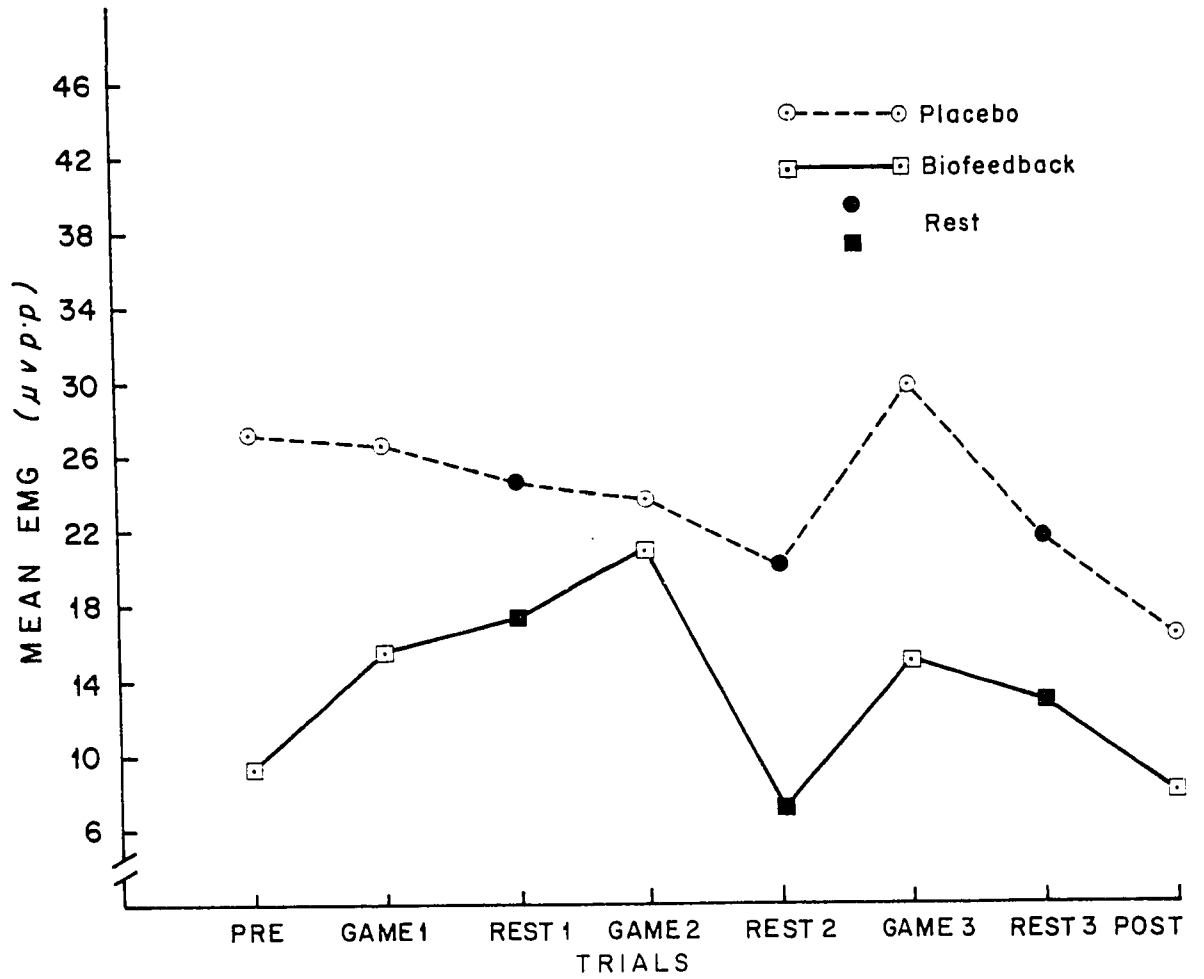


Figure 10. Frontalis EMG mean peak-to-peak microvoltage of placebo and Biofeedback groups (n=10) for Match 4 (session # 5)

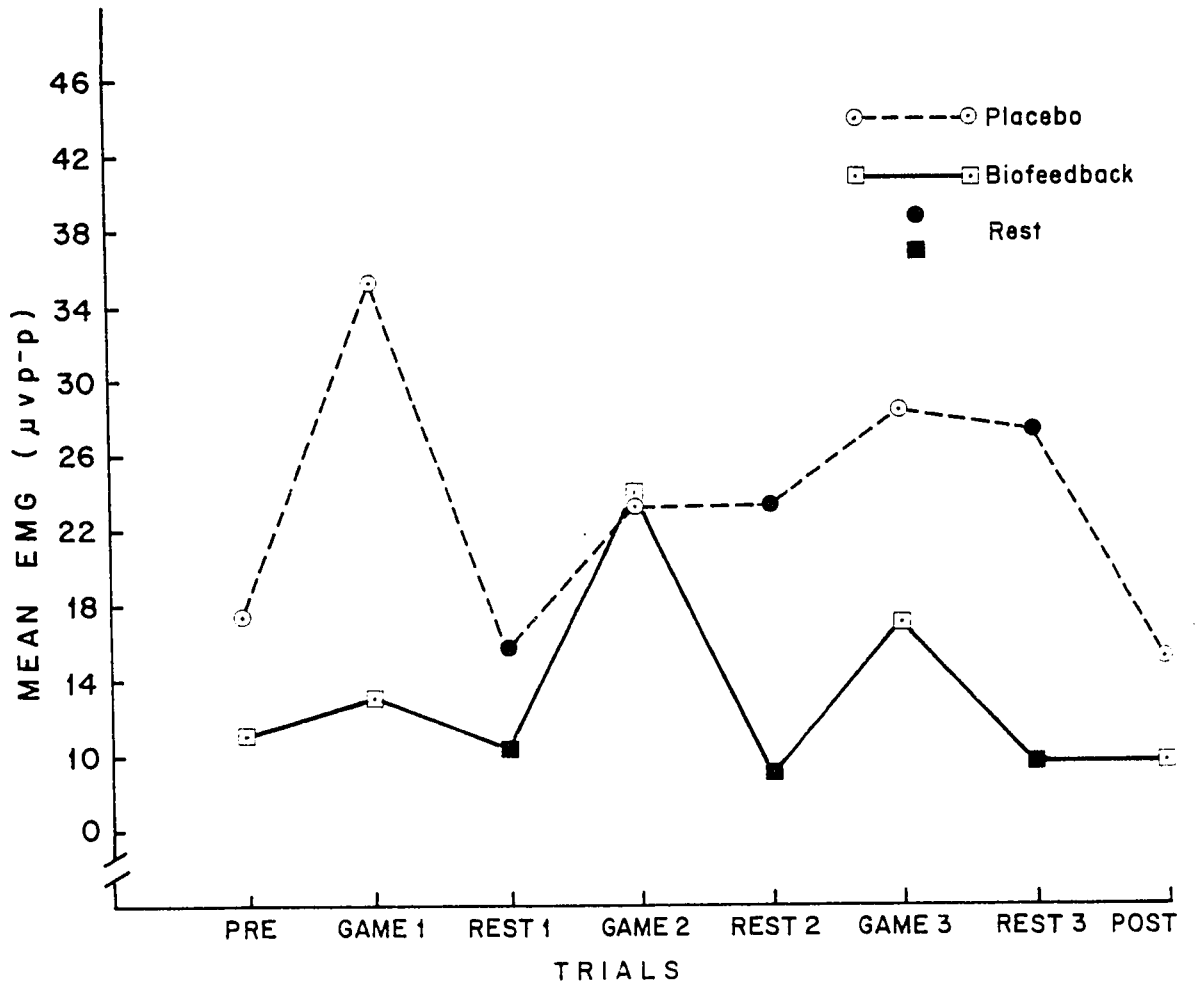


Figure 11. Frontalis EMG mean peak-to-peak microvoltage of Placebo and Biofeedback groups (n=10) for Match 5 (session #6)

Frontalis EMG During Rest Periods.

It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak microvoltage than that of the placebo group during the rest periods.

In Figures 6 to 11 (pp. 78-83) the darkened dots represents the averaged rest readings. These latter figures seem to reveal lower readings for the BF group when compared with the readings of the placebo group. The results of the ANCOVA supported this hypothesis. The summary table for this latter analysis shows a significant group effect,  $F(1, 17) = 9.36$ ,  $p < .007$  (see Table 3, p.85) Thus the BF group reduced their frontalis EMG significantly more than did the placebo group during rest periods.

Table 3

ANCOVA Summary Table of Frontalis EMG during  
Rest Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	11160.6	9.36	* 0.007
Error	17	1193.0		
Sessions	4	163.1	0.62	0.653
Sessions X Groups	4	158.2	0.60	0.665
Error	72	264.7		
Trials	2	290.2	1.05	0.362
Trials X Groups	2	332.5	1.20	0.314
Error	36	277.8		
Sessions X Trials	8	147.8	1.02	0.427
Sessions X Trials X Groups	8	98.6	0.68	0.711
Error	144	145.5		

\* Significant F value

### Frontalis EMG During Competitive Stress Periods.

It was hypothesized that the EMG BF group would have significantly lower pre-competitive EMG mean peak-to-peak microvoltage than that of the placebo group during the competitive stress periods.

Table 1 (p. 76) shows variations in mean EMG for both groups during the stress periods. A closer look at the games data only presented in Figures 7,9,10 and 11 (pp. 79-82) suggests possible interactions among the three factors. The last two matches (see Figures 10 and 11, pp. 82-83) seem to have followed the same pattern of variations between groups. Thus, an interaction seems evident during the last match. Results from the ANCOVA showed no evidence of a significant group effect, therefore, this hypothesis was rejected.

However, a significant sessions' effects,  $F(4, 72) = 4.1, p < .005$  (see Table 4, p. 89), was found, indicating that EMG variations for both groups was partly a function of the experimental sessions. A significant interaction between the three factors, sessions, trials and groups  $F(8, 144) = 2.05, p < .044$ , can also be seen in the summary table (see Table 4, p. 89), thus, showing that all the factors contributed to the majority of the variance not attributed to error. This significant interaction may be attributed to the general contribution of EMG BF training over sessions and trials. The BF group means were consistently lower than that of the placebo group (see Figures 7 to 11, pp. 79-83).

The trends among the sessions varied between the groups. The BF group decreased almost consistently when comparing the first game of each of the five matches and consistently in the third game of each of the five matches. The measures on the second game of each of the five matches however varied, thus changing the trends.

In the placebo group, the trends among sessions were not as consistent as with the BF group. The placebo group showed increases and decreases among sessions in the EMG measurements (see Figures 7 to 11, pp. 79-83).

The trends within sessions showed variations between groups except during the second match, where the two groups were almost parallel. In the first match (see Figure 7, p. 79) there was almost a linear increase for the placebo group, while an inverted "u" curve for the BF group. The second match (see Figure 8, p. 80), contrary to other matches, illustrates more or less parallel "u" curves for both groups. With regard to the second match the placebo group's third game reading had a higher EMG level than their first game reading. The BF group however, did manage to keep their third game increase lower than their original first game reading. From the first to the third game in the second match, the means were: 31.0, 22.7, 33.5 respectively for the placebo group and 24.2, 14.6, 20.0 respectively for the BF group (see Table 1, p. 76).

A general view of Figures 7 to 11 (pp. 79-83) does suggest a general contribution of the three factors toward

the explanation of the the variance not attributed to error.

Table 4

ANCOVA Summary Table of Frontalis EMG During  
Competitive Stress Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	4095.4	3.03	0.100
Error	17	1351.0		
Sessions	4	907.2	4.10	0.005*
Sessions X Groups	4	39.7	0.18	0.949
Error	72	221.4		
Trials	2	31.2	0.27	0.764
Trials X Groups	2	300.3	2.61	0.087
Error	36	115.1		
Sessions X Trials	8	158.1	1.31	0.244*
Sessions X Trials X Groups	8	148.3	2.05	0.044*
Error	144	120.9		

\* Significant F value

### Heart Rate During General Competitive Setting

It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rates than that of the placebo group during the general competitive setting.

Table 5 (p. 91) illustrates variations in the means between Games and Rests within the Matches. However, no group differences seem apparent in the latter Table and in Figure 12 (p. 92). The ANCOVA did not support this hypothesis. The latter analysis did find support for a main effect on the trials factor,  $F(7, 126) = 5.54$ ,  $p < .000$  (see table 6, p. 93), revealing significant variations from Games to Rests in both groups.

Table 5

Means and Standard Deviations of Heart Rate for Biofeedback and Placebo Groups (n=10) across the Practice and the Five Matches

	PRACTICE						PHASE 1						PHASE 2						PHASE 3						PHASE 4												
	PHE	RI	R2	R3	POST		PHE	GI	RI	R2	R3	POST	PHE	GI	RI	R2	R3	POST	PHE	GI	RI	R2	R3	POST	PHE	GI	RI	R2	R3	POST	PHE	GI	RI	R2	R3	POST	
BIOFEEDBACK	$\bar{X}$	73.2	71.5	72.0	71.2	70.2	81.2	83.8	84.4	83.8	85.4	86.2	84.0	82.2	78.0	81.4	77.8	80.2	78.6	85.2	80.2	78.2	80.6	79.4	80.6	80.2	79.0	82.0	82.4	81.2	81.6	83.4	81.2	81.6	83.4	81.2	84.8
	$\sigma$	10.4	9.1	12.0	9.3	10.7	11.8	10.3	6.0	11.8	11.5	12.8	13.3	13.3	11.2	12.4	13.2	12.1	13.1	10.2	15.8	15.2	10.5	9.2	13.1	10.2	9.6	8.9	13.0	11.1	9.6	11.9	11.3	11.0	11.6	12.9	
PLACEBO	$\bar{X}$	74.4	72.2	72.4	72.0	71.0	80.0	85.0	82.6	82.5	80.8	83.4	81.6	79.6	76.0	80.6	78.4	79.5	79.6	81.4	77.0	76.2	80.0	83.2	81.8	82.8	83.8	83.8	78.8	78.0	78.8	83.4	82.5	82.8	81.4	81.6	
	$\sigma$	4.5	6.2	6.5	4.8	5.3	12.3	14.2	14.3	15.0	14.4	15.4	14.9	13.8	14.0	15.3	15.3	13.0	11.5	19.3	11.8	14.3	10.8	9.8	12.0	12.2	10.7	14.4	12.8	13.8	7.6	9.4	11.7	8.3	9.3	11.5	

R = Rest  
G = Game







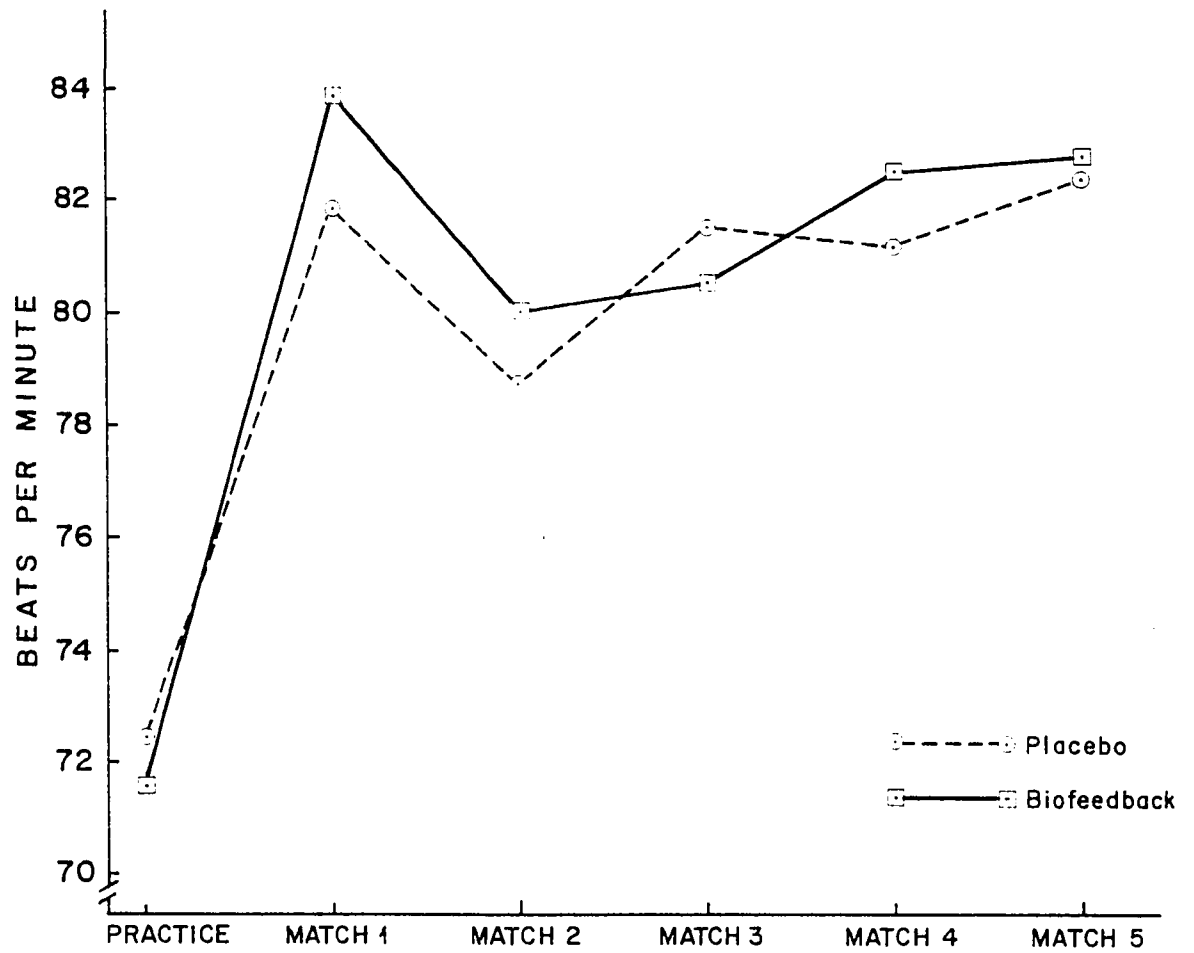


Figure 12. Mean heart rate for Placebo and Biofeedback groups (n=10) across the Practice and the five Matches.

Table 6  
 ANCOVA Summary Table of Heart Rate During  
 General Competitive Setting

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	721.0	0.40	0.537
Error	17	1814.8		
Sessions	4	323.8	1.09	0.370
Sessions X Groups	4	47.0	0.16	0.959
Error	72	298.4		
Trials	7	230.8	5.53	0.000*
Trials X Groups	7	20.4	0.49	0.841
Error	126	41.7		
Sessions X Trials	28	16.1	0.67	0.904
Sessions X Trials X Groups	28	22.8	0.95	0.548
Error	504	24.2		

\* Significant F value

### Heart Rate During Rest Periods

It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rates than that of the placebo group during the rest periods.

The means (see Table 5, p. 91) do not seem to reveal any large variability with respect to the heart rate data taken during rest periods. Furthermore, the ANCOVA did not support this latter hypothesis (see Table 7, p. 95).

Table 7

ANCOVA Summary Table of Heart Rate  
During Rest Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	234.4	0.31	0.588
Error	17	779.0		
Sessions	4	168.2	1.18	0.325
Sessions X Groups	4	28.9	0.20	0.936
Error	72	142.0		
Trials	2	39.2	1.33	0.277
Trials X Groups	2	32.4	1.10	0.345
Error	36	29.5		
Sessions X Trials	8	18.6	0.90	0.518
Sessions X Trials X Groups	8	29.2	1.41	0.197
Error	144	20.7		

Heart Rate During Competitive Stress Periods.

It was hypothesized that the EMG BF group would have significantly lower pre-competitive heart rates than that of the placebo group during the competitive stress periods.

The means (see Table 5, p. 91) do not seem to reveal large variability with respect to the heart rate data taken during competitive stress periods. Furthermore, the ANCOVA did not support this latter hypothesis nor did it support any of the sub-hypotheses (see Table 8, p. 97)

Table 8

ANCOVA Summary Table of Heart Rate During  
Competitive Stress Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	189.9	0.24	0.630
Error	17	787.5		
Sessions	4	99.7	0.86	0.495
Sessions X Groups	4	56.5	0.49	0.747
Error	72	116.5		
Trials	2	40.3	0.86	0.432
Trials X Groups	2	27.7	0.59	0.559
Error	36	46.9		
Sessions X Trials	8	17.3	0.59	0.787
Sessions X Trials X Groups	8	18.9	0.64	0.740
Error	144	29.4		

Respiratory Rate During General Competitive Setting.

It was hypothesized that the EMG BF group will show lower pre-competitive respiratory rates than that of the placebo group during the general competitive setting.

Results from the ANCOVA did not provide any support for this hypothesis, thus showing no significant differences between groups. Table 9 (p. 99) and Figure 13 (p. 100) however demonstrate some variations across sessions. Evidence was found to support a sessions' main effect,  $F(4, 72) = 5.21, p < .001$  (see Table 10 p. 101), thus indicating significant variations in respiratory rates across the Matches.

Table 9

Means and Standard Deviations of Respiratory Rate for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

	PRACTICE					MATCH 1					MATCH 2					MATCH 3					MATCH 4					PRE												
	PRE	RI	R2	R3	POST	PRE	GI	RI	R2	R3	POST	PRE	GI	RI	R2	R3	POST	PRE	GI	RI	R2	R3	POST	PRE	GI		RI	R2	R3	POST	PRE							
BIOFEEDBACK	15.4	17.9	18.6	17.0	16.8	18.0	18.2	19.5	18.2	19.3	18.3	20.6	19.4	16.6	16.1	17.9	18.5	17.3	17.2	19.2	18.3	17.4	17.0	17.7	17.1	17.5	17.6	19.2	18.5	16.7	16.9	16.7	17.3	19.4	17.3	18.9	18.7	18.8
	3.1	4.6	4.9	2.7	3.6	3.3	2.8	3.6	2.6	4.6	2.9	6.2	4.4	2.4	4.3	3.9	3.3	3.4	4.4	4.3	3.4	2.3	2.9	3.3	2.3	4.5	4.0	3.1	4.6	4.1	2.6	2.7	3.8	6.8	4.0	4.2	3.4	3.8
	18.8	19.2	19.2	16.8	16.8	19.4	20.9	19.9	19.9	19.6	20.4	19.8	19.0	19.2	18.6	20.1	17.7	17.9	17.1	17.2	17.4	18.5	21.1	17.5	18.3	18.2	19.4	20.1	19.5	18.4	18.4	19.2	17.4	17.8	19.5	17.0	19.9	
PLACEBO	3.4	4.0	3.2	3.9	4.1	3.1	4.1	5.2	3.8	2.5	3.0	3.0	2.7	3.1	4.1	5.2	3.8	2.5	3.0	3.0	2.7	6.1	4.8	3.8	3.1	3.9	3.6	5.7	6.1	2.1	4.6	3.4	3.7	3.5	4.0	2.7	3.9	3.5

R - Rest  
C - Game

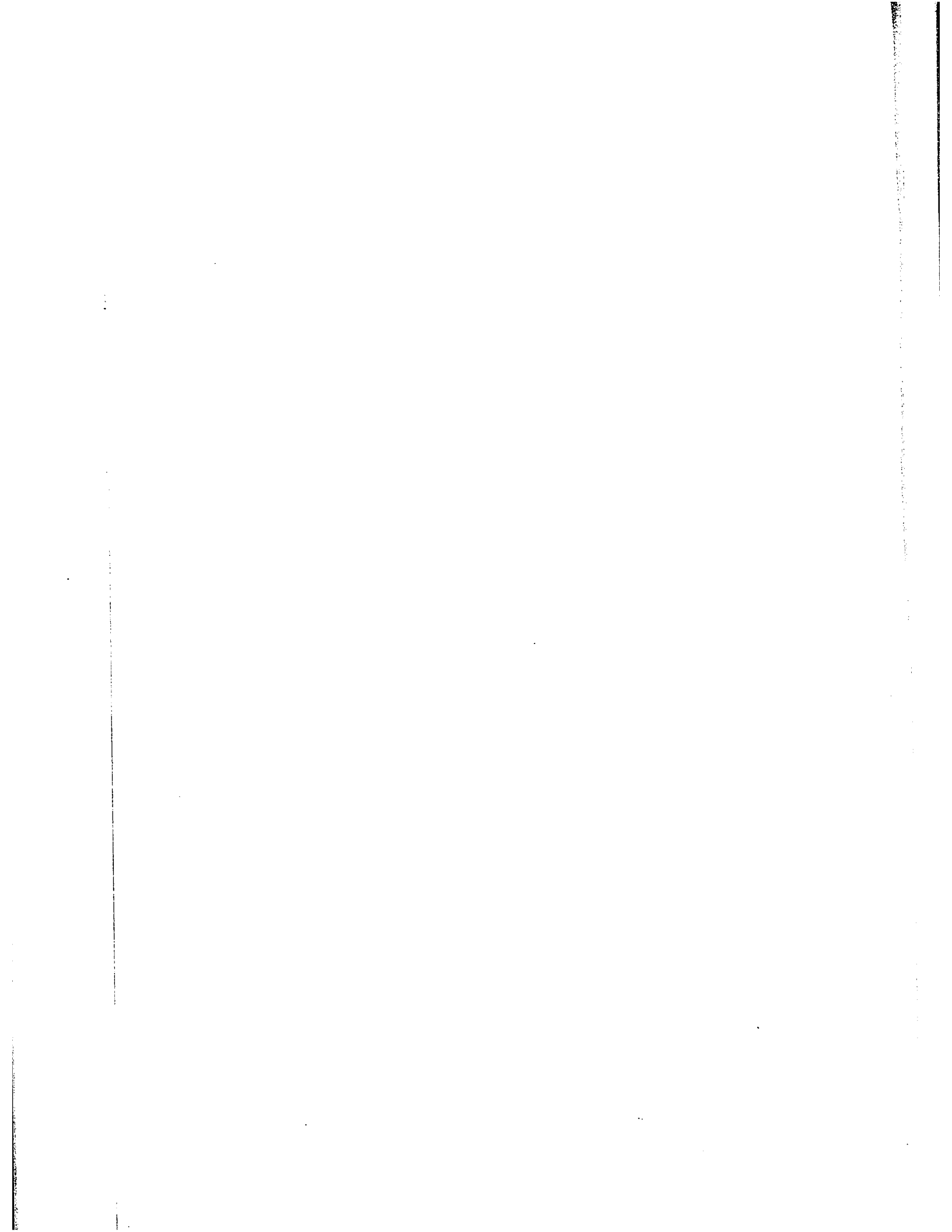
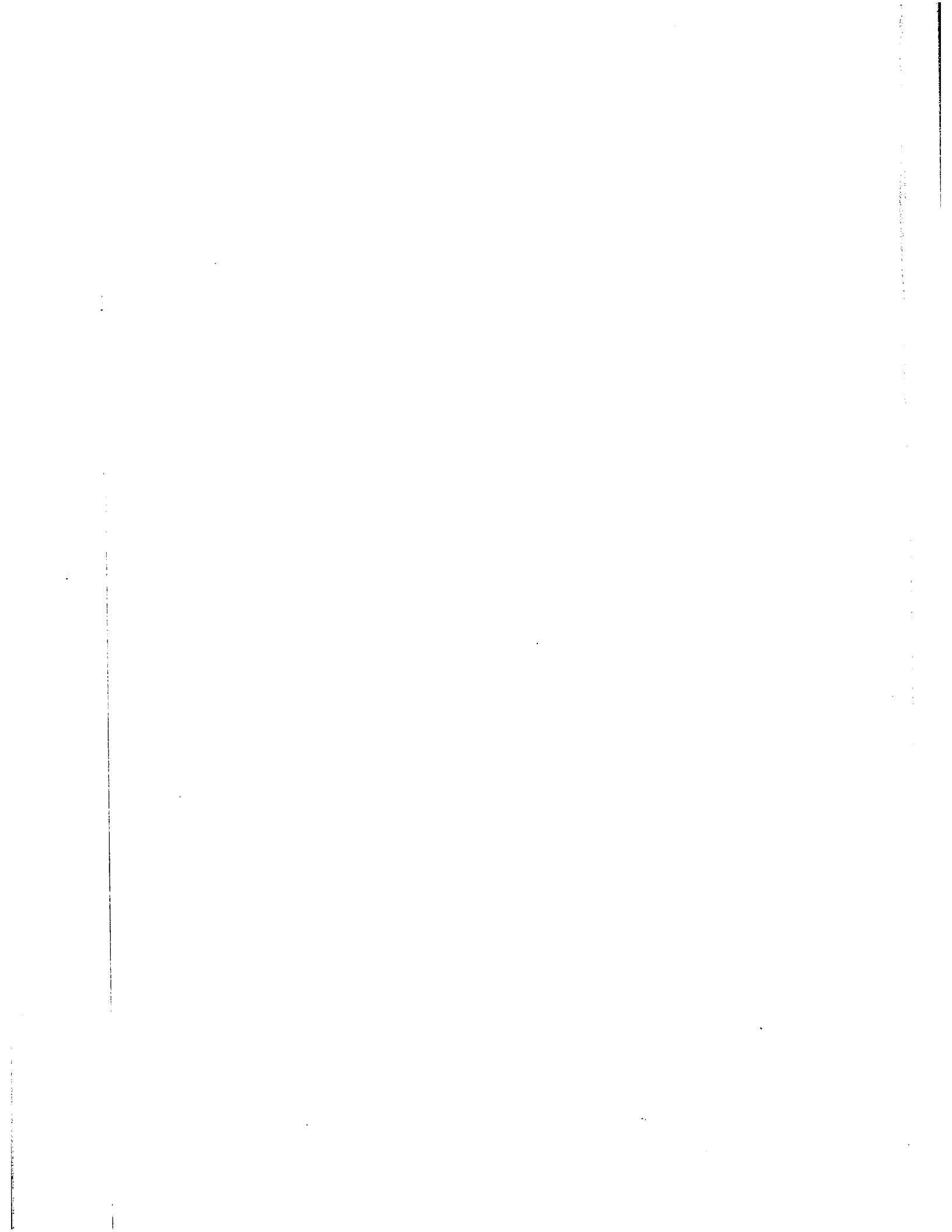


Table 9

Means and Standard Deviations of Respiratory Rate for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

TID	MATCH 1										MATCH 2										MATCH 3										MATCH 4										MATCH 5									
	PRE	GI	RI	Q	R	G	RI	Q	R	POST	PRE	GI	RI	Q	R	G	RI	Q	R	POST	PRE	GI	RI	Q	R	G	RI	Q	R	POST	PRE	GI	RI	Q	R	G	RI	Q	R	POST	PRE	GI	RI	Q	R	G	RI	Q	R	POST
17.0	16.8	18.0	18.2	19.5	18.2	19.3	18.3	20.6	19.4	16.6	16.1	17.9	18.5	17.3	17.2	19.2	18.3	17.4	17.0	17.7	17.1	17.5	17.6	19.2	18.5	16.7	16.9	16.7	17.3	19.4	17.3	18.9	18.7	18.8	20.0	18.3	18.4	19.4	19.2	19.3	17.5									
2.7	3.6	3.3	2.8	3.6	2.6	4.6	2.9	6.2	4.4	2.4	4.3	3.9	3.3	3.4	4.4	4.3	3.4	2.3	2.9	3.3	2.3	4.5	4.0	3.1	4.6	4.1	2.6	2.7	3.8	6.8	4.0	4.2	3.4	3.8	4.4	6.1	4.0	3.1	3.9	5.1	4.5									
16.8	16.8	19.4	20.9	19.9	19.9	19.6	20.4	19.8	19.0	19.2	18.6	20.1	17.7	17.9	17.1	17.2	17.4	18.5	21.1	17.5	18.3	18.2	19.4	20.1	19.5	18.4	18.4	19.2	17.4	17.8	17.8	19.5	17.0	19.9	20.5	19.9	19.8	19.8	17.7	19.4	18.7									
3.9	4.1	3.1	4.1	5.2	3.8	2.5	3.0	3.0	2.7	3.1	4.1	5.2	3.8	2.5	3.0	3.0	2.7	6.1	4.8	3.8	3.1	3.9	3.6	5.7	6.1	2.1	4.6	3.4	3.7	3.5	4.0	2.7	3.9	3.5	7.0	3.0	3.2	3.4	2.8	3.0	3.7									



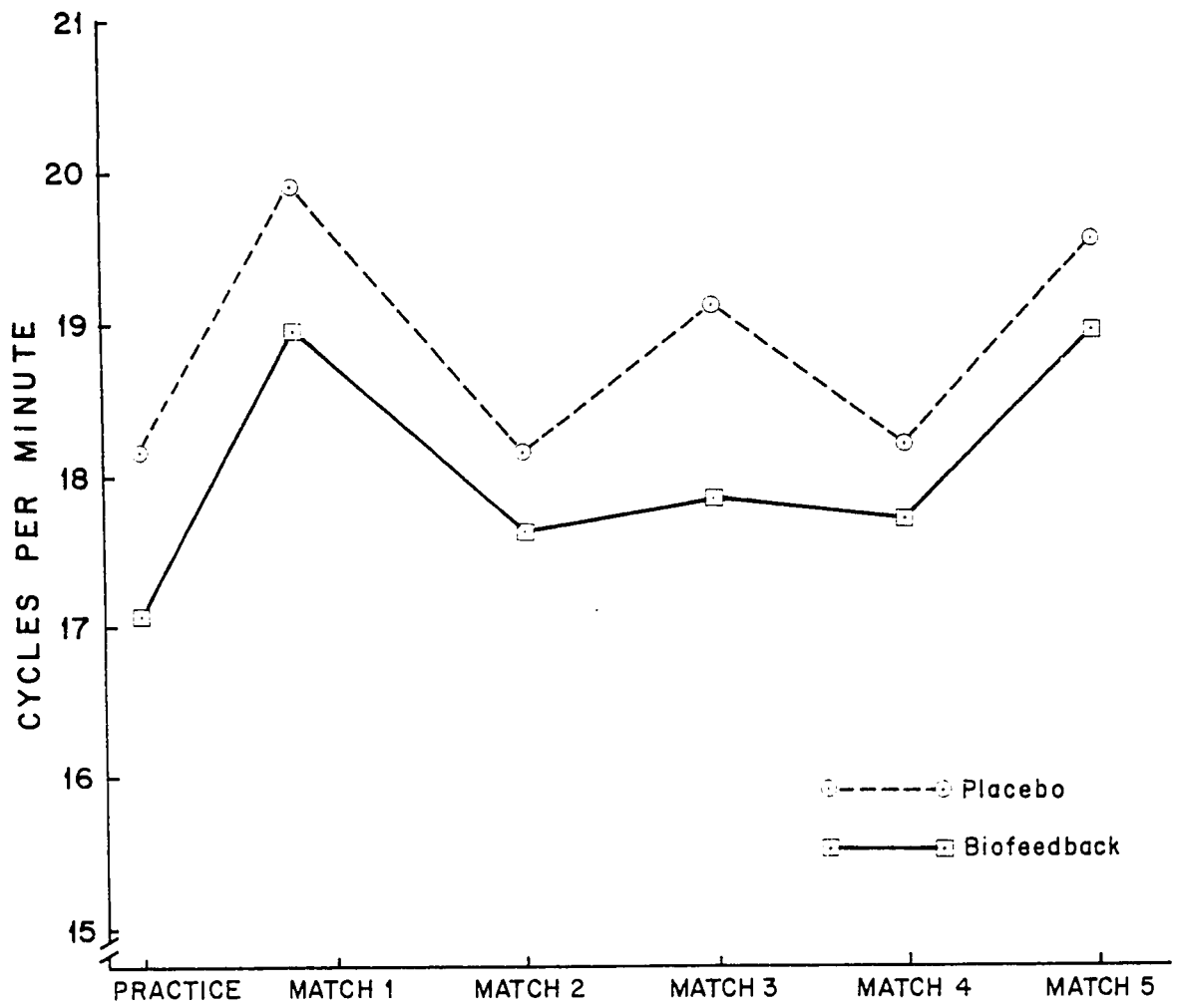


Figure 13. Mean respiratory rate for Placebo and Biofeedback groups (n=10) across the Practice and the five Matches.

Table 10

ANCOVA Summary Table of Respiratory Rate During  
General Competitive Setting

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	75.1	0.40	0.538
Error	17	190.4		
Sessions	4	75.6	5.21	* 0.001
Sessions X Groups	4	5.3	0.37	0.833
Error	72	14.5		
Trials	7	13.7	1.22	0.296
Trials X Groups	7	19.9	1.78	0.097
Error	126	11.2		
Sessions X Trials	28	6.3	0.79	0.770
Sessions X Trials X Groups	28	6.8	0.86	0.670
Error	504	7.9		

\* Significant F value

Respiratory Rate During Rest Periods.

It was hypothesized that the EMG BF group will show lower pre-competitive respiratory rates than that of the placebo group during the rest periods.

The ANCOVA did not support this hypothesis thus, showing no significant differences between groups. Table 9 (p. 99) seems to suggest however, that both groups varied in respiratory rate across the sessions. The ANCOVA showed evidence to support a significant sessions effect  $F(4, 72) = 2.72$   $p < .036$  (see table 11, p. 103) and therefore indicating significant variation in respiratory rate across sessions with the rest data for both groups.

Table 11

ANCOVA Summary Table of Respiratory Rate  
During Rest Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	112.1	1.19	0.290
Error	17	94.1		
Sessions	4	26.5	2.72	* 0.036
Sessions X Groups	4	1.2	0.12	0.975
Error	72	9.7		
Trials	2	15.3	2.65	0.084
Trials X Groups	2	26.5	2.87	0.070
Error	36	5.8		
Sessions X Trials	8	7.9	0.97	0.461
Sessions X Trials X Groups	8	8.5	1.05	0.404
Error	144	8.1		

\* Significant F value

Respiratory Rate During Competitive Stress Periods.

The EMG BF group will show lower pre-competitive respiratory rates than that of the placebo group during the competitive stress periods.

The results of the ANCOVA did not support this hypothesis thus showing no significant differences between the groups. Table 9 (p. 99) seems to suggest however, that both groups varied in respiratory rate across the sessions during competitive stress periods. The ANCOVA did provide evidence to support a significant sessions' effect  $F(4, 72) = 5.08$ ,  $p < .001$  (see Table 12, p. 105) and therefore showing significant variations across sessions on the competitive stress data for both groups.

Table 12

ANCOVA Summary Table of Respiratory Rate During  
Competitive Stress Periods

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	0.1	0.00	0.970
Error	17	67.9		
Sessions	4	46.8	5.08	* 0.001
Sessions X Groups	4	15.5	1.68	0.164
Error	72	9.2		
Trials	2	9.8	1.08	0.350
Trials X Groups	2	22.0	2.43	0.102
Error	36	9.1		
Sessions X Trials	8	5.7	0.59	0.783
Sessions X Trials X Groups	8	4.9	0.51	0.846
Error	144	9.6		

\* Significant F value

Psychological and Performance Variables.

Subjective Perception of Optimal Tension Level.

It was hypothesized that the EMG BF group will perceive significantly lower levels of tension than that of the placebo group during the general competitive setting.

Results from the ANCOVA showed no significant differences on the groups factor and therefore did not support this hypothesis. Table 13 (p. 107) and Figure 14 (p. 108) suggest however, an increase in subjective perception of optimal tension across sessions for both groups. Subjective perception of optimal tension varied significantly  $F(4, 72) = 3.68, p < .009$  (see Table 13, p. 107) across matches for both groups.

Table 13

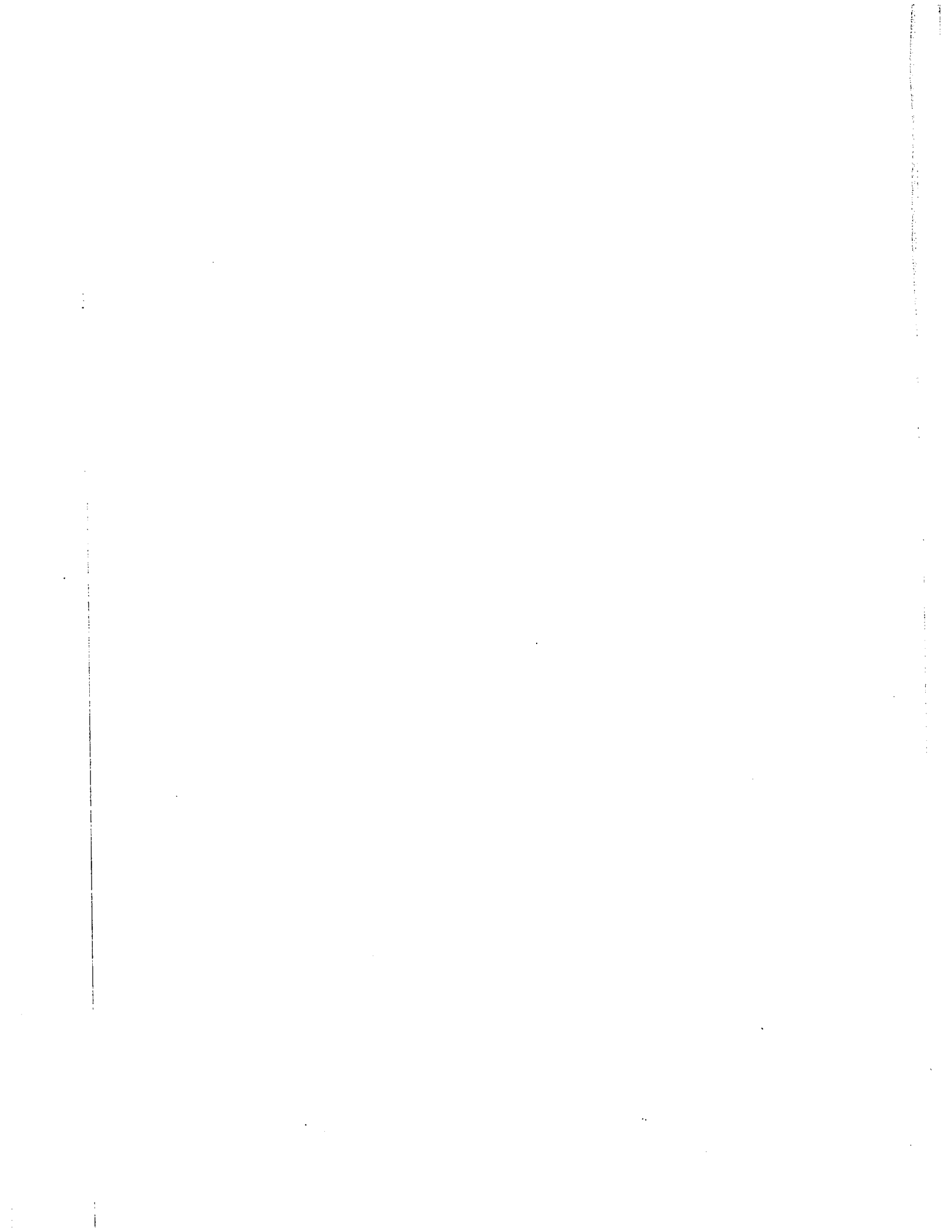
Means and Standard Deviations of Subjective Optimal Tension for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

	PRACTICE						MATCH 1						MATCH 2						MATCH 3						MATCH 4																
	PRE	RI	R2	Q3	POST		PRE	GI	RI	Q2	R2	Q3	POST		PRE	GI	RI	Q2	R2	Q3	POST		PRE	GI	RI	Q2	R2	Q3	POST		PRE	GI	RI	Q2	R2	Q3	POST				
BIOFEEDBACK	R	0.99	0.91	0.55	-	-	1.98	-	1.11	-	0.70	-	-	-	-	1.55	-	1.86	-	1.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	σ	0.21	0.22	0.15	-	-	0.19	-	0.14	-	0.41	-	-	-	-	0.20	-	0.29	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLACEBO	R	3.03	0.95	-0.98	-	-	1.96	-	1.67	-	1.80	-	-	-	-	1.90	-	1.63	-	1.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	σ	0.37	0.19	0.25	-	-	0.27	-	0.23	-	0.23	-	-	-	-	0.23	-	0.14	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

R = Rest  
G = Game







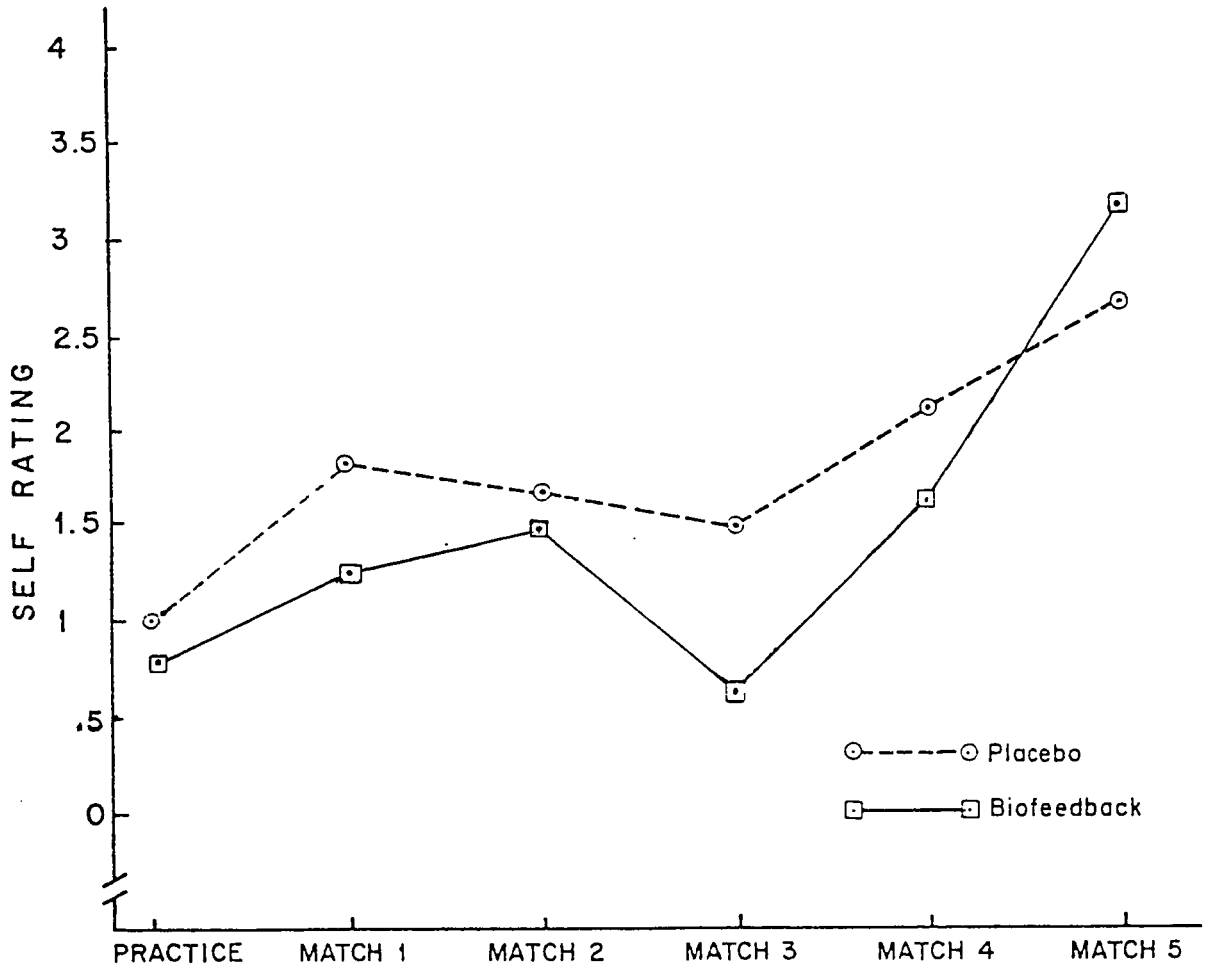


Figure 14. Mean score of subjective optimal tension to perform for Placebo and Biofeedback groups (n=10) across the Practice and the five Matches.

Table 14

## ANCOVA Summary Table of Subjective Optimal Tension

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	36.4	0.01	0.926
Error	17	4090.3		
Sessions	4	2475.6	3.68	0.009*
Sessions X Groups	4	285.4	0.42	0.791
Error	72	673.4		
Trials	2	96.3	0.18	0.839
Trials X Groups	2	25.9	0.05	0.954
Error	36	546.0		
Sessions X Trials	8	323.0	0.96	0.472
Sessions X Trials X Groups	8	237.4	0.70	0.688
Error	144	337.6		

\* Significant F value

### State Anxiety.

It was hypothesized that the EMG BF group would have significantly lower levels of state anxiety than that of the placebo group.

Results from the ANCOVA showed no significant differences between the groups. Table 15 (p. 111) and Figure 15 (p. 112) however suggest variability in the state anxiety data across the Matches and the Games. Significant differences were found on the session and trial interaction  $F(8, 144) = 5.44, p < .000$  (see Table 16, p. 113). This result supports a strong variation in state anxiety for both groups across Games and Matches. These variations may be attributed to success-failure outcomes of Games and Matches. Figure 17 (p. 115) clearly illustrates this point showing increases in state anxiety after the S had previously lost a game and the inverse process after the S had previously won a game.

Table 15

Means and Standard Deviations of State Anxiety for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

	PRACTICE										MATCH 1					MATCH 2					MATCH 3					MATCH 4																		
	PRE	R1	R2	R3	POST	PRE	G1	R1	G2	R2	G3	R3	POST	PRE	G1	R1	G2	R2	G3	R3	POST	PRE	G1	R1	G2	R2	G3	R3	POST	PRE	G1	R1	G2	R2	G3	R3	POST							
																																						R2	R3					
$\bar{X}$	29.6	29.1	28.3	-	-	-	29.9	-	27.1	-	31.4	-	-	-	29.0	-	30.9	-	29.0	-	27.8	-	27.7	-	30.3	-	-	-	29.1	-	31.9	-	31.0	-	-	-	29.1	-	31.9	-	31.0	-	-	-
$\sigma$	4.4	3.5	4.1	-	-	-	6.4	-	5.3	-	7.3	-	-	-	6.9	-	4.6	-	5.8	-	5.1	-	5.5	-	6.6	-	-	-	5.2	-	6.4	-	6.6	-	-	-	5.2	-	6.4	-	6.6	-	-	-
$\bar{X}$	33.4	28.1	28.4	-	-	-	31.5	-	30.3	-	32.8	-	-	-	29.5	-	34.3	-	31.8	-	31.5	-	31.0	-	33.6	-	-	-	31.5	-	34.8	-	33.0	-	-	-	31.5	-	34.8	-	33.0	-	-	-
$\sigma$	7.2	3.7	4.7	-	-	-	4.8	-	3.2	-	8.0	-	-	-	5.6	-	6.1	-	6.3	-	4.4	-	4.7	-	7.6	-	-	-	5.0	-	6.0	-	8.2	-	-	-	5.0	-	6.0	-	8.2	-	-	-

R - Rest  
G - Game

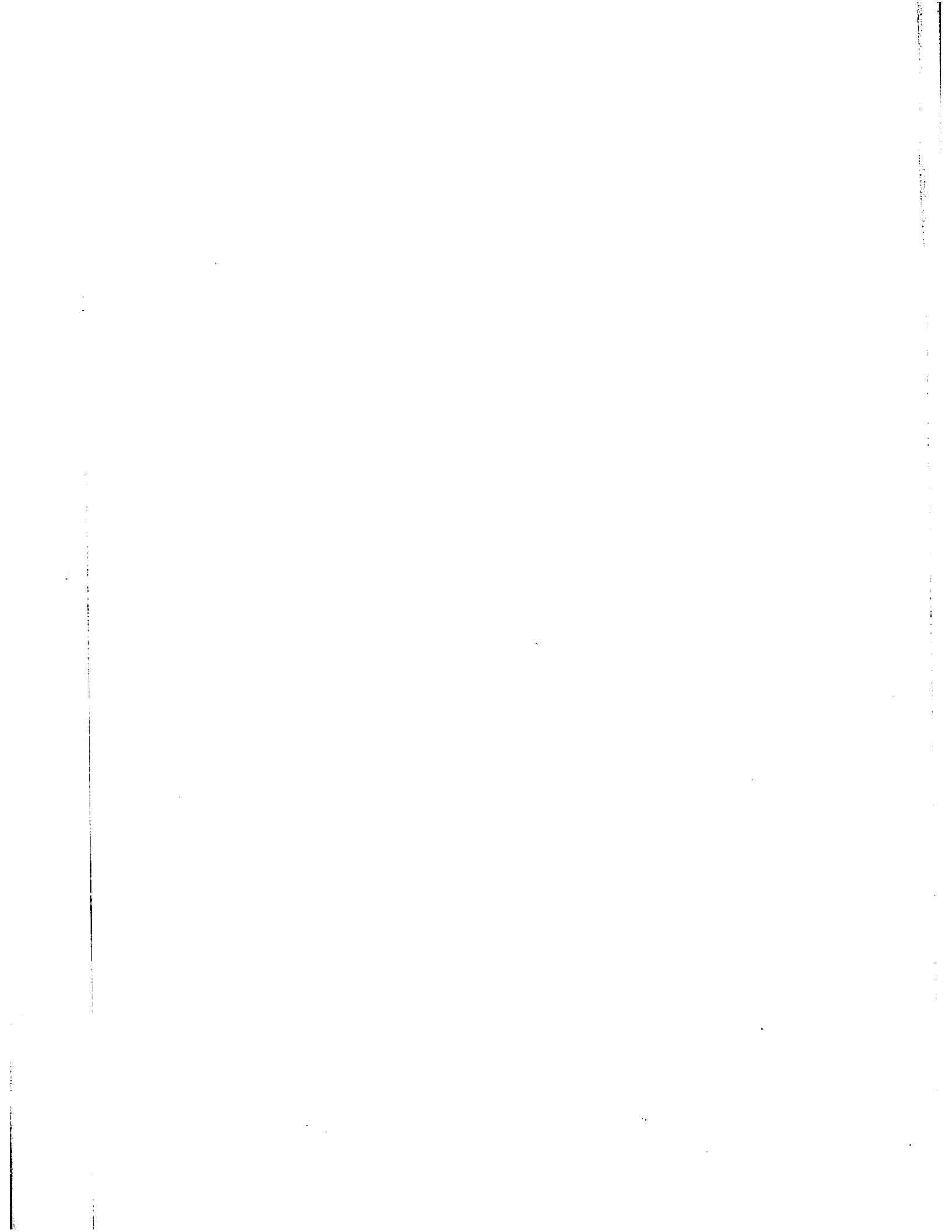
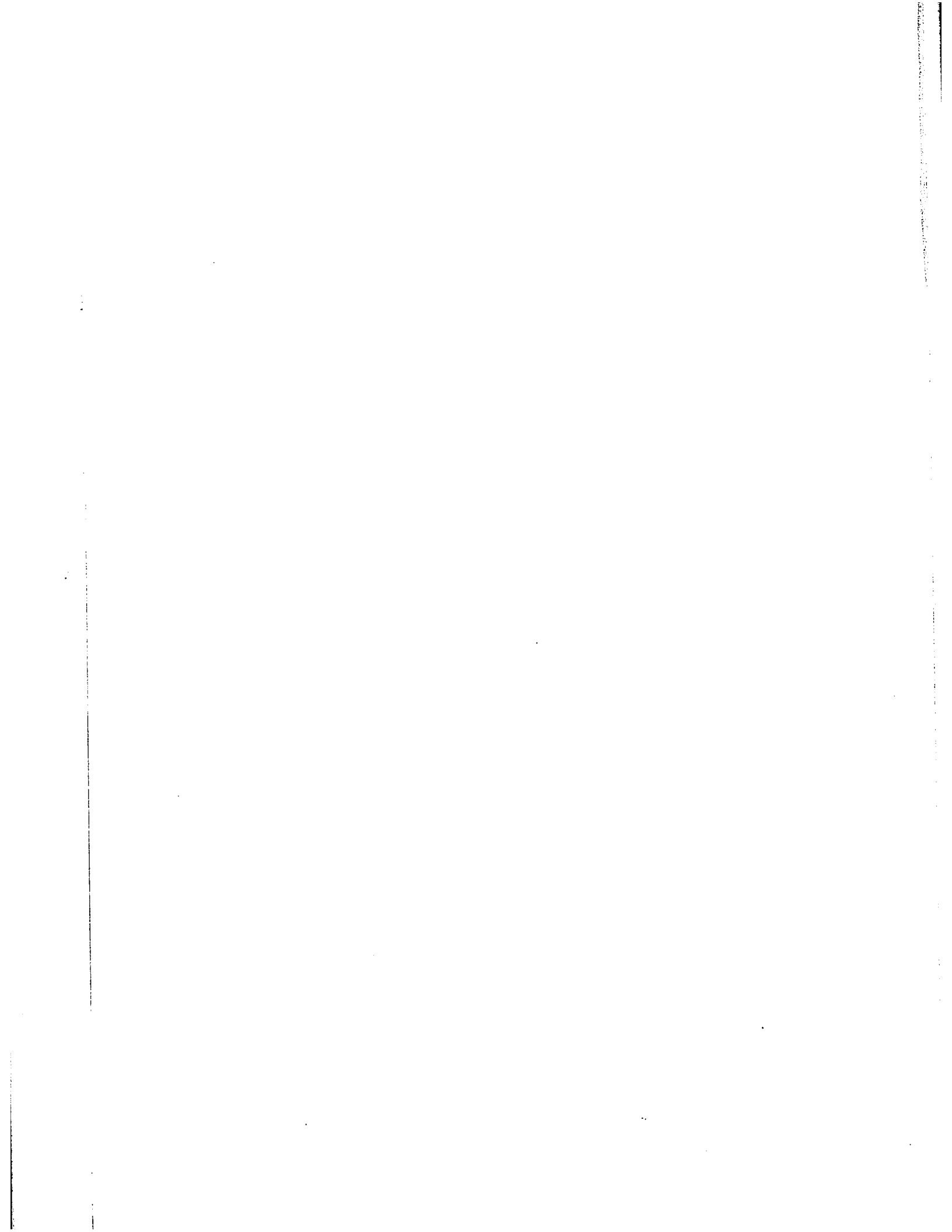


Table 15

Means and Standard Deviations of State Anxiety for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

PRACTICE	MATCH 1										MATCH 2										MATCH 3										MATCH 4										MATCH 5											
	PHE	GL	RU	Q2	R2	G3	R3	POST	PHE	GL	RU	Q2	R2	G3	R3	POST	PHE	GL	RU	Q2	R2	G3	R3	POST	PHE	GL	RU	Q2	R2	G3	R3	POST	PHE	GL	RU	Q2	R2	G3	R3	POST	PHE	GL	RU	Q2	R2	G3	R3	POST				
3.3	-	29.9	-	27.1	-	31.4	-	-	-	29.0	-	30.9	-	29.0	-	-	-	27.8	-	27.7	-	30.3	-	-	-	-	29.1	-	31.9	-	31.0	-	-	-	29.0	-	31.0	-	31.0	-	-	-	-	-	29.0	-	31.0	-	31.5	-	-	-
4.1	-	6.4	-	5.3	-	7.3	-	-	-	6.9	-	4.6	-	5.8	-	-	-	5.1	-	5.5	-	6.6	-	-	-	5.2	-	6.4	-	6.6	-	-	-	6.2	-	6.6	-	6.6	-	-	-	6.2	-	6.6	-	6.3	-	-	-			
8.4	-	31.5	-	30.3	-	32.8	-	-	-	29.5	-	34.3	-	31.8	-	-	-	31.5	-	31.0	-	33.6	-	-	-	31.5	-	34.8	-	33.0	-	-	-	32.5	-	33.6	-	33.0	-	33.0	-	-	-	32.5	-	32.5	-	32.5	-	-	-	
4.7	-	4.8	-	3.2	-	8.0	-	-	-	5.6	-	6.1	-	6.3	-	-	-	4.4	-	4.7	-	7.6	-	-	-	5.0	-	8.0	-	8.2	-	-	-	5.9	-	8.2	-	8.2	-	8.2	-	-	-	5.9	-	7.5	-	7.5	-	-	-	



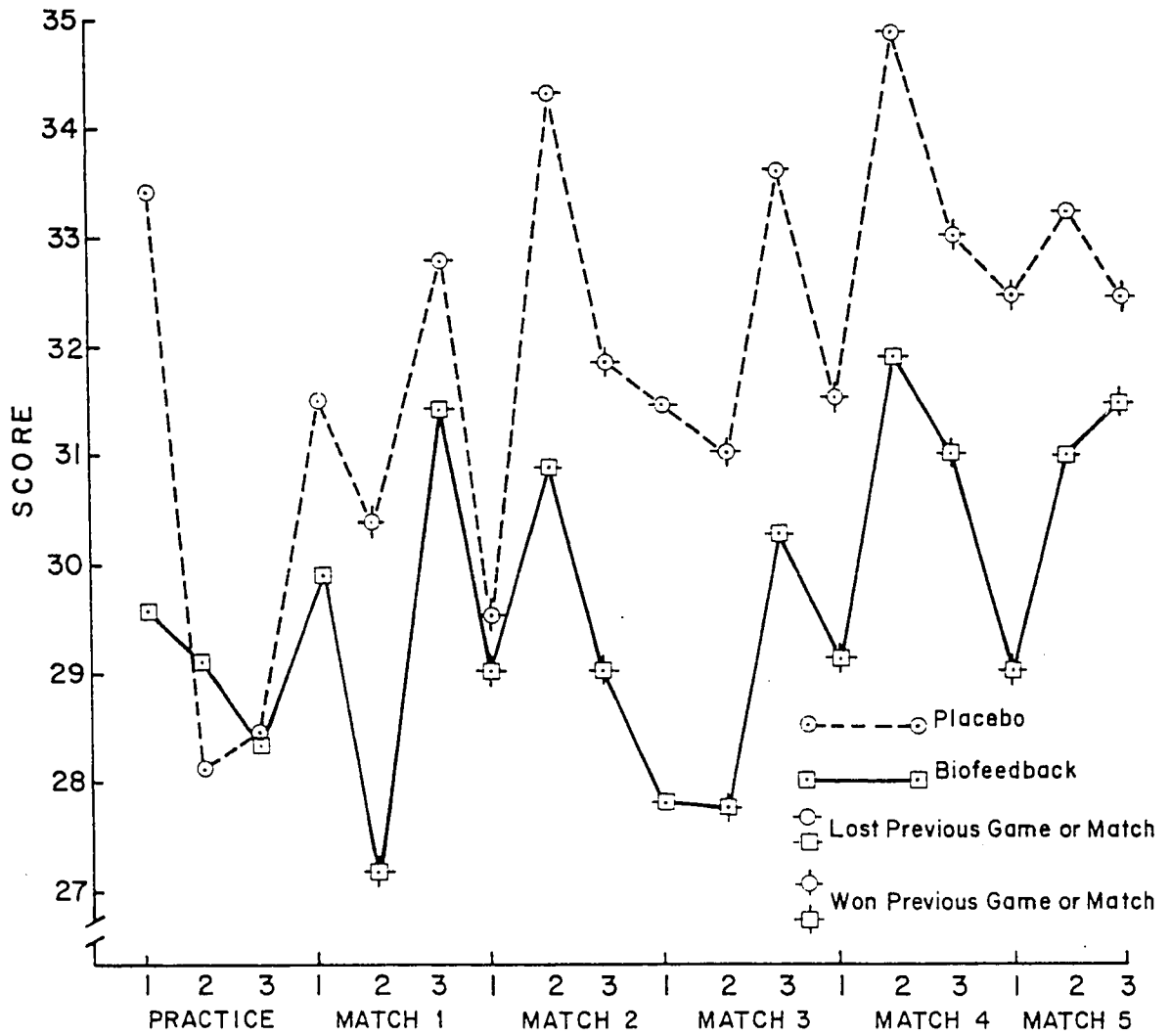


Figure 15. Mean score of state anxiety as assessed by the STAIC FORM C-1 for the Placebo and the Biofeedback groups (n=10) across the Practice and the five Matches.

Table 16

ANCOVA Summary Table of State Anxiety (STAIC FORM C-1)

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	175.1	0.46	0.508
Error	17	382.5		
Sessions	4	29.1	1.52	0.205
Sessions X Groups	4	4.5	0.24	0.917
Error	72	19.1		
Trials	2	64.0	2.42	0.103
Trials X Groups	2	5.4	0.21	0.815
Error	36	26.4		
Sessions X Trials	8	37.7	5.44	0.000*
Sessions X Trials X Groups	8	5.1	0.73	0.664
Error	144	6.9		

\* Significant F value

Performance (Time).

It was hypothesized that the EMG BF group, will improve their performance (higher times) on the stabilometer significantly more than that of the placebo group.

Results from the ANCOVA revealed no significant differences between groups, thus not supporting this hypothesis. Table 17 (p. 115) and Figure 16 (p. 116) suggest however, a linear variability across both sessions and trials. Time in balance significantly increased among sessions  $F(4, 72) = 8.95, p < .000$  and among trials  $F(2, 36) = 9.86, p < .000$  (see table 18, p. 117), demonstrating progressive motor learning for both BF and placebo groups.

Table 17

Means and Standard Deviations of Performance (Time) for Biofeedback and Placebo Groups (n=10) across the Practice and the Five Matches

	PRACTICE				MATCH 1						MATCH 2						MATCH 3						MATCH 4													
	PIE	RI	R2	R3	POST	PIE	GI	RI	R2	R3	G3	R3	POST	PIE	GI	RI	R2	R3	G3	R3	POST	PIE	GI	RI	R2	R3	G3	R3	POST	PIE	GI	RI	R2	R3	G3	R3
$\bar{x}$	3.09	3.11	4.03	-	-	-	3.40	-	3.75	-	4.14	-	-	-	4.88	-	4.89	-	5.76	-	-	-	-	5.54	-	7.52	-	7.12	-	-	-	6.87	-	6.58	-	7.05
$\sigma$	1.05	1.18	1.46	-	-	-	1.03	-	1.20	-	2.65	-	-	-	1.93	-	1.98	-	3.54	-	-	-	-	4.12	-	5.77	-	4.37	-	-	-	3.72	-	5.33	-	4.84
$\bar{x}$	3.58	3.95	4.30	-	-	-	3.98	-	4.90	-	5.90	-	-	-	5.59	-	5.79	-	7.65	-	-	-	-	6.75	-	6.91	-	7.32	-	-	-	6.55	-	6.91	-	7.85
$\sigma$	1.43	1.56	1.53	-	-	-	1.77	-	1.81	-	2.59	-	-	-	1.40	-	3.71	-	3.63	-	-	-	-	3.95	-	3.72	-	4.82	-	-	-	4.18	-	4.33	-	5.75

R - Rest  
G - Game

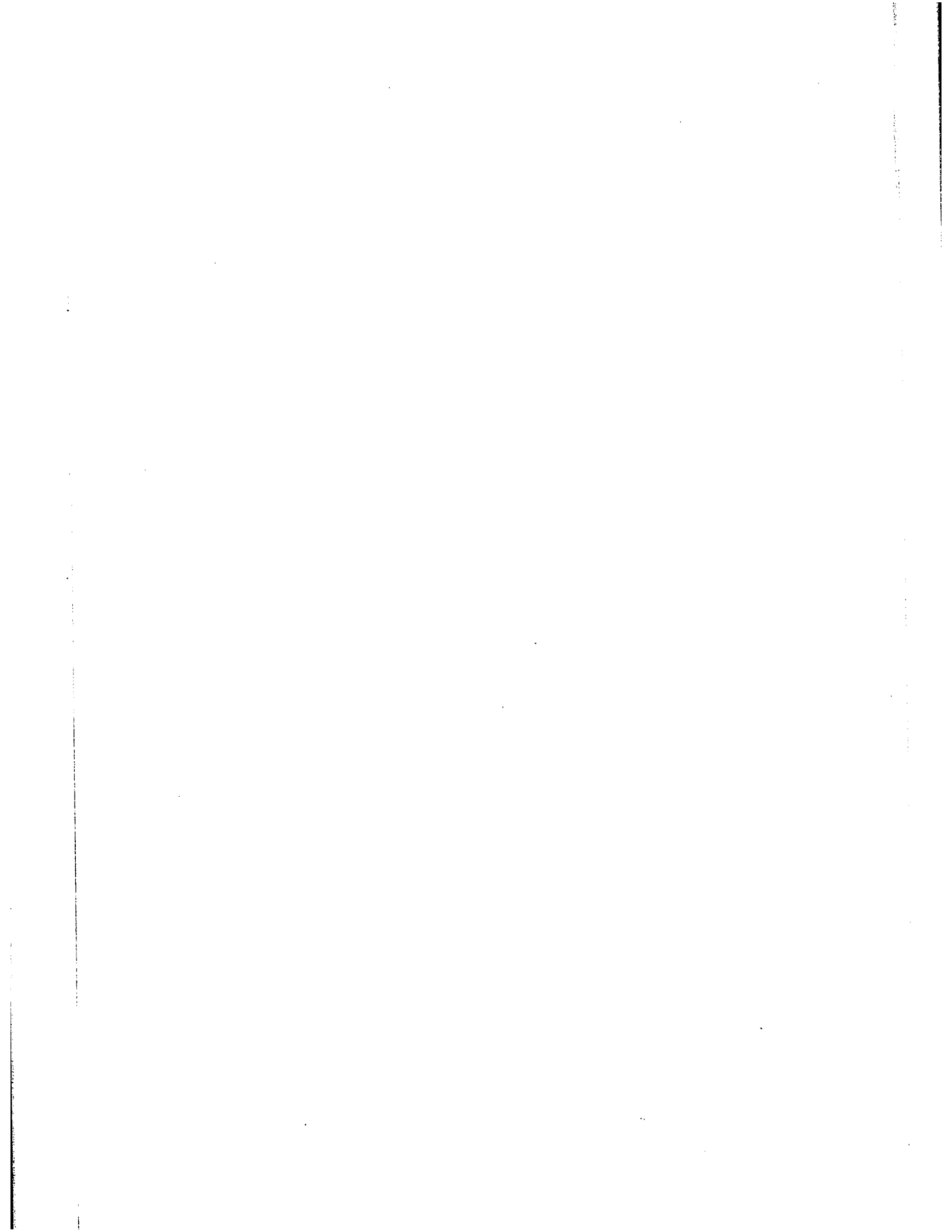
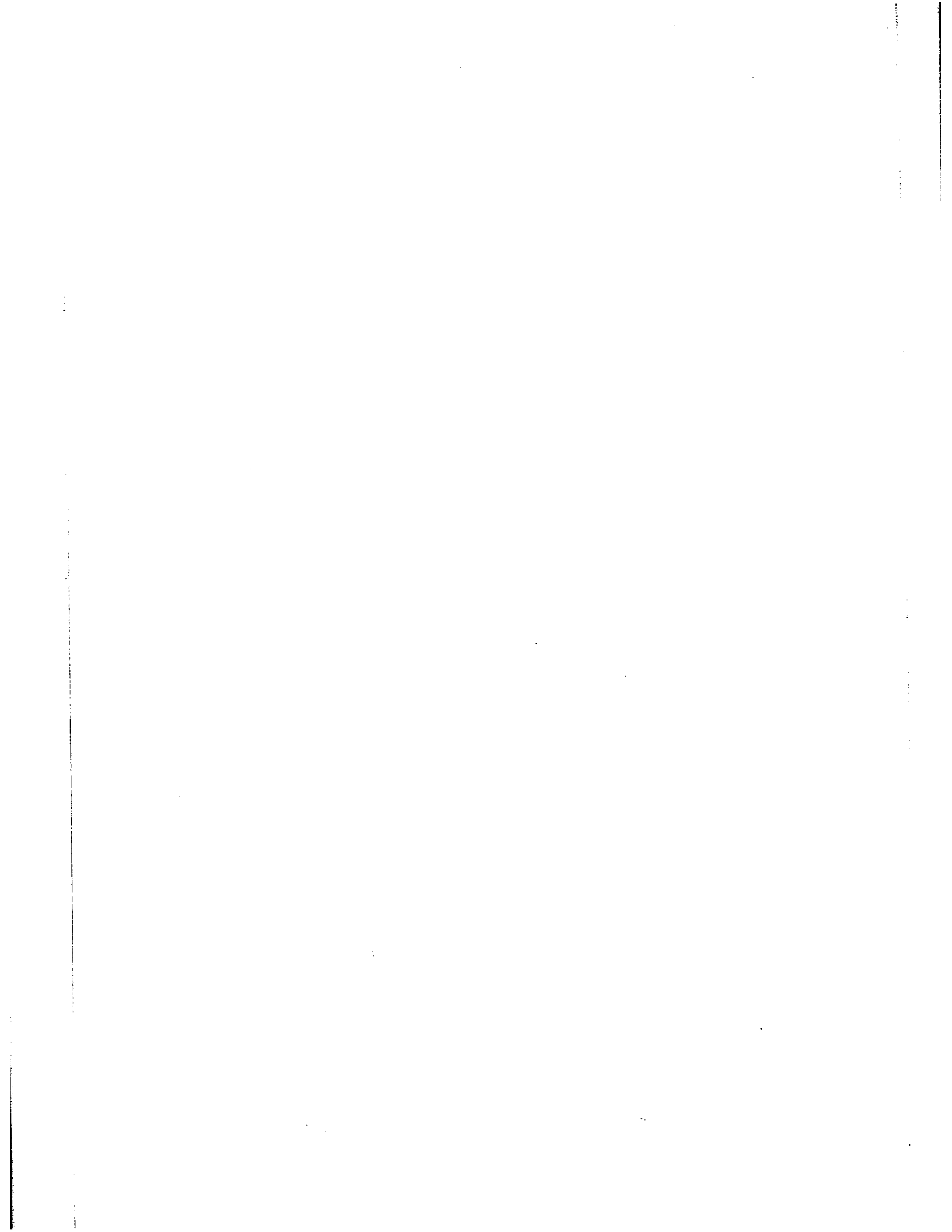


Table 17  
Means and Standard Deviations of Performance (Time) for Biofeedback and Placebo  
Groups (n = 10) across the Practice and the Five Matches

PRACTICE	MATCH 1										MATCH 2										MATCH 3										MATCH 4										MATCH 5									
	PRE	Q1	Q2	Q3	R1	R2	R3	POST	PRE	Q1	Q2	Q3	R1	R2	R3	POST	PRE	Q1	Q2	Q3	R1	R2	R3	POST	PRE	Q1	Q2	Q3	R1	R2	R3	POST	PRE	Q1	Q2	Q3	R1	R2	R3	POST										
4.03	-	3.40	-	3.75	-	4.14	-	-	4.88	-	4.89	-	5.76	-	-	-	-	6.87	-	6.58	-	7.05	-	-	-	6.83	-	7.20	-	7.74	-	-	-	-	6.83	-	7.20	-	7.74	-	-									
1.66	-	1.03	-	1.20	-	2.65	-	-	1.93	-	1.98	-	3.94	-	-	-	-	3.72	-	5.33	-	4.84	-	-	-	5.34	-	4.72	-	5.65	-	-	-	-	5.34	-	4.72	-	5.65	-	-									
4.30	-	3.98	-	4.90	-	5.90	-	-	5.99	-	5.79	-	7.65	-	-	-	-	6.55	-	6.91	-	7.85	-	-	-	7.94	-	8.35	-	7.89	-	-	-	7.94	-	8.35	-	7.89	-	-										
1.53	-	1.77	-	1.81	-	2.59	-	-	1.40	-	3.71	-	3.63	-	-	-	-	4.18	-	4.33	-	5.75	-	-	-	5.64	-	4.00	-	4.87	-	-	-	5.64	-	4.00	-	4.87	-	-										



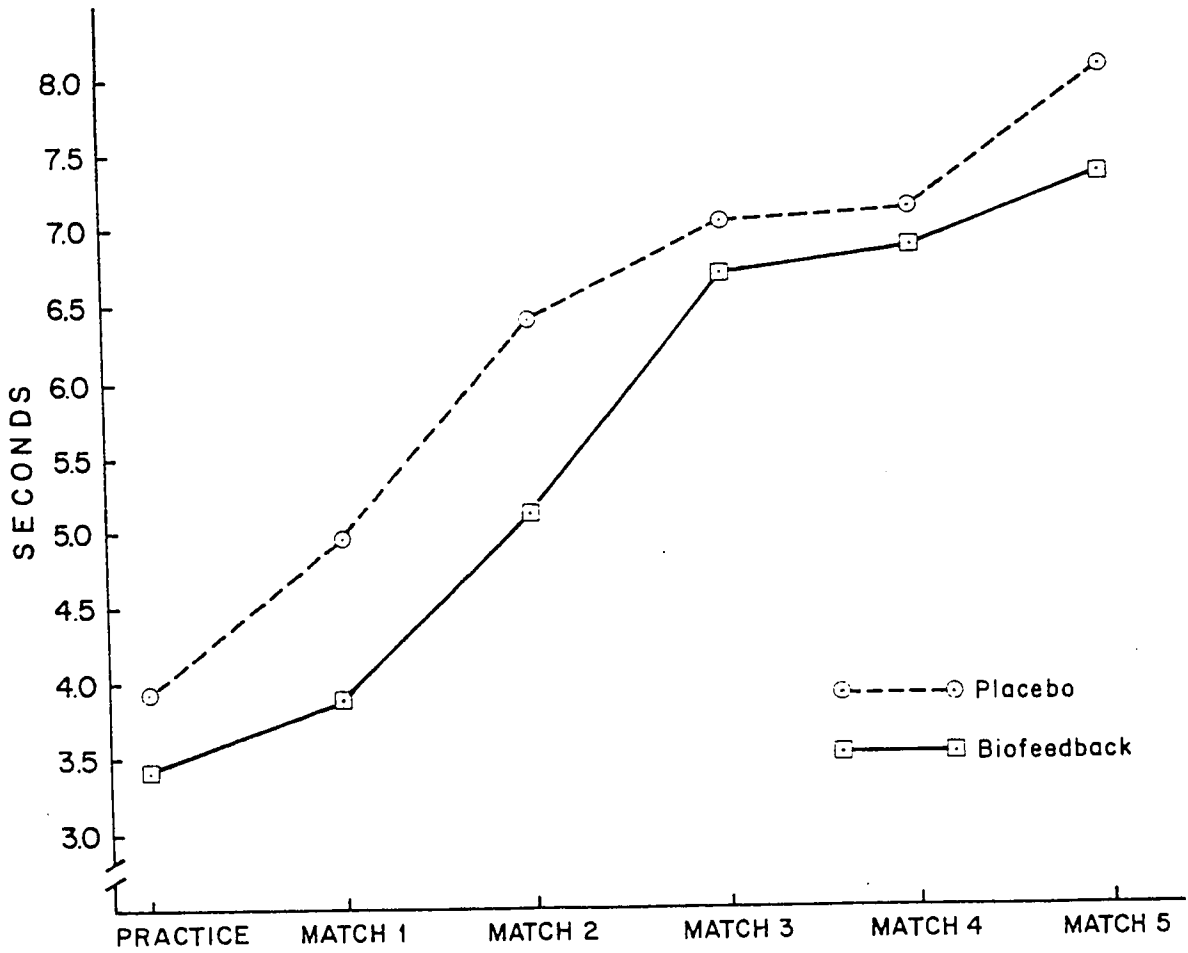


Figure 16 Mean performance for Placebo and Biofeedback groups (n=10) across the Practice and the five Matches.

Table 18

## ANCOVA Summary Table of Performance ( Time)

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	0.4	0.00	0.953
Error	17	114.0		
Sessions	4	100.9	8.95	0.000*
Sessions X Groups	4	3.0	0.27	0.897
Error	72	11.3		
Trials	2	25.8	9.86	0.000*
Trials X Groups	2	1.0	0.38	0.684
Error	36	2.6		
Sessions X Trials	8	2.3	1.03	0.417
Sessions X Trials X Groups	8	2.5	1.14	0.338
Error	144	2.2		

\* Significant F value

Performance (Error).

It was hypothesized that the EMG BF group, will improve their performance (lower errors) on the stabilometer significantly more than that of the placebo group.

Table 19 (p. 119) and Figure 17 (p. 120) suggest weak differences between groups. However, Table 19 (p. 119) suggests possible variability across sessions for both groups. Results from the ANCOVA revealed no significant differences between groups. The analysis however revealed that the error variable significantly changed across sessions  $F(4, 72) = 4.58, p < .002$  (see table 20, p. 121).

Table 19

Means and Standard Deviations of Performance (Error) for Biofeedback and Placebo Groups (n=10) across the Practice and the Five Matches

	PRACTICE										MATCH 1					MATCH 2					MATCH 3					MATCH 4										
	PRE	RI	R2	R3	POST	PRE	GI	RI	Q2	R2	G3	R3	POST	PRE	GI	RI	Q2	R2	G3	R3	POST	PRE	GI	RI	Q2	R2	G3	R3	POST	PRE	GI	RI	Q2	R2	G3	R3
BIOFEEDBACK	$\bar{X}$	30.3	31.2	37.5	-	-	43.5	-	48.8	-	44.2	-	-	-	57.8	-	57.0	-	50.0	-	-	-	-	51.8	-	53.9	-	53.6	-	57.1	-	48.6	-	-	-	-
	$\sigma$	10.1	12.4	15.3	-	-	21.3	-	19.2	-	22.1	-	-	-	15.8	-	12.3	-	21.2	-	-	-	-	24.2	-	20.0	-	13.0	-	19.6	-	24.4	-	-	-	-
PLACEBO	$\bar{X}$	33.6	31.2	30.1	-	-	38.1	-	43.5	-	47.9	-	-	-	55.2	-	55.5	-	57.3	-	-	-	-	56.5	-	57.4	-	56.7	-	61.5	-	54.1	-	-	-	-
	$\sigma$	13.6	10.2	7.6	-	-	14.7	-	10.0	-	12.7	-	-	-	19.6	-	22.2	-	20.6	-	-	-	-	21.4	-	23.9	-	24.2	-	22.4	-	16.6	-	-	-	-

R = Rest  
G = Game

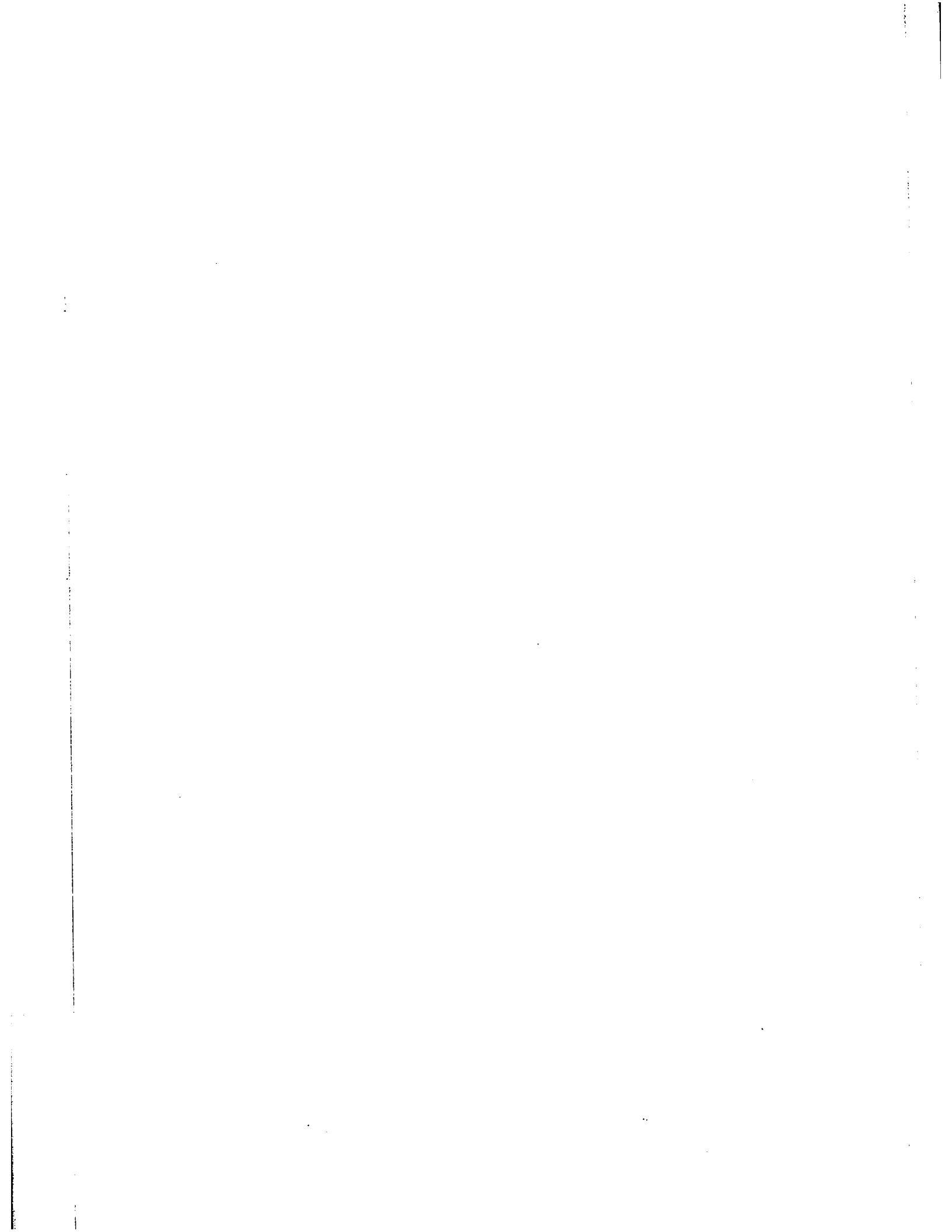
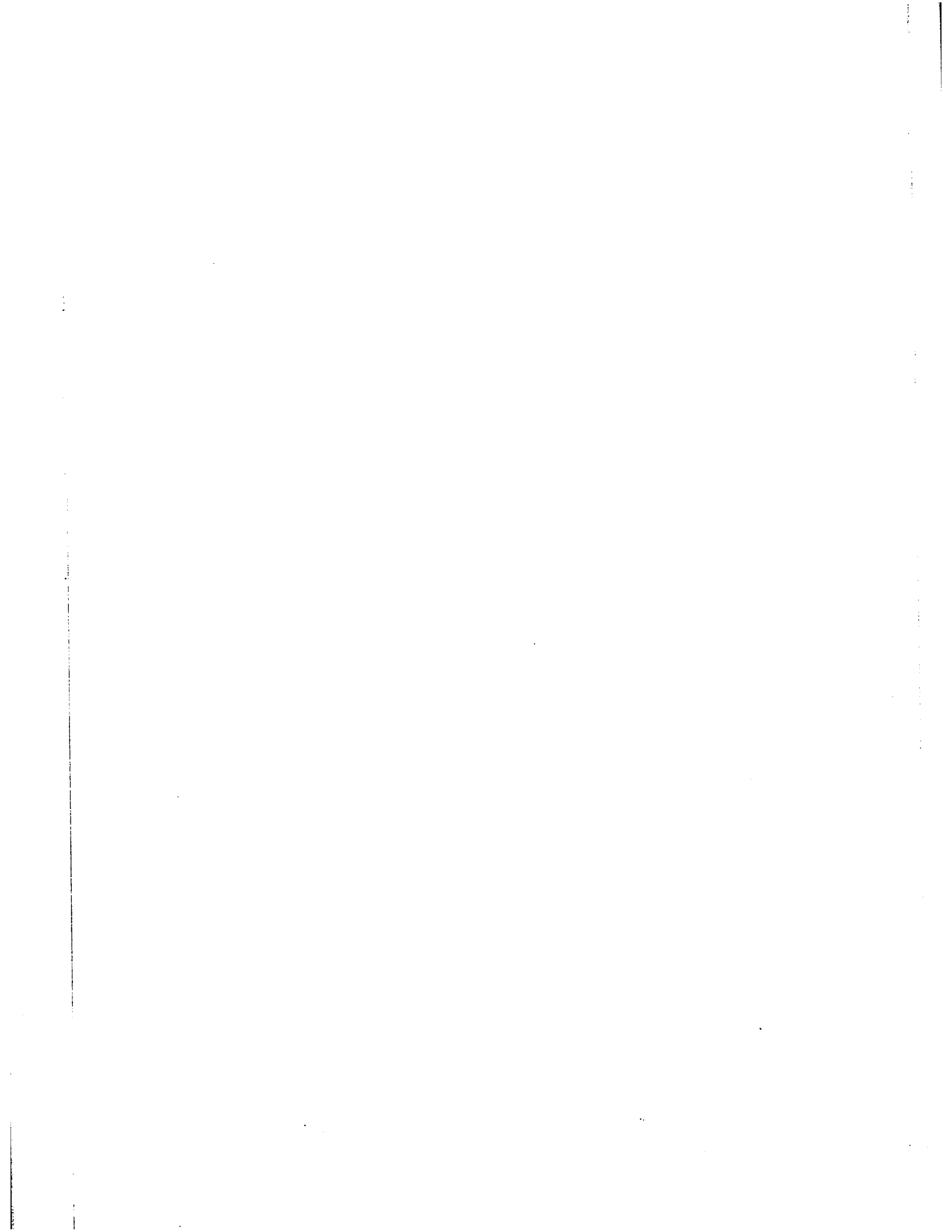


Table 19

s and Standard Deviations of Performance (Error) for Biofeedback and Placebo Groups (n = 10) across the Practice and the Five Matches

POST	PHI01 1							PHI01 2							PHI01 3							PHI01 4							PHI01 5														
	PFE	GI	RI	Q2	R2	G3	FB	POST	PFE	GI	RI	Q2	R2	G3	FB	POST	PFE	GI	RI	Q2	R2	G3	FB	POST	PFE	GI	RI	Q2	R2	G3	FB	POST											
-	43.5	-	48.8	-	44.2	-	-	-	57.8	-	57.0	-	50.0	-	50.0	-	-	51.8	-	53.9	-	53.6	-	-	-	-	57.1	-	48.6	-	57.8	-	-	-	-	57.9	-	56.8	-	58.8	-	-	-
-	21.3	-	19.2	-	22.1	-	-	-	15.8	-	12.3	-	21.2	-	21.2	-	-	24.2	-	20.0	-	13.0	-	-	-	-	19.6	-	24.4	-	17.5	-	-	-	22.1	-	17.9	-	21.7	-	-	-	
-	38.1	-	43.5	-	47.9	-	-	-	55.2	-	55.5	-	57.3	-	57.3	-	-	56.5	-	57.4	-	56.7	-	-	-	-	61.5	-	54.1	-	54.8	-	-	-	52.3	-	57.2	-	62.6	-	-	-	
-	14.7	-	10.0	-	12.7	-	-	-	19.6	-	22.2	-	20.6	-	20.6	-	-	21.4	-	23.9	-	24.2	-	-	-	-	22.4	-	16.6	-	17.7	-	-	-	16.1	-	22.8	-	26.7	-	-	-	



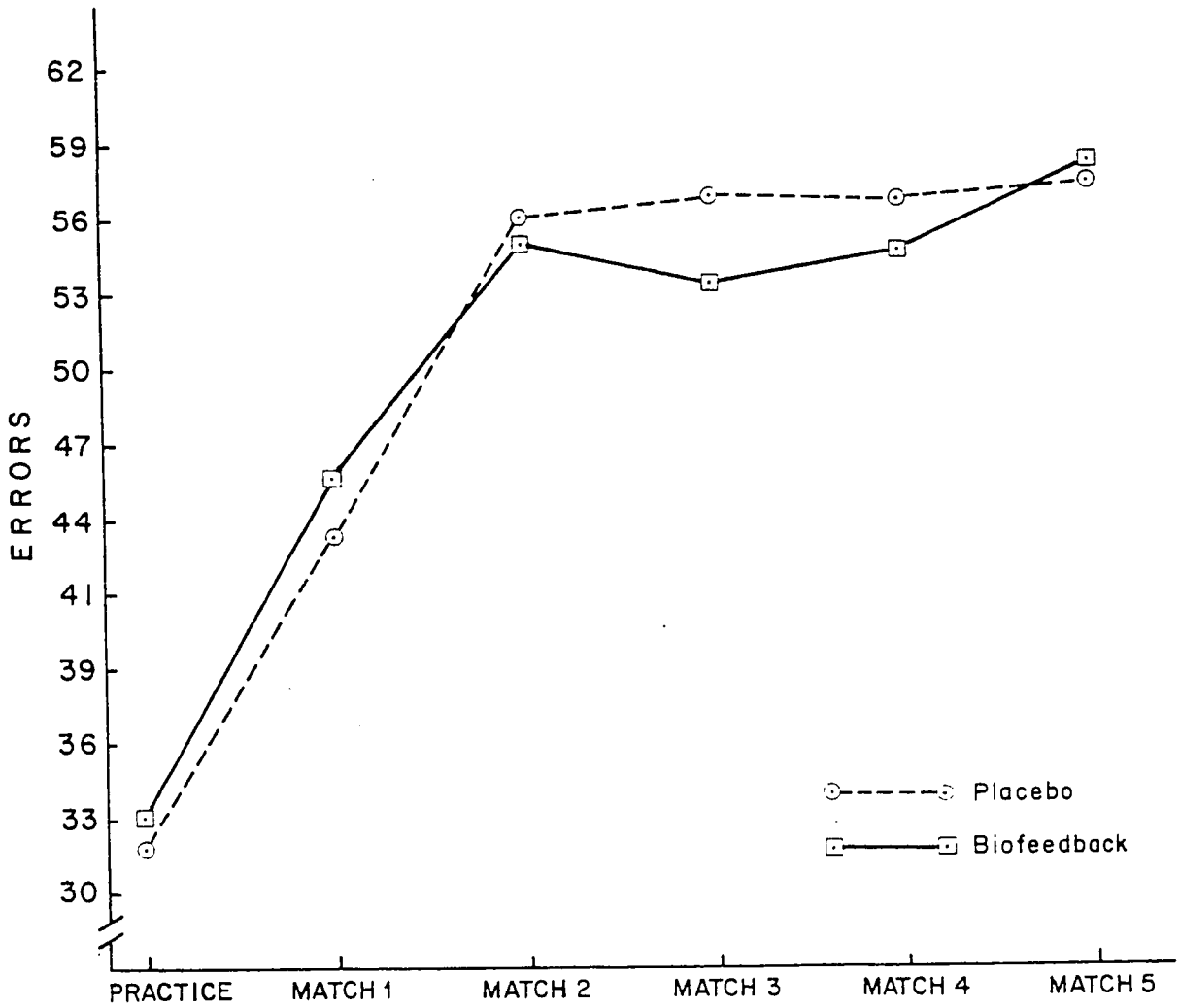


Figure 17. Mean errors for Placebo and Biofeedback groups (n=10) across the Practice and the five Matches.

Table 20

## ANCOVA Summary Table of Performance (Error)

	Degrees of freedom	Mean square	F	Probability F exceeded
Groups	1	123.8	0.04	0.851
Error	17	3394.6		
Sessions	4	1672.1	4.58	*
Sessions X Groups	4	84.5	0.23	0.920
Error	72	365.4		
Trials	2	44.0	0.39	0.679
Trials X Groups	2	96.3	0.86	0.432
Error	36	112.2		
Sessions X Trials	8	172.3	1.38	0.209
Sessions X Trials X Groups	8	102.7	0.82	0.583
Error	144	124.7		

\* Significant F value

### Specific Trait Anxiety.

It was hypothesized that the EMG BF group would have significantly lower levels of specific trait anxiety (SCAT) than that of the placebo group.

The means in Table 21 (p. 123) suggest a decrease in specific trait anxiety (SCAT) from pre to post measures. A 2 X 2 ANOVA (groups X sessions) with repeated measures on the last factor, revealed no significant group effect on sports specific trait anxiety (SCAT). However, a significant sessions effect  $F(1, 9) = 23.67, p < .001$  (see Table 23, p. 124) was revealed by the ANCOVA for specific trait anxiety (SCAT). These latter results demonstrate a significant reduction in sports specific trait anxiety between the period of the pre-test and the post-test for both groups.

Table 21

Means and Standard Deviations of Specific Trait Anxiety (SCAT) of Pre-Post Measurements for Biofeedback and Placebo Groups (n = 10)

		SCAT PRE	SCAT POST
BIOFEEDBACK	$\bar{X}$	24.1	21.1
	$\sigma$	3.43	2.77
PLACEBO	$\bar{X}$	25.1	23.0
	$\sigma$	2.56	3.59

Table 22

Means and Standard Deviation of General Trait Anxiety (STAIC FORM C-2) of Pre-Post Measurements for Biofeedback and Placebo Groups (n = 10)

		STAIC FORM C-2 PRE	STAIC FORM C-2 POST
BIOFEEDBACK	$\bar{X}$	39.9	37.0
	$\sigma$	4.01	5.83
PLACEBO	$\bar{X}$	42.4	41.5
	$\sigma$	5.6	8.68

Table 23

ANOVA Summary Table for Specific  
Trait Anxiety (SCAT)

	Degrees of freedom	Mean square	F
Groups	1	21.0	1.84
Error	9	11.4	
Sessions	1	65.0	23.67
Error	9	2.8	***
Sessions X Groups	1	2.0	0.31
Error	9	6.5	

\*\*\* Significant at the .001 level.

General Trait Anxiety.

It was hypothesized that the EMG BF group would have significantly lower levels of general trait anxiety (STAIC FORM C-2) than that of the placebo group.

Table 22 (p. 123) does not suggest any variability on any of the factors investigated for general trait anxiety. A 2 X 2 ANOVA (groups X sessions) with repeated measures on the last factor, revealed no significant evidence to support the hypothesis of the general trait anxiety (STAIC FORM C-2) variable (see Table 24, p. 126).

Table 24

ANOVA Summary Table for General  
Trait Anxiety (STAIC FORM C-2)

	Degrees of freedom	Mean square	F
Groups	1	136.9	1.61
Error	9	85.1	
Sessions	1	44.1	3.70
Error	9	11.9	
Sessions X Groups	1	6.4	.24
Error	9	27.1	

### Post Hoc Analysis.

A Bonferroni  $t$  statistic (Miller, 1966) was used for post hoc analysis whenever a significant main effect was found, a summary of which is presented in Table 25 (p. 128). Due to high error variance, no single session or trial was found to be significant. This phenomena has been reported elsewhere by Scheffe (1967) as "data snooping".

High variability as expressed by standard deviation was particularly evidenced in the EMG data. Table 26 (p. 129) illustrates this high variability throughout the standard deviations of the continuous EMG data of the rest periods. Curiously, the standard deviation in the placebo group seems higher than that of the BF group. There was one particular recording that showed almost consistently lower standard deviations for both groups. This latter reading was taken after the last rest period while the S did not have any feedback or white noise.

Table 25

Summary Table of Significant F Values

	GENERAL COMPETITIVE SETTING										REST PERIODS										STRESS PERIODS									
	MAIN EFFECTS					INTERACTIONS					MAIN EFFECTS					INTERACTIONS					MAIN EFFECTS					INTERACTIONS				
	G	S	T	SG	ST	ST	ST	STC	G	S	T	SG	ST	STC	G	S	T	SG	ST	STC	G	S	T	SG	ST	STC				
EMG	.02*	-	.000*	-	-	-	-	.007*	-	-	-	-	-	-	-	.005*	-	-	-	-	-	-	-	-	-	.044*				
Heart Rate	-	-	.000*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Respiratory Rate	-	-	.001*	-	-	-	-	-	.036*	-	-	-	-	-	-	.001*	-	-	-	-	-	-	-	-	-	-				
State Anxiety	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Subjective Tension	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.009*	-	-	-	-	-	-	-	-	-	-				
Performance (Time)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.000*	-	-	-	-	-	-	-	-	-	-				
Performance (Error)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.002*	-	-	-	-	-	-	-	-	-	-				
Trait Anxiety (SCAT)	-	-	.001*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Trait Anxiety (STAIC G-2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

\* Probability F Exceeded  
 - Not Significant

G Groups  
 S Sessions  
 T Trials

Table 26

Standard Deviation of Mean EMG Reading for Biofeedback  
and Placebo Groups (n = 10) Taken from Pre-Post  
Measurements and Rest Periods Across Sessions

		BIOFEEDBACK	PLACEBO
PRACTICE	PRE *	17.4	41.2
	AVERAGE SD **	9.4	34.0
	POST *	8.9	8.8
MATCH 1	PRE	21.1	13.8
	AVERAGE SD	8.2	17.3
	POST	6.5	4.9
MATCH 2	PRE	13.1	18.8
	AVERAGE SD	11.1	18.6
	POST	11.1	7.4
MATCH 3	PRE	5.8	14.9
	AVERAGE SD	10.1	16.9
	POST	8.7	24.3
MATCH 4	PRE	5.9	38.0
	AVERAGE SD	9.9	15.0
	POST	2.5	9.3
MATCH 5	PRE	4.9	8.4
	AVERAGE SD	8.4	16.8
	POST	4.1	8.0

\* Standard deviation taken from the baseline reading (PRE) and the post reading (POST) while subjects were not having biofeedback or placebo treatment.

\*\* Average standard deviation of groups' mean frontalis EMG between pre and post measurements. Readings were not taken while subjects were having biofeedback or placebo treatment.

### Post Interview

Responses from the interview relevant to the treatment effects are presented in the Appendix L (p. 200). The interview results were similar to the other more objective parameters used, showing group differences only on the specific target response (frontalis muscle tension). In this respect, 50% of the placebo Ss compared to 90% of the BF Ss said that they were more aware of their frontalis muscle tension than before their involvement in the study. Forty percent of the placebo Ss compared to 20% of the BF Ss stated that they were aware of muscles other than the frontalis. The small number of BF Ss (i.e., 20%) that felt a generalization of muscle tension awareness, supports the study's negative results with other parameters of relaxation.

An other difference in responses between groups was on item 10, asking the S if he had to play again "would you prefer playing and resting like you just did or would you prefer only playing?" In response 90% of the placebo Ss compared to 60% of the BF Ss said that they would prefer the original format of playing and resting (listening to their forehead muscle).

In both groups, 80% of the Ss said that the treatment helped them to relax (items 1,2,3,5) except after playing (item 4), 60% of the Ss in both groups negated that the treatment helped them at this latter moment. However, 80% of the Ss in both groups said that the treatment helped them to

relax better than before (item 6). There were six Ss (all in the BF group) who mentioned that they were using frontalis muscle relaxation outside the experimental setting such as at home when trying to sleep or before playing in a tournament, as many Ss were involved in baseball finals.

The Ss were asked to rate from 1 to 10 the amount of effort they made 1) on the stabilometer and 2) to relax (1 being no effort and increasing in value where 10 being their best effort). The BF group's average perceived effort on the stabilometer was of 8.8 (1.2 standard deviation) and the placebo group's average was also of 8.8 (1.5 SD). The perceived effort score for relaxing was somewhat lower with the BF group averaging 7.7 (1.5 SD) and the placebo group averaged the score of 7.9 (1.2 SD).

No Ss mentioned any dislike for the tournament or the study, (item 11). Most Ss preferred the game itself, but others preferred relaxing and the winning outcomes. Among the responses of what the boys liked the least in the tournament, was that of sitting in the armchair and relaxing; others mentioned losing and getting electrodes adhesives removed.

Before terminating the interview, the Ss were asked if they had any further comments. All of the S who responded to this question (15 Ss) said that it was fun.

Credibility of the Simulated Competitive Environment.

Various overt behaviors from the Ss indicated their strong belief and involvement in the tournament. Here are a few examples:

1- S praying before playing. At the last Match the S made the Sign of the Cross five times before playing.

2- S swearing at opponent before playing the last games.

3- S starting to cry for joy after winning the tournament

4- The majority of the Ss asked if they could get a poster of the tournament.

5- There were 80% of the Ss who mentioned that they were thinking a lot about whether they would win or lose the following match and the tournament, while watching T.V. at home, and/or before sleeping.

6- Two Ss mentioned that they dreamed about the competition.

7- Many Ss asked if they could practice at home (i.e. using a board on a log)

8- The majority asked if there would be another tournament the following year and said that they would be highly interested in participating again.

These were some of the responses given by the Ss which provide evidence to support a high level credibility for the

simulated sport tournament.

### DISCUSSION

Results from the present study support's previous findings (Alexander, 1975; Coursey, 1975; Cox, 1975; Haynes, Griffin, Mooney and Parise, 1975; Haynes, Moseley and McGowen, 1975; Reinking and Kohl, 1975) showing that EMG BF is more efficient than a placebo or a control group in reducing its target response (frontalis). However, results from this study do not support previous reports of a cross modality effect of frontalis EMG BF as reported by Schandler and Grings (1976) and Degood and Chisolm (1977). It is important to note however, that the present study differed from previous works as it assessed EMG BF's validity in a competitive stress environment with young Ss (children) whereas in the previous studies, researchers were using older Ss (adults) in a "calm" environment. The results from this study thus support a specificity of the locus of control with respect to frontalis EMG BF.

The high variability across sessions and trials that was found in the majority of the dependent variables supports the concept of competitive stress and the credibility of the present study's simulation of a sport competitive environment. The competitive setting however, did not interfere with motor learning as expressed through time, but errors did however increase across the matches.

The significant trials' effect in the EMG data in the general competitive situation may be attributed to the variations of the competitive environment; where the Ss were exposed alternatively to a stress (game) then to a rest environment (rest). This may support the assumption that sport competitive stress may influence frontalis EMG.

Statistical techniques for evaluating relationships (correlations) among this study's dependent and independent variables might shed additional light on the interpretation of the variability among trials. An observation of the Game and the Rest data throughout the Matches (see Figures 7 to 11, p. 79-83), may suggest a relationship between frontalis EMG and sport competitive stress. Figure 7 (p. 79) illustrates this latter point, showing increases in rest to stress (pre-game) and marked decreases (more pronounced for the BF group) from game to rest in Match 1. Match 2 (Figure 8, p. 80) also demonstrates variations between the rests and games. The latter game-rest pattern of responses of the frontalis is seen but less pronounced from subsequent matches 2 to 4. This maybe due to a general adaptation to the environment, whereby the Ss were increasing their familiarity with the consistent procedures. However, variations in EMG level became more pronounced in the last match (Figure 11, p. 83) where importance and uncertainty of outcomes were maximized. The reader may refer to Figure 3 (p. 67) for further details of the win-loss ratios.

The high variability observed in the last rest periods

is worthy of additional comment. The cause of this phenomena may be attributed to the effect of the feedback values of the treatment.

The placebo Ss were told to relax their frontalis muscle and they may have become confused with the false feedback (white noise). The placebo Ss may also have tried to relax by trial and error (muscle contraction and decontraction) so as to "feel" the muscle relax, thus producing high variations in EMG throughout sessions and trials. However, during the post interview (see Appendix L, p. 200), only 50% of the placebo Ss reported being more aware of their frontalis muscle tension but 80% of the Ss reported that the treatment helped them to relax (see Appendix L). The question that may arise then is were they trying to relax when told to do so? Were they practicing a type of "progressive relaxation" technique without actually being instructed to do so?

Another explanation to this problem may be simply that the Ss could not relax consistently while instructed to do so. In other words, the attention span of the placebo group may have been more restricted than that of the BF group due to the non-relevance of the false feedback (white noise). The placebo Ss may have decided at times (during rest periods) to relax but then, since the task was too difficult, as no actual feedback was given, they may have decided to stop "trying" to relax and rather, get involved in some irrelevant motor activities to "pass the time".

Several yawnings and stretching, previously reported as counter phobic responses (Nideffer and Macartney, 1976), were observed and may have influenced the EMG data that was consistently recorded during rests periods. The standard deviations of the latter recordings are presented in the Table 26 (p. 129). The BF group's standard deviation was also high; however it was somewhat lower than that of the placebo group. It could therefore be speculated that the BF group also had difficulty in keeping a consistent EMG reading but managed to relax more consistently than the placebo group. Hence, the BF group's attention span to relax was probably better due to the BF modality.

Counter phobic responses (Nideffer and Macartney, 1976) such as yawning and stretching should be considered for future studies. Counter phobic responses may be generated by the S's lack of ability to cope with sport competitive stress. If this latter point is true, we should see high standard deviations in the EMG "Game" data. Table 1 (p. 85) illustrates this latter point. These readings were taken after the S was asked "o.k., now we want to see how well you can relax for only one minute." The S may have felt that he would have "only one more minute to try to relax" sitting quietly. He also knew that the E was recording his tension level, and may have decided to comply with the E's demands. As a result, consistent low variability was obtained for this specific recording.

Consequently, it may be speculated that the BF process

per se may have strong potential for children where the BF modality seems valuable so as to maintain the child's "attention" and to his understanding of relaxation.

Results from the present study suggest also that EMG BF may transfer its specific effects from rest to stress environments at least for a short term interval between the latter settings. A significant interaction between groups, sessions and trials during the competitive stress periods on frontalis EMG suggested the latter speculation.

Significant differences between the BF group and the placebo group were found on the EMG variable using the rest data and was also found using both the rest and stress (identified as the general competitive setting) data combined. This latter result may suggest a transfer ability of the treatment from the rest setting to the induced stress setting. In this respect, results failed to report significant differences between groups with the stress data however the results did report a significant group X sessions X trials interaction, thus suggesting a possible transfer effect due to the treatment over time (matches and games). The possible transfer of EMG control consisted of two major abilities: 1) to control frontalis EMG in a relatively calm environment (rest periods) and then transfer this to an induced competitive stress environment (competitive stress periods) and 2) to control frontalis EMG with the help of BF (for BF Ss) during rest periods and then to control frontalis EMG during competitive stress periods

without the help of BF (for BF Ss).

The general environment, whether or not the S was resting or waiting to play, was designed to induce competitive stress and in consequence, the results obtained from the "general" data may reflect a strong potential for EMG BF application even during an actual sport tournament environment on its target response. EMG BF did not show any transfer potential with the other physiological variables. It should be noted however, that initial values may have had some effects on the results.

The other parameters assessed in this study did not have any significant differential effect of the BF treatment when compared to the placebo group. Heart rate during the general competitive setting varied significantly across trials while the respiratory rate data differed significantly across sessions during the general competitive setting, the rest periods and the competitive stress periods. Figures 12 and 13 (pp. 92,100) show increases for both the latter variables across sessions, specifically from the Practice (non-competitive) to Match 1 (competitive). Table 5 (p. 91) for the heart rate data shows the variability between the games and the rests data to support for its significant trials effect.

The experimental design, shifting from rest to induced competitive stress, was used in order to increase uncertainty and importance of outcome across sessions. In this respect, success-failure appears to be responsible for

the large variance attributed to the session and trial interaction on self-reports of state-anxiety. This observation coincides with Scanlan's work (1975) on the effects of success-failure on state anxiety.

Reductions in trait anxiety for both groups may also be attributed to the success-failure variable. Sport specific trait anxiety (SCAT) was significantly reduced from pre to post measurements. However, results from the general trait anxiety (STAIC FORM C-1) were not significant on the latter trials main effect but the means (see Table 22, p. 123) suggested a reduction. These responses may be explained by the fact that every S had highly successful outcomes where every boy won a total of nine games and lost six, winning four Matches out of five including the championship. These highly successful experiences, specifically at the end of the tournament may have influenced sport specific trait anxiety (as it did with state anxiety).

Curiously, the subjective measure of feelings of optimal tension level to perform did not seem to be as much influenced by success-failure outcomes. Maybe the boys perceived that a certain amount of "nervousness" was a function of this perception of the optimal condition to perform. Further analysis on the relationship between the different variables investigated might shed additional light to the discussion.

Results of the motor performance variables showed learning as reflected by the time variable. However, the

error variable also increased significantly. Thus, suggesting that, under the present study's stress environment, the Ss tried more frequently to bring the balancing platform to the horizontal position and consequently increased error counts. Hence, the Ss' improvement of time in balance does not seem to be a function of control as reflected by the error variable.

Responses from the post interview showed that 80% of the placebo Ss said that the treatment (placebo condition) helped them to relax better than before participating in the study. These results may suggest a possible placebo effect on the latter subjective measure.

Through anecdotal conversations, many Ss reported to be completely unaware of relaxation techniques or anxiety control strategies. Several Ss mentioned that they already used what they had learned in the laboratory for various purposes ranging from trying to sleep at night to relaxing before performing in sport competitions.

## CHAPTER V

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Sport competitive stress appears to enhance state anxiety specifically on high trait anxious Ss. A large number of children are presently involved in competitive sports and investigating alternatives for them to cope with competitive stress is needed. EMG BF's credentials as a self-control strategy appears to warrant consideration with respect to children's relaxation training.

The purpose of this study was to investigate the effects of frontalis EMG BF training on sport pre-competitive anxiety variables and on motor performance, within a laboratory controlled environment with high trait anxious boys from 10 to 13 years of age.

From 261 tested Ss, 80 Ss scored in the upper quartile of the SCAT and from this latter sample, 20 Ss were randomly selected and were randomly assigned to either a group having frontalis EMG BF (n = 10) or to a group receiving a placebo condition. The Ss were yoked for contingent positive verbal qualitative feedback (CPVQF).

The Ss participated in a bogus sport competitive tournament. An elaborate bogus setting was presented to the Ss in order to control for variables such as opponents, audience and success-failure. The objective of the game was to beat an opponent two out of three times to win a match

and to achieve first place in a pyramidal tournament that consisted of five matches. The opponent was a bogus character who was purportedly in a different location and represented by a timer in the subject's room. The task consisted of keeping a stability platform in horizontal balance for as long as possible within a 30 seconds trial. The six laboratory sessions consisted of a practice session and five matches. Each session was comprised of an adaptation period, three games separated by three rest periods, then post measurements. During rest periods, the BF Ss (n = 10) were given frontalis EMG auditory and visual feedback. During this period, the placebo Ss (n = 10) were given the same instructions as the BF group but modified so as to describe the treatment's procedures pertinent to each group. The BF group received verbal feedback CPVQF from the E at the end of the rest period when warranted. The placebo group had the same CPVQF as their respective yoked BF S.

General trait anxiety (STAIC FORM C-2) and sports specific trait anxiety (SCAT) were administered before and after the laboratory sessions. Frontalis EMG mean peak-to-peak microvoltage was recorded continuously during the 20 minute rest periods in every session. Frontalis EMG, heart rate, and respiratory rate were recorded within every session: after adaptation, before every game (except during the practice) at the end of every rest period and at the end of every session. State-anxiety (STAIC FORM C-1) and subjective perception of optimal tension level for

performance were recorded before every game. Time performance and error performance were recorded three times per session. A taped interview concluded the last session. The data for all the variables (except for trait anxiety and the post interview) was treated by a three way ANCOVA with repeated measures using the baseline measure of the practice session as the covariate. The data for the trait anxiety variables were treated by a two way ANOVA with repeated measures. The post interview data was kept descriptive.

#### CONCLUSIONS

Significant group differences were found only on the EMG variable in the general competitive setting and in the rest periods, thus, supporting the notion of specificity of frontalis EMG BF. However, the results did suggest the potential use of the frontalis EMG BF to transfer its specific effect from rest to a general competitive setting. The high variability during the rest periods recorded by the placebo Ss on the EMG data also suggested the possibility that BF may have strong potential for children where the BF modality seems valuable so as to retain the child's attention and to increase his understanding of relaxation.

The study showed significant increases in all of the anxiety parameters assessed in this study except for trait anxiety thus, providing some support for Martens' (1977) model of competitive stress. Significant decrease in sport

specific trait anxiety (SCAT) was found and could be attributable to the highly successful outcomes experienced during the tournament. The success-failure variable may have influenced variations in state anxiety across the sessions and trials. Results on the motor performance variables as expressed by time and error showed a positive learning curve with regard to time, thus Ss remained in balance for longer periods of time across sessions. However, motor performance as assessed by error, increased across sessions. Results from the post interview suggest a placebo effect on subjective measures. This study does not provide support for a cross modality effect or performance enhancement under competitive stress that may be attributed to frontalis EMG BF.

## RECOMMENDATIONS

Further investigation is needed to assess the validity of relaxation techniques with respect to their appropriateness for helping young sport participants of varying age groups, to cope with competitive stress.

Comparative designs assessing relative effectiveness of different relaxation techniques or coping strategies, should be considered. Both placebo and control conditions should be included in the latter designs. A control condition would permit one to assess the relative effect of a placebo condition which according to this study, warrants consideration.

With respect to BF, more work could also be done on the motivational components of feedback modalities considering intrinsic rewards for children. Developments of proper feedback displays (interface) that will appropriately draw the child's interest and focus on trying to relax would be of value.

Further investigations on the validity of different coping strategies for sport competitive anxiety with both boys and girls varying in sport specific trait anxiety (SCAT) are needed.

Further studies assessing the cross modality effects of longer EMG BF training are also needed.

Results from the present study would support the use of EMG BF to train specific muscle groups that are impaired

under high competitive stress and more specifically, those responsible for motor behavior, if performance is to be investigated.

It is recommended for future controlled studies that, success-failure outcomes be controlled. This latter variable appears to influence state anxiety and if not controlled would likely confound the assessment of another independent variable (e.g., relaxation technique).

The assessment of the cognitive components of the coping process of competitive stress for children would be of value.

The assessment of the cognitive components involved during BF and placebo training for children would also contribute to this area of research.

Overt behavior observations during relaxation training and stress periods are also recommended for future studies similar to the present one.

The present study's laboratory controlled environment was very effective in simulating sport competitive stress of real world conditions. Similar procedures are recommended for future controlled studies.

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**APPENDIX A**

**PRACTICE SESSION**

PRACTICE SESSION

1. The S entered the control room. E.: " This is where all the measurements will be recorded. Also, the cameras will be controlled in this room so you will not be disturbed when competing in the opposite room. This plate glass (E. showing one-way mirror ) is a one-way mirror so that the technician can see if everything is o.k. in the tournament room. Your performance will be transmitted on closed circuit television transmission ( E. showing closed circuit television screens) . These are monitors for the cameras in the room you will be competing in, and also from the room where your opponent will be competing against you. We can now enter the tournament room."
2. E and S entered the tournament room: " O.k., this is where the tournament will take place. Sit in this chair and I will explain the procedures that we will follow during the tournament. (E takes the surface electrodes) During the tournament we will measure the tension of your forehead muscle and your heart rate with these things called surface electrodes. Once the electrodes were placed the E said: "Now you will come and relax in this comfortable armchair. (The E placed the pneumograph around the S's chest) This is to measure your breathing. It is sensitive so dont touch the belt while it is on you. I will connect the electrodes to our recorders and I would

like see how well you can relax for only five minutes. I will leave you alone for this period and I will then come back after the five minutes will be over." The E returned after the 5 minutes adaptation period.

3. Now, before every game we will take measurements on you to see how you feel. First, I will give you this questionnaire. During the tournament you will complete this questionnaire after you will hear the technician announce that the game will start in three minutes. Now, answer all the questions as honestly as possible. This is very important." E gives the questionnaire to the S and E reads aloud the instructions situated at the beginning of the questionnaire. E: " So you have to answer what you feel at the exact moment that you are filling out the questionnaire. Try it right now.
4. When the S appears to be finished to answer the questionnaire. E: " Are you finished?..." If S said "no", E replied: "Do not try to spend too much time on a question, just answer how you feel." In either case E said: " Are there any words you do not understand ?" If so, synonyms of the words were given.
5. "Then, during the tournament the judge will announce a one minute before playing time".
6. " I will then unplug the electrodes from this box." E

does what he is explaining. "And you will set this slide rule (tension scale) according to how you feel to play on this platform. The marker at zero means that you feel just perfect to play. If you set the marker where the plus numbers are it means that you are nervous to play. Where at plus one would mean that you are slightly nervous to play and at plus ten that you are very nervous. If you set the marker on the minus numbers, it means that you feel lazy to play where at minus one means that you are slightly lazy to play and at minus ten that you are very lazy to play. So remember that you can set the marker anywhere between minus ten and plus ten and be as precise and as honest as possible to how you feel to play. Now listen closely to this tape. The voice you will hear is that of M. Gordon who is director of this tournament."

7. E started the tape recorder. The voice on the tape was from a different person than that of the E or the T.
8. Welcome to the First Annual Motor Performance Tournament. As the director of the tournament, it is my duty to explain to you the official rules and procedures of the tournament.
9. First, the prime objective of this tournament is to determine which regions throughout Ontario and Quebec can give superior performances on a stability task.
10. At the same time, we are trying out a new communications

method to transmit instantiously audio-visual and performance data on closed circuit transmission.

11. You have been selected to represent the Ottawa region. So your participation is very important for your region. All the contestants you will be competing against are of the same age.
12. Now, I'll explain the rules and procedures to you. You should be able to see in front of you, what is called a stability platform. This is the official game of our tournament. (E points with his finger the stabilometer)
13. The game is very simple to play. All you have to do is stand on the platform and wait for the starting signal. Then, you simply try to maintain the platform in a balanced position within a time period of thirty seconds. Every time the platform is in balance, you will hear a 'click'. In addition you will see your timer adding up the total time that you kept the platform in this position. Another timer will show your opponent's performance.
14. Now, here is the objective of the game. You should be able to see in front of you the tournament board (E shows the tournament board). The objective of the game is to end up in level 1 which is first place. This means you win the tournament for your section.
15. Before the tournament starts, the names of all of the contestants in your section will be picked at random

by the computer and your names will be placed on a specific level on the tournament board.

16. In order to get to a higher level, you have to beat everyone in the same level as you are in. Then, you can challenge a player from the next level above you and so on, until you reach level 1.
17. At this level, there is only one contestant and he is in first place. If you lose a game against someone in a lower level, he takes your place and you take his place. This means that, before you can challenge someone in the level above you, you have to beat everybody in your own level. So, if you want to win the tournament you have to get to the top and stay there, regardless of all the others that will try to get your place.
18. The tournament consist of five matches. Every match consists of three games against the same opponent. To win a match you have to win two out of three games.
19. I'll explain briefly our communications network for this particular tournament. Our master control for the Ottawa-Hull region is located at Carleton University.
20. The judges will watch you during every match on their closed circuit monitors. This will permit them to officiate the games while you and your opponents are at two different locations.
21. If you don't understand certain points you may ask your

coach to either clarify them or rewind this tape to the specific part you would like to hear.

22. (E stops the tape and asks the S if everything is clear on what was said. If not, E either clarifies or replay's the tape at the specified places. After, E starts the tape where it was stopped.)
23. Now that you know a bit more about the tournament, we want you to think about it very seriously and inform your coach if you are certain that you can attend the five matches withon the two week period. If not, simply say no and we will appreciate your honesty. If you do agree we will be very proud to have you among the contestants. On behalf of the organizing committee of the First Annual Motor Performance Tournament, I wish you the best of luck."
24. E stops the tape recorder and says to the S : " So, (name of S) do you agree to compete throughout the tournament?"
25. If S says "no" , E will say: " O.k. it is your privilege and it is good that you are honest about it. Now (name of S) , would it be possible for you to tell me the reason why you do not want to participate?". Then the S was excused and randomly replaced by another.
26. If the S says "yes" the E responded: " Great! Let's start the practice. The practice will be just like during a match except you will have no opponent and

there will be nobody watching you except the technician and myself.

27. E said: "Now, after the one minute before playing will be announced the judge will ask you to step on the stability platform keeping the right side down... O.k. ? Get on it, keep the right side down. Now the judge will ask if you are ready. I will give him the signal then the judge will give the starting count: "Ready...5,4,3,2,1,go!". Then you will have to keep the platform in balance longer than your opponent for a thirty seconds period... if you want to beat him. You will see your time adding up on this timer (showing the S's timer) and during the tournament you will also be able to check your opponent's time on this timer (showing opponent's timer) that is connected to our communication You can also check with this timer (showing the clock timer) if you want to see how much time you have left to play.
28. "O.k. now, let's try it, I'll give the starting signal:Ready...5,4,3,2,1,go!" S performed for thirty seconds. After, the technician recorded the readings on the S's timer and error counter from the camera.
29. E said: "Let's say that you have won this game I will put a '1' under 'you' on the score board. After the game, you have a rest period of five minutes.
30. Because there is very little time to practice on the stabilometer and because the competition his going to

be tough to get to first place and to get to the top you will have to remain calm throughout the entire tournament. This is why we will give you special time to relax."

31. Instructions for the placebo group: "During the rest period you will try to relax as much as you can and you will try to remain relaxed and calm until you will be actually playing. So get as comfortable as you can in this chair and try to relax. To help you do this you will listen to your forehead muscle and try to relax it. However, don't concentrate too hard on the task. OK? I will come back after five minutes, before we start a second game." E went to the control room and returned to the tournament room five minutes later.

32. Instructions for the experimental group: "During the rest period you will try to relax as much as you can and you will try to remain relaxed and calm until you will be actually playing. So you will sit down as comfortable as you can in this chair and try to relax. To help you do this, you will listen to your muscle on your forehead or look how tense it is with the help of this meter (showing the analog meter on the EMG BF unit). E connected EMG electrodes in the junction cable. EMG tone from the speaker was heard. "Harden your forehead muscles... then relax it. Can you see the needle peg to the right as you harden

your muscle then falling back to the left side as you relax your muscle? Do you hear a difference in the sound as you relax your muscle? (S answered) So when you relax, the sound gets weaker until it is no longer heard. Now you try to lower the clicks? " technician sets the BF instrument at high micro-voltage threshold so that the auditory signal could be easily turned off by the S. E said: "This is easy, but gradually we will set the machine so that it is more sensitive and that you will have to relax much more to shut off the clicks or to put the needle to zero. Now during the rest periods you will try to relax as much as you can with the help of this tone. Are there any question?" If there was any question, the E clarified or repeated the above instructions. E said: "Now, I will let you relax with the help of the tone for five minutes. I will leave you alone and return in five minutes, o.k.." E went in the controls room for this period.

33. For both groups: After five minutes the E entered the tournament room.
34. E said: "After the rest period, you will repeat the same tests. The S completed the STAIC FORM C-1 then set the tension scale. E said: "Then, we will get the one minute warning. Then, it will be the signal to step on the platform keeping the right side down.
35. Could you step on the platform now.

Ready...5,4,3,2,1,go!" S performed for thirty seconds.

36. Time and error were recorded.

37. E: "Now sit down in the chair again and relax before the last game."

38. For both groups the E inserted the EMG electrodes in the junction cable and said: "You will now practice to relax by lowering your muscle tension."

39. For both groups the E left the tournament room and returned five minutes after. Repetition of procedure 34. Then the E said: "O.k. now let's give it a last try on the platform." E disconnected the electrodes from the junction cable and directed the S to the stabilometer. E said: "Ready...5,4,3,2,1,go!".

40. S performed and at the end of the thirty seconds of play, the readings on the timer and error counter were recorded. E said: "The third game is the last game in a match. So after this game it is easier to learn to relax because you know that there are no more game left for the day. You will then practice relaxation for ten minutes after the third game."

41. E left the tournament room and returned ten minutes later. E said: "I would want to see now, how well you can relax for only one minute without the help of the instrument". Feedback modality and white noise were stopped and after the minute the E returned then removed the electrodes from the S and said: "So

you will make it for the next session (determined day and time) for the starting game?...We will be counting on you...Oh! before you leave there is something very important that I have to ask you."

42. "I need your promise that you will not mention anything about the tournament to any of your friends. This is very important to follow throughout the entire tournament. If not, it could influence the measurements that I will be taking. Can I count on you? (If S answers: "yes" he was thanked if he answered: "no" then he was excused and randomly replaced by another.) The E added: "If you want, you can talk about it to your parents but keep it a secret between the three of you."

APPENDIX B  
TOURNAMENT SESSIONS

TOURNAMENT SESSIONSMatch 1Game 1:

1. E met the S at the door of the laboratory and said: "Hi! (S first name) come in."
2. E directed the S inside the tournament room then said: "I will place the electrodes on you and we will be ready to start as soon as your opponent is ready." The electrodes were placed and the E said: "Now sit in the armchair and I will attach this belt around your chest so that we can see how you breathe. Try not to touch the belt because it is very sensitive. Now try to relax as much as you can for five minutes then after we will start the game."
3. After the five minutes adaptation period the technician started the tape recorded dialogue between bogus characters. They are: Technician 1 (T-1) that was situated at Carleton University in the master control, Coach 1 (C-1) who was situated at Carleton University in a tournament room and the Judge (J) that was situated also at Carleton University and in the master control.
4. T-1: "Carleton, this is central can you give me a count?"

C-1: "1,2,3,4,5,...0.k.?"

T-1: "Good. Thank you."

T-1: "Ottawa U can you give me a count?"

Blank space on tape so the E can answer:  
"1,2,3,4,5,...0.K?"

T-1: "Good. Thank you...Carleton, can you switch your timer to the "on" position and manipulate the stability platform so we can check the accuracy of the readings."

C-1: "O.k. here it is."

5. E to S, showing the opponent's timer: "This is going to be the timer that will give you the constant performance of your opponent." Timer was activated and stopped by the technician at any time between ten and fifteen seconds.

C-1: "What is your reading Ottawa U?"

Blank space on tape so the E can answer: "The time we have here at Ottawa U is (time indicated on the timer)"

C-1: "Right on the dot! What is your reading central?"

T-1: "Exactly the same reading...Carleton? How is your visual reception of Ottawa U contestant?"

C-1: "Reception is very clear."

T-1: "Great, are you ready to start in about three minutes?"

C-1: "We will be ready by that time."

T-1: "O.k., how about you Ottawa?"

Blank space on the tape so the E could answer: "Yes we will be ready."

6. J: "Attention please...As it should be shown on the tournament board here is the following placement of the contestants of your group that was made at random by the computer. Your coach may now tell you the number that you will have for the entire tournament. ( E shows the Figure "1" with his finger to the S). Contestants, please excuse our use of numbers rather than your name. This policy was adopted so that the communications would be clearer and as brief as possible during the tournament."
7. J: "The contestants of this match are: from University of Ottawa, contestant number '1' and at Carleton University, contestant number '2'. Good luck to both of you."
8. T-1: "Attention everybody, we will start in about three minutes from now." Technician stopped the tape recorder and the E opened the TV monitor in the tournament room.
9. Physiological measurements were taken, followed by the STAIC FORM C-1 which was also given to the S. The E reminded the S: "Do not forget to answer honestly how you feel right now. As soon as you are finished answering all the questions, just leave the pencil and the questionnaire on the floor and I will pick it

up."

10. When the S finished answering the questionnaire the E collected it and the technician started the tape recorder
11. J: " Attention, we will start the game in one minute after the signal... (auditory signal).
12. During the latter minute, the S set the tension scale and was reminded that: "Zero means that you feel just perfect to play, while plus ten means that you feel very nervous to play and minus ten means that you feel very lazy to play.
13. S moved the marker to his perceived level of "tension".
14. Technician started the tape recorder with the J's voice:  
"Both contestants please stand on the stabilometer keeping the right side down. Carleton, are you ready?"  
C-1: "Yes we are."  
J: "Ottawa are you ready?"
15. Blank space on tape so the E could answer: "Yes we are."  
J: "O.k....Ready...5,4,3,2,1,go!"
16. E pushed the button to start the clock timer. The clock signaled with a buzzer when the minute was over.
17. End of game 1 and the S won.
18. The E recorded the S's time, errors and bogus opponent's time. Later the technician pushed the reset button to clear both timers.
19. E said: "Good start! (first name of S), now come and

- relax in the chair."
20. J: "Contestant number one wins the first game and it is one to nothing."
  21. You will now have a rest period of five minutes, all cameras are turned off during this period."
  22. Cameras were moved to point elsewhere than on the S. The E closed the TV monitor in the tournament room.
  23. Instructions to experimental Ss, E: "Try to relax as much as you can, and try to remain calm after the rest period for the game."
  24. Repetition of procedure 38 from Appendix A.
  25. E left the tournament room to enter in the controls room. After five minutes, the E re-entered the tournament room.
  26. Repetition of procedures 8 to 16.
  27. End of game 2 and the S loses.
  28. E: "Gee, that's too bad. But we still have a third game to go. Now come and relax in the chair."
  29. J: " Player number two wins the second game."
  30. Repetition of procedure 18.
  31. Technician started the tape with J's voice:" Player number two wins the second game and the score is a one to one tie.
  32. So the third game will decide the winner of this match."
  33. Repetition of procedures 21 to 26.
  34. End of game 3 and the S won.
  35. E : "Great! (first name of S) and you are still in first

place."

36. J: "The winner of this match is player number one, congratulations! So the first place in the tournament is still maintained by plarer number one ."
37. Rest period of ten minutes; same procedures as 40 to 42 in Appendix A.

Match 2

- 38 Repetition of procedures 3,4,5,8,9.
39. On tape recorder, J: "Attention please, here is the following placement of the contestants in this group after match number one. At level one in first place, it is still player number one, at level two, we have contestant number three and number six, and in level three we have contestants number two, four and five. So number one is still undefeated."
40. J: "The contestants in this match are from University of Ottawa; player number one who will play against player number three at Carleton University. Good luck to both of you."
41. Repetition of procedures 8 to 16.
42. End of first game, S loses.
43. E: "Well... you will have to win the following two games if you want to remain in first place. Now come and relax in the chair."
44. Technician started the tape recorder with the J's voice:  
" player number two wins the first game and it is one

- to nothing."
45. Repetition of procedures 21 to 26.
  46. End of game 2, S wins.
  47. E: "Good, now you've got to win the last one...Let's relax now before the game."
  48. Technician started the tape recorder with the J's voice:  
"player number one won the second game and the score is now a one to one tie."
  49. J: "The last game will decide the winner."
  50. Repetition of procedures 21 to 26.
  51. End of the third game, S loses and loses the match.
  52. E responds sympathetically: "Well, you can't always win...but you still have a chance to challenge the first place. In order to do so, you have to win against a challenger in level three, then, you can play against the other one in the level two, and if you win again you can challenge the one who is in first place for the last game of the tournament. Winning the last game would make you champion of the tournament for your group. But remember, you have to win all of the following matches."
  53. Repetition of procedure 18.
  54. Technician started the tape with the J's voice:"The winner of this match is player number two, congratulations! You are now in first place."
  55. Rest period of ten minutes. Repetition of procedures 40 to 42 in Appendix A.

Match 3:

56. Repetition of procedures 3,4,5,8,9.
57. J's voice on the tape recorder: "Attention please, here is the following placement of contestants in this group after the second match. In first place; it is contestant number three, in level two; we have contestants number 1 and number 6 and in level three we have; contestants number two, four and five.
58. The contestants of this match are: player number one of the University of Ottawa and will play against player number four at Carleton University. Good luck to both of you."
59. Repetition of procedures 8 to 16.
60. End of the first game and the S wins.
61. E: " Good start! Now let's relax."
62. Technician started the tape with the J's voice: " Player number one wins the first game and it is one to nothing."
63. Repetition of procedures 21 to 26.
64. S loses, same procedures as 27.
65. E said: "Well...You've got to win the third one (S's first name) if you still want to be in the race. Come on and relax a bit."
66. Technician started the tapewith the J's voice: " Player number four wins the second game and it is a tie having each won a game."
67. Repetition of procedure 21 to 26.

68. S wins the third game and the third match.
69. E said: "That's it! Good! Now let's practice some relaxation for the next match."
70. Technician started the tape with the J's voice: "The winner of this match is player number one, congratulation!"
71. Rest period of ten minutes, same procedures as 40 to 42 in Appendix A

#### Match 4

72. Repetition of procedures 3,4,5,8,9.
73. J's voice on tape recorder: "Attention please, here is the following placement of contestants in this group after the third match. At level one in first place it is contestant number six, in level two; we have contestants number one and three, and in level three we have contestants number two, four and five.
74. J: "The contestants in this match are: player number one at University of Ottawa and will play against player number three at Carleton University. Good luck to both of you.
75. Repetition of procedures 8 to 16.
76. S lost the first game.
77. E said: "We have to win the two games left...come, relax in the chair."
78. Technician started the tape with the J's voice: " Player number three wins the first game."
79. Repetition of procedures 21 to 26.

80. S won the second game.
81. E said: "O.k.! One more and we are in business. Let's relax before the last game."
82. Technician started the tape with the J's voice: "Player number one wins the second game and it is a tie."
83. Repetition of procedures 21 to 26.
84. J: "The third game will decide the winner. It is going to be an important game because the winner wins not only the match but will be able to challenge first place for the last match of the tournament."
85. S wins the third game and wins the fourth match.
86. E : "Thats it your in! Now you've got to prepare yourself for the last match against the contestant in first place".
87. Repetition of procedure 18.
88. Technician started the tape with the J's voice: "The winner of this match is player number one, congratulation! He will the play against contestant number six for the first place in the next match
89. Rest period of ten minutes.
90. Repetition of procedures 40 to 42 in Appendix A.

#### Match 5

91. Repetition of procedures 3,4,5,8,9.
92. J: " The contestants in this match are: player number six at Carleton University and will play against player number one at University of Ottawa."
93. J: "This is the final match and the one who will win,

- will be the winner of the tournament for your division. So, good luck to both of you."
94. Repetition of procedures 8 to 16.
95. End of first game, S lost.
96. E said: "You still have two other games, hang on...come and relax in the chair."
97. Technician started the tape with the J's voice: "Player number six wins the first game. The next game may determine the winner of the tournament."
98. Repetition of procedures 21 to 26.
99. S won the second game.
100. E: "O.K.! Good! One more like this one and you're the winner."
101. Technician started the tape with the J's voice: "Player number one wins the second game and so it is a very close race to get the title. So it will be all decided after the next game".
102. Repetition of procedures 21 to 26.
103. S wins the third game and wins the tournament.
104. E: " Hey that's great! You're the winner. Congratulation!"
105. Repetition of procedure 18.
106. Technician started the tape recorder with the J's voice: "The winner of this match and tournament is player number one, congratulations!"
107. E said: "Now that the tournament is over I want to see how well you can relax for the last time".

Repetition of procedures 40 to 42 in Appendix A. After which the E asked the S: "would you mind answering a few questions on the tournament while I would be recording you on tape?" The E asked the interview questions seen in Appendix K

108. E removed the electrodes from the S.

109. S is thanked for his collaboration and is reminded not to mention anything about the tournament except to his parents.

APPENDIX C

TELEPHONE CALL TO PROSPECTIVE SUBJECTS

TELEPHONE CALL TO PROSPECTIVE SUBJECTS

"The competition will be different from any others that you may have experienced. We are going to evaluate this new way of making competitions, and we would like to see how you feel about it, and how you will improve your performance throughout the game.

You would be competing against other boys of your age in a game that none of you has ever played. This game will not demand any great physical effort. The game consists of balancing a platform.

I would be coaching you throughout this tournament and I would take the opportunity to study a new way for you to relax before competition. This could help you to play better. So, for the tournament committee's interest and for my study, we would be very interested in having you competing in this tournament. Would you like to participate?"

If the S answered "no", he was excused from the sample and randomly replaced. If the subject said that he was interested, he was then given further explanations.

"The tournament will consist of five matches. There will be a practice session before the tournament. You will be asked to participate on three different days in a week. Every time you will come, it will take approximately sixty minutes.

During the practice, you will try out the game, and will receive the rules and further instructions concerning the tournament. The tournament will be held at the University of Ottawa in the Physical Education building.

Your parents or guardian will have to sign a form, so if you agree, I will drop the letter for your parents in your mail box. Each time you will come to play, I will bring you to the University with my car and bring you back home after. You will have to get your form signed for the practice .

Do you have any questions? Now, could I talk to your mother or father?". The E introduced himself to the parent and gave a summary of the information letter (see Appendix G) then answered all the questions that the parent asked him. The E then asked the parent if he (or she) consented in letting his (or her) boy participate in the study and sign a consent form to this effect (see Appendix G). If the parent accepted his (or her) son's participation the E asked him (or her) if his (or her) son was taking any drugs that may influence his arousal level and if the boy had any physical or psychological problems or disorders that the E should be aware of.

APPENDIX D

SPORT COMPETITION ANXIETY TEST

(ILLINOIS COMPETITION QUESTIONNAIRE)

Name: \_\_\_\_\_ ILLINOIS COMPETITION QUESTIONNAIRE

Telephone: \_\_\_\_\_

**DIRECTIONS:** We want to know how you feel about competition. You know what competition is. We all compete. We try to do better than our brother or sister or friend at something. We try to score more points in a game. We try to get the best grade in class or win a prize that we want. We all compete in sports and games. Below are some sentences about how boys and girls feel when they compete in sports and games. Read each statement below and decide if you HARDLY-EVER, or SOMETIMES, or OFTEN feel this way, when you compete in sports and games. Mark A if your choice is HARDLY-EVER, mark B if you choose SOMETIMES, and C if you choose OFTEN. There are no right or wrong answers. Do not spend too much time on any one statement. Remember choose the word which describes how you usually feel when competing in sports and games.

- |                            |                            |                            |   |                 |               |           |
|----------------------------|----------------------------|----------------------------|---|-----------------|---------------|-----------|
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 1. Competing against others is fun.                                 | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 2. Before I compete I feel uneasy.                                  | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 3. Before I compete I worry about not performing well.              | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 4. I am a good sportsman when I compete.                            | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 5. When I compete I worry about making mistakes.                    | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 6. Before I compete I am calm.                                      | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 7. Setting a goal is important when competing.                      | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 8. Before I compete I get a funny feeling in my stomach.            | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 9. Just before competing I notice my heart beats faster than usual. | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 10. I like rough games.   | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 11. Before I compete I feel relaxed.                                | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 12. Before I compete I am nervous.                                  | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 13. Team sports are more exciting than individual sports.           | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 14. I get nervous wanting to start the game.                        | Hardly-ever (A) | Sometimes (B) | Often (C) |
| <input type="checkbox"/> A | <input type="checkbox"/> B | <input type="checkbox"/> C | 15. Before I compete I usually get up tight.                        | Hardly-ever (A) | Sometimes (B) | Often (C) |

APPENDIX E

STAIC FORM C-2 QUESTIONNAIRE

HOW-I-FEEL QUESTIONNAIRE  
STAIC FORM C-2

NAME \_\_\_\_\_ AGE \_\_\_\_\_ DATE \_\_\_\_\_  
TEL: \_\_\_\_\_

**DIRECTIONS:** A number of statements which boys and girls use to describe themselves are given below. Read each statement and decide if it is *hardly-ever*, or *sometimes*, or *often* true for you. Then for each statement, put an X in the box in front of the word that seems to describe you best. There are no right or wrong answers. Do not spend too much time on any one statement. Remember, choose the word which seems to describe how you usually feel.

- 1. I worry about making mistakes . . . . .  hardly-ever  sometimes  often
- 2. I feel like crying . . . . .  hardly-ever  sometimes  often
- 3. I feel unhappy . . . . .  hardly-ever  sometimes  often
- 4. I have trouble making up my mind . . . . .  hardly-ever  sometimes  often
- 5. It is difficult for me to face my problems . . . . .  hardly-ever  sometimes  often
- 6. I worry too much . . . . .  hardly-ever  sometimes  often
- 7. I get upset at home . . . . .  hardly-ever  sometimes  often
- 8. I am shy . . . . .  hardly-ever  sometimes  often
- 9. I feel troubled . . . . .  hardly-ever  sometimes  often
- 10. Unimportant thoughts run through my mind and bother me . . . . .  hardly-ever  sometimes  often
- 11. I worry about school . . . . .  hardly-ever  sometimes  often
- 12. I have trouble deciding what to do . . . . .  hardly-ever  sometimes  often
- 13. I notice my heart beats fast . . . . .  hardly-ever  sometimes  often
- 14. I am secretly afraid . . . . .  hardly-ever  sometimes  often
- 15. I worry about my parents . . . . .  hardly-ever  sometimes  often
- 16. My hands get sweaty . . . . .  hardly-ever  sometimes  often
- 17. I worry about things that may happen . . . . .  hardly-ever  sometimes  often
- 18. It is hard for me to fall asleep at night . . . . .  hardly-ever  sometimes  often
- 19. I get a funny feeling in my stomach . . . . .  hardly-ever  sometimes  often
- 20. I worry about what others think of me . . . . .  hardly-ever  sometimes  often

APPENDIX F

STAIC FORM C-1 QUESTIONNAIRE

## HOW-I-FEEL QUESTIONNAIRE

Developed by C. D. Spielberger, C. D. Edwards, J. Montuori and R. Lushene  
STAIC FORM C-1

NAME \_\_\_\_\_ AGE \_\_\_\_\_ DATE \_\_\_\_\_

**DIRECTIONS:** A number of statements which boys and girls use to describe themselves are given below. Read each statement carefully and decide how you feel *right now*. Then put an X in the box in front of the word or phrase which best describes how you feel. There are no right or wrong answers. Do not spend too much time on any one statement. Remember, find the word or phrase which best describes how you feel right now, *at this very moment*.

- |     |                  |                          |                 |                          |            |                          |                |
|-----|------------------|--------------------------|-----------------|--------------------------|------------|--------------------------|----------------|
| 1.  | I feel . . . . . | <input type="checkbox"/> | very calm       | <input type="checkbox"/> | calm       | <input type="checkbox"/> | not calm       |
| 2.  | I feel . . . . . | <input type="checkbox"/> | very upset      | <input type="checkbox"/> | upset      | <input type="checkbox"/> | not upset      |
| 3.  | I feel . . . . . | <input type="checkbox"/> | very pleasant   | <input type="checkbox"/> | pleasant   | <input type="checkbox"/> | not pleasant   |
| 4.  | I feel . . . . . | <input type="checkbox"/> | very nervous    | <input type="checkbox"/> | nervous    | <input type="checkbox"/> | not nervous    |
| 5.  | I feel . . . . . | <input type="checkbox"/> | very jittery    | <input type="checkbox"/> | jittery    | <input type="checkbox"/> | not jittery    |
| 6.  | I feel . . . . . | <input type="checkbox"/> | very rested     | <input type="checkbox"/> | rested     | <input type="checkbox"/> | not rested     |
| 7.  | I feel . . . . . | <input type="checkbox"/> | very scared     | <input type="checkbox"/> | scared     | <input type="checkbox"/> | not scared     |
| 8.  | I feel . . . . . | <input type="checkbox"/> | very relaxed    | <input type="checkbox"/> | relaxed    | <input type="checkbox"/> | not relaxed    |
| 9.  | I feel . . . . . | <input type="checkbox"/> | very worried    | <input type="checkbox"/> | worried    | <input type="checkbox"/> | not worried    |
| 10. | I feel . . . . . | <input type="checkbox"/> | very satisfied  | <input type="checkbox"/> | satisfied  | <input type="checkbox"/> | not satisfied  |
| 11. | I feel . . . . . | <input type="checkbox"/> | very frightened | <input type="checkbox"/> | frightened | <input type="checkbox"/> | not frightened |
| 12. | I feel . . . . . | <input type="checkbox"/> | very happy      | <input type="checkbox"/> | happy      | <input type="checkbox"/> | not happy      |
| 13. | I feel . . . . . | <input type="checkbox"/> | very sure       | <input type="checkbox"/> | sure       | <input type="checkbox"/> | not sure       |
| 14. | I feel . . . . . | <input type="checkbox"/> | very good       | <input type="checkbox"/> | good       | <input type="checkbox"/> | not good       |
| 15. | I feel . . . . . | <input type="checkbox"/> | very troubled   | <input type="checkbox"/> | troubled   | <input type="checkbox"/> | not troubled   |
| 16. | I feel . . . . . | <input type="checkbox"/> | very bothered   | <input type="checkbox"/> | bothered   | <input type="checkbox"/> | not bothered   |
| 17. | I feel . . . . . | <input type="checkbox"/> | very nice       | <input type="checkbox"/> | nice       | <input type="checkbox"/> | not nice       |
| 18. | I feel . . . . . | <input type="checkbox"/> | very terrified  | <input type="checkbox"/> | terrified  | <input type="checkbox"/> | not terrified  |
| 19. | I feel . . . . . | <input type="checkbox"/> | very mixed-up   | <input type="checkbox"/> | mixed-up   | <input type="checkbox"/> | not mixed-up   |
| 20. | I feel . . . . . | <input type="checkbox"/> | very cheerful   | <input type="checkbox"/> | cheerful   | <input type="checkbox"/> | not cheerful   |



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**APPENDIX G**

**PARENTS' INFORMATION AND CONSENT FORM**

UNIVERSITÉ D'OTTAWA



UNIVERSITY OF OTTAWA

ÉCOLE DES SCIENCES DE L'ACTIVITÉ  
PHYSIQUE ET DU LOISIR  
DÉPARTEMENT DE KINANTHROPOLOGIE

SCHOOL OF HUMAN KINETICS  
AND LEISURE STUDIES  
DEPARTMENT OF KINANTHROPOLOGY

June, 1977.

## PARENT INFORMATION AND CONSENT FORM

Dear Mr./Mrs. \_\_\_\_\_

Over 20 million boys and girls are participating in competitive games. Many of them have high anxiety level before playing. Not being able to cope with competitive anxiety results in an unpleasant experience. Consequently, it may influence greatly boy's and girl's appreciation of the sporting environment and may impair their motor learning ability. In this regard, I have prepared a study to observe how different relaxation methods can help boys to cope with competition and possibly improve their performance.

In order to study the effectiveness of a specific relaxation method, the participants will be involved in a competitive situation. The game is simple and measures an important motor ability for athletes: dynamic balance. The task will be one whereby your son will be required to maintain a platform in a horizontal position while standing on it. The period of play will be of 30 seconds and within this time he will try to maintain the perfect balance for as long as possible.

The study will be held after school hours at the University of Ottawa in the Physical Education building (Montpetit Hall) at 35 McDougal in room 321.

The responses of the participants will be measured by:

- a) An EKG recording; consisting of placing 3 surface electrodes\* on the chest and connected to a recorder to assess heart rate.
- b) An EMG recording; consisting of placing 3 surface electrodes\* on the forehead and connected to a recorder to assess the "contraction" level of the frontalis muscle.
- c) A respiratory rate recording; consisting of placing a flexible band (pneumograph) around the chest and connected to a recorder to assess the respiratory rate.

The study consists of one practice and 5 matches, involving therefore 6 sessions. Every match will include 3 games of 30 seconds each and 20 minutes of relaxation training. The total involvement time will be approximately 60 minutes for every session. Under no circumstances your son will be forced to proceed with the study and tournament procedures if he chooses to withdraw from the study.

\* SURFACE ELECTRODES are small metal discs that are applied to the skin with an adhesive tape. They only detect body activity, they are painless and ABSOLUTELY NO SHOCKS ARE INVOLVED in the entire procedure.

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SCHOOL OF HUMAN KINETICS  
AND LEISURE STUDIES  
DEPARTMENT OF KINANTHROPOLOGY

If the participant cannot afford transportation to the University, I will personally provide transportation with my car from his home to the University of Ottawa and return back to his home after the session. More detail on the study may be given by contacting me at 238-4670.

Thus I sincerely hope that you may see fit to have me include \_\_\_\_\_ in my study. They are very few studies on relaxation strategies to cope with sport competition and none related to the young participants. It is critical for these latter to learn how to cope with the process of competition.

If you do agree with your son to his participation in this study, please fill the Parent Consent Form. Hoping you realize that your authorization is mandatory.

Thank you very much for your time and interest.

Sincerely,

Marc Blais  
Graduate student, Kinanthropology.

Dr. Jean-Louis Boucher  
Thesis supervisor, Kinanthropology.

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DEPARTMENT OF KINANTHROPOLOGY

PARENT CONSENT FORM

I consent to having my son \_\_\_\_\_ participating in a competitive situation and tested by graduate students of the department of Kinanthropology at the University of Ottawa.

I realize this involves:

- a) EKG recordings.
- b) EMG recordings.
- c) Respiratory rate recordings.
- d) Performing on a stability platform for 30 seconds for every game (3 games per session for 6 sessions).
- e) Private transportation from home to Montpetit Hall (Physical Education building) and return.

Signed: \_\_\_\_\_  
(Parent or tutor)

Witness: \_\_\_\_\_

**APPENDIX H**

**TOURNAMENT POSTER**

# ANNUAL MOTOR PERFORMANCE TOURNAMENT



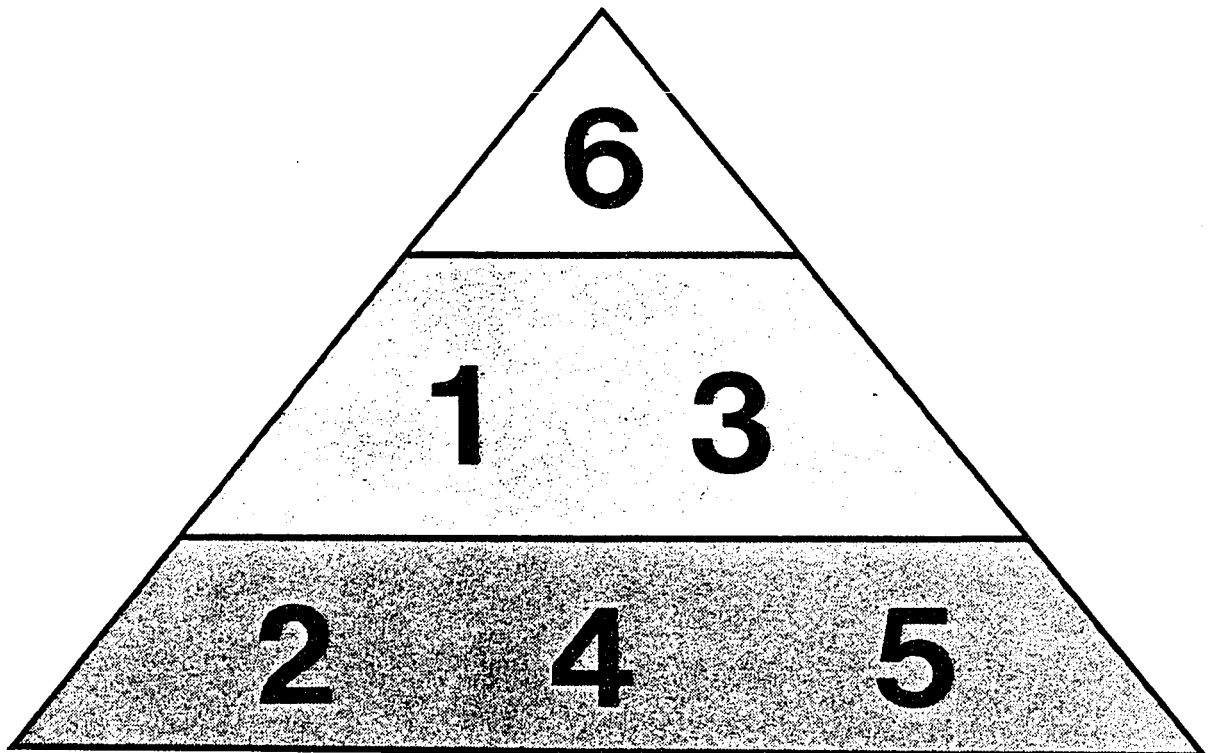
first  
closed circuit transmitted tournament  
between competitors from the  
Ontario and Quebec regions

APPENDIX I

TOURNAMENT BOARD FOR PLAYER'S POSITION

# ANNUAL MOTOR PERFORMANCE TOURNAMENT

tournament board



**APPENDIX J**

**TOURNAMENT SCORE BOARD**

# ANNUAL MOTOR PERFORMANCE TOURNAMENT

score board

**HOME**

**OPPONENT**

**2**

**1**

**APPENDIX K**

**POST INTERVIEW QUESTIONS**

POST INTERVIEW QUESTIONS

1. When you came here for your first competition what did you think about this tournament? Why?
2. What do you think about it now?
3. What did you like best? Why?
4. What did you like least? Why?
5. Did you try hard or not so hard on the platform?  
Give a score from 1 to 10 (least to most).
6. How do you think you did in this competition?
7. What's the main reason you think you did (O.K., lousy or good).
8. Did you talk to anybody else about this tournament?  
Who?
9. Did you try to relax? How much did you try?  
Give a score from 1 to 10 (least to most).
10. Did you feel that listening to your muscle helped you to relax?  
How did it help you?  
When did it help you?  
Before playing, while, after, while resting?
11. Do you feel that you can now relax the same as before? or better?  
Faster, deeper, what makes you think that?
12. Are you more aware of your muscle tension? Where?
14. Did listening to your muscle distract you from the tournament?

15. If you had the choice to play and rest (listening to your muscle ) or only play which one would you prefer?

APPENDIX L

L. FREQUENCY OF POSITIVE (YES) AND NEGATIVE (NO)  
RESPONSES TO THE INTERVIEW ITEMS FOR PLACEBO  
(N = 10) AND BIOFEEDBACK (N = 10) GROUPS

FREQUENCY OF POSITIVE (YES) AND NEGATIVE (NO) RESPONSES  
 TO THE POST INTERVIEW ITEMS FOR PLACEBO  
 (N=10) AND BIOFEEDBACK (N=10) GROUPS

ITEMS		PLACEBO		BIOFEEDBACK	
		YES	NO	YES	NO
1	Treatment helped	8	2	8	2
2	Treatment helped before playing ?	7	3	7	3
3	Treatment helped while playing ?	6	4	6	4
4	Treatment helped after playing	4	6	4	6
5	Treatment helped while resting ?	8	2	7	3
6	Treatment helped to relax better than before ?	8	2	8	2
7	More aware of muscle tension ?	9	1	9	1
8	Which muscle ? "Frontalis"	5	5	9	1
9	Which muscle ? Other than frontalis.	4	6	2	8
10	Prefer play/relax (yes) or only play (no)	9	1	6	4
11	Anything you did not like in this tournament ?	0	10	0	10
12	What did you like the most ? "The game itself"	5	5	6	4
13	What did you like the least ? "Sitting down/relaxing"	5	5	5	5
14	Further comments ? "It was fun"	7	3	8	2

**APPENDIX M**

**EMG FEEDBACK PRE-DETERMINED THRESHOLDS**

EMG FEEDBACK PRE-DETERMINED THRESHOLDSFEEDBACK THRESHOLDSUBJECT'S EMG RANGE

0--- 4.5

0--- 2.0

0--- 15.0

2.0--- 7.0

0--- 45.0

7.0---30.0

0---150.0

30.0---90.0

0---450.0

90.0---