A MANUAL FOR IMPLEMENTING HEART RATE VARIABILITY BIOFEEDBACK WITH COLLEGIATE ATHLETES

A DISSERTATION

SUBMITTED TO THE FACULTY

OF

THE GRADUATE SCHOOL OF APPLIED AND PROFESSIONAL PSYCHOLOGY

OF

RUTGERS

THE STATE UNIVERSITY OF NEW JERSEY

BY

LEAH M. LAGOS

IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE

OF

DOCTOR OF PSYCHOLOGY

NEW BRUNSWICK, NEW JERSEY MAY 2009

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ABSTRACT

A process for developing and implementing Heart Rate Variability (HRV) Biofeedback (BFB) in a collegiate sport setting is presented in this dissertation. The objective of this manual is to detail methods used in a pilot project study conducted at Rutgers University (RU) with five male and female golfers. The protocol delineates the scope of preparation activities, strategies and guidelines for training, and a seven-session protocol for conducting HRV BFB with athletes. In addition, this manual was edited and formalized following completion of the study to incorporate knowledge gained during the conduct of HRV BFB with RU golfers. Methodological considerations for future research evaluating the utility of HRV BFB for athletes are proposed.

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CHAPTER I

LITERATURE REVIEW

Sport psychology researchers have become interested in the potential of Heart Rate Variability (HRV) Biofeedback (BFB) for practical sport performance enhancement. According to findings by Lehrer et al, (2000, 2003, 2004), HRV BFB increases peak expiratory flow and improves autonomic reflexes associated with fast reaction times, stress management and human performance. In the “Third Edition of the BFB Practitioner’s Guide,” Simes (2003) provided an introduction to HRV BFB, as well as to several studies that support the efficacy of such techniques to improve sport performance. Indeed, preliminary research in this area has yielded empirically robust results. There remains, however, a strong need for greater research using more precise methodologies and ecologically valid outcome measures to demonstrate the utility of HRV BFB for athletes.

Given the seeming importance of psychophysiological variables in affecting athletic performance, the limited scientific literature in this area is surprising. It appears that while clinical applications of HRV BFB have proliferated since the 1980's, applications of HRV BFB to practical sport have only recently evolved. There have been only a handful of sport psychology studies that have evaluated the impact of HRV BFB on sport performance, and even fewer have focused on a specific sport (e.g. baseball) or a specific subset of athletes (e.g. a professional athlete).

The objective of this dissertation, therefore, was to design a protocol for implementing HRV BFB with collegiate athletes that could subsequently be replicated and evaluated across sport settings. The design of this manual was based on a vision that centered on using HRV BFB as a coaching tool-- combined with sport training technologies-- so athletes could learn how to apply breathing techniques to improve their functioning in practice, competition, and also their day-to-day lives. The following chapters will introduce the origins of HRV BFB and articulate practical issues faced in conducting HRV BFB in a collegiate sport setting. Strategies for conducting HRV BFB with collegiate athletes were detailed and actual session-by-session guidelines described so that research could be replicated. Examples from a pilot study with four collegiate golfers were used to illustrate the application of this methodology. A larger-scale study has just begun at our laboratory.

History of Heart Rate Variability Biofeedback

Russian physiologist, Evgeny Vaschillo, began studying (HRV), the beat-to-beat change in heart rate, as a measure of autonomic function in the early 1980's. Initially, he used BFB to teach Cosmonauts to increase the amplitude of HRV at specific frequencies (Vaschillo et al, 1983). Vaschillo's experimental paradigm consisted of displaying a computer-produced sinus wave as a pacer and current heart rate on a computer screen, and instructing subjects (e.g. six male Cosmonauts) to replicate pacer oscillation with their own physiological activity (in heart rate). He varied the frequency of the pacer within the very low and low frequency heart bands. Beat-to-beat blood pressure and respiration were measured as well. A transfer function analysis of heart rate, blood pressure, and respiration rate at various frequencies was performed.

What Vaschillo found was that subjects typically showed the highest-amplitude of HR oscillation within the low frequency range of ~0.075-0.11 Hz. Measurement of blood pressure variability in these subjects showed that the same frequency high-amplitude oscillation was imposed on blood pressure, although no direct BFB was provided for this measure. It was also discovered that the highest amplitude blood pressure oscillations generally occurred within the very low frequency range of ~0.02-0.04 Hz. As such, Vaschillo labeled the rates at which individuals produced the highest amplitude of heart rate and blood pressure as an individual's resonant frequencies. He theorized that because respiration strongly affects HR through respiratory sinus arrhythmia (RSA), HRV BFB training that taught individuals to breathe at their resonant frequency could produce high-amplitude oscillation in functions of the autonomic nervous system (ANS) and would strengthen the body's homeostatic control mechanisms including the baroreflexes (Vaschillo et al, 1983, 2002, 2006).

To validate Vaschillo's findings, Alexander Smetankin manufactured a portable HRV BFB device and established a BFB clinic in St. Petersburg, Russia. At this site, Russian children with asthma were taught to breathe at their individual resonant frequency as a method to control asthma. Influenced by this Russian research, Paul Lehrer evaluated this method of BFB in the United States. In a small-randomized controlled trial among asthma patients, Lehrer et al (1997) found significantly greater decreases in respiratory resistance among those receiving HRV BFB than other groups.

He also reported significant improvements in pulmonary function among 20 clinical cases of pediatric asthma treated with BFB but no medication (Lehrer et al, 2000).

The report, issued by Lehrer et al (2001) delineated a unique method for carrying out HRV BFB. The manual set forth a ten-session process for teaching individuals to breathe at a rate that was specifically adapted to the rhythms of his/her own systems to improve the baroreflex (e.g. the negative feedbacks system in which during inhalation, heart rate increases and blood pressure falls). This report was thematically linked around the premises that (a) HRV BFB would be useful for treating hypertension, particularly because the problem is related to baroreflex dysfunction, (b) HRV BFB would be useful for tonic hypotension where individuals with low blood pressure are also said to suffer from baroreflex dysfunction, and (c) HRV BFB would be useful as a treatment for patients suffering from various anxiety related disorders. The report included comprehensive descriptions of HRV, a manual for carrying out HRV BFB, and called for an imperative need to conduct more extensive research to determine the effectiveness of the experimental protocol.

Given this context, several researchers implemented HRV BFB to treat disorders marked by autonomic dysregulation. In a large placebo-controlled trial with random assignments to treatments, Lehrer et al (2004) found that participants who underwent HRV BFB demonstrated clinically significant improvements in asthma (Lehrer et al, 2004). In specific, asthma patients who received HRV BFB benefited in several ways including better pulmonary function, fewer asthma symptoms, and consumption of less asthma medication. Further clinical demonstrations have been published, applying this method to treat fibromyalgia (Hasset et al, 2006), major depression (Karavidas et al, 2006), hypertension (Herbs et al, 1994), and a variety of stress-related physical disorders (Chernigovskaya, Vaschillo, Petrash, & Rusanovsky, 1990).

HRV BFB has also been found to improve peak expiratory flow and baroreflex gain in healthy individuals (Lehrer et al, 2003). These results indicated that the benefits of HRV BFB extended beyond just influencing sympathetic or parasympathetic arousal. HRV BFB improved the modulatory function of reflexes that controlled the sympathetic and parasympathetic systems. The balance between the two systems became more tightly regulated, and, where autonomic dysfunction existed, the balance was restored. Such findings bear profound theoretical implications for treating disease as well as improving human performance (Lehrer at al, 2004).

Principles

HRV and Autonomic Regulation

The term heart rate variability refers to a measure of the beat-to-beat changes in duration of RR intervals (RRI) in the electrocardiogram (ECG). Psychophysiological models consider HRV as a measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate that yield information about autonomic flexibility and thereby represent the capacity for regulated emotional responding (Applehans & Luecken, 2006). The sympathetic branch of the ANS activates or increases the heart's action, while the parasympathetic branch acts as a brake slowing the action of the heart. The vagus nerve plays a role in the parasympathetic braking action. The balance between this throttle and braking system produces an ongoing oscillation, an orderly increase and decrease in heart rate known as Resonance Sinus Arrhythmia

(Lehrer et al, 2001). This variation in heart rate can be augmented or minimized by a variety of factors including breathing, pressure sensors (baroreceptors) in the arteries, emotions such as anxiety, and various behavioral changes. In general, high HRV represents a flexible ANS, responsive to both internal and external stimuli, and is related to fast reaction times and adaptability. Diminished HRV, on the other hand, represents a less transient, less flexible ANS that is unable to respond to changing stimuli. Further, low HRV has been identified as a significant factor for disease and there is some evidence that it is related to mortality from all sources (Lehrer et al, 2003). It follows that HRV is an indicator of an athlete's ability to respond to stress and thus an important index of optimal sport performance.

Assessment and Calculation of HRV

HRV measures are derived by estimating the temporal distance between R-Wave Peaks known as interbeat intervals. The prominent R-wave pattern reflects the contraction of the heart's ventricles (see Figure 1). The series of interbeat intervals require a continuous measure of heart rate, typically assessed by an electrocardiogram (ECG). Electrodes attached to the right arm, left leg, and the grounds are sufficient for HRV analysis. Bernstein et al (1997) recommended data should be sampled at a rate rapid enough to produce a high-resolution signal between 500 and 1,000 Hertz frequency ranges in HRV.

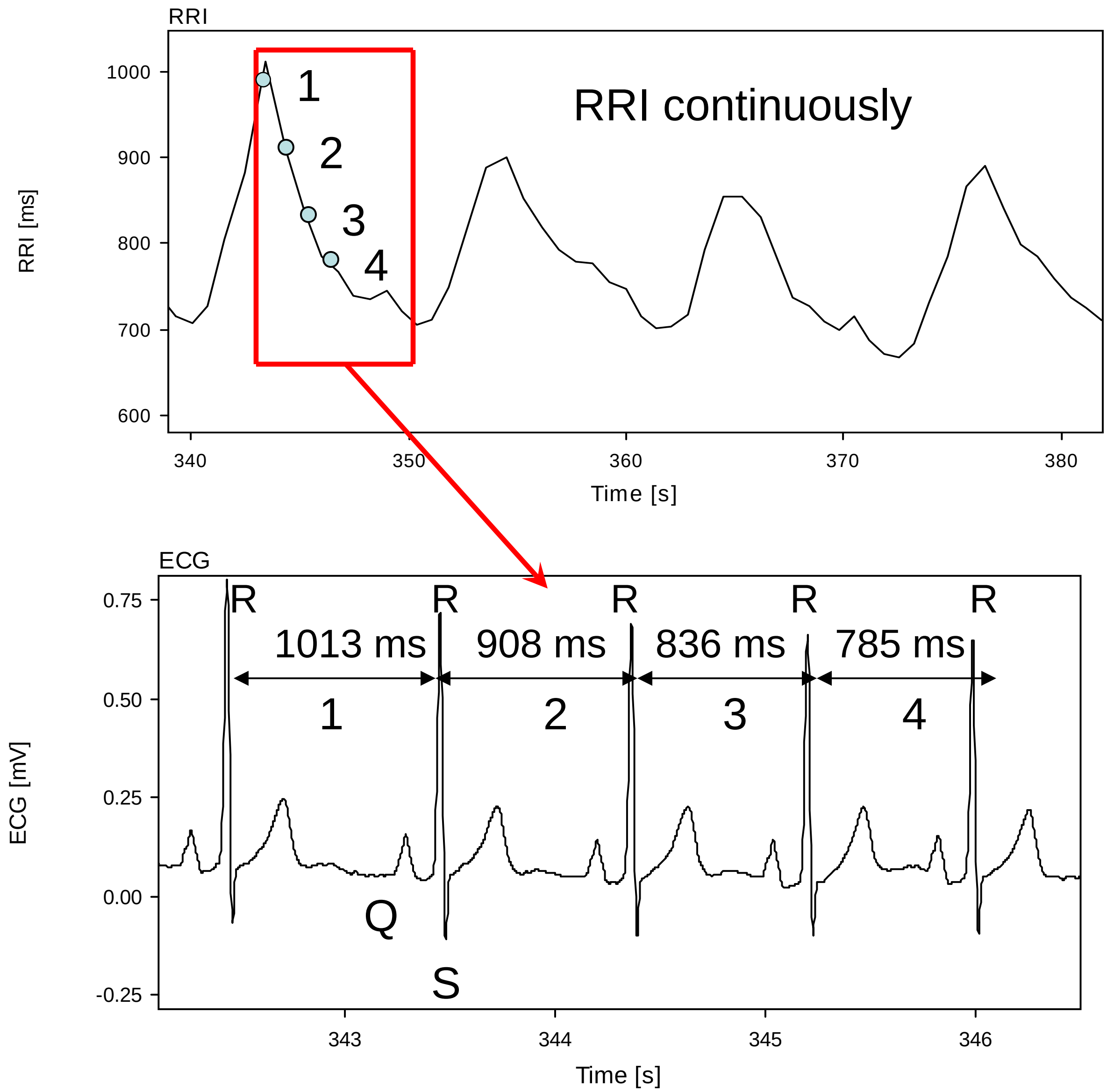

Figure 1. HRV is a measure of beat-to-beat changes in heart rate.

Analysis of HRV

A statistical technique, known as spectral analysis, separates out the component rhythms that represent the major oscillatory mechanisms of HRV. To date, spectral analysis classifies four types of rhythms that have been established by the task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996). High Frequency (HF) range varies from .15 to .4 Hz. Low Frequency (LF) range varies from .04 to .15 Hz. Very Low Frequency (VLF) range is considered as .0033 to .04 Hz. Ultra Low Frequency (ULF) range consists of waves less than .0033 Hz.

Moreover, each frequency represents a distinct adaptive reflex that helps to control the autonomic nervous system (Lehrer et al, 2001, Task Forse, 1996). HF indicates parasympathetic pathways, and the influences of respiration on vagal tone (e.g. the nerve that mediates parasympathetic innervation). LF reflects the influence of baroreceptors on heart rhythm. Research has demonstrated that meditative/slow breathing augments this range (Vaschillo et al, 2002). VLF is activated by the sympathetic nervous system or more probably the withdrawal of parasympathetic braking. Rumination and worry increase this range (Lehrer et al, 2001). ULF is mediated by slower acting biological influences and is still in the process of being defined by current research.

Mechanisms of HRV BFB

Resonant Frequency Breathing

According to Vaschillo et al, (2002), there is an individual resonant frequency, which is optimal for performance and exists in the LF range. Two features (Vaschillo et al, 2006) can be used to determine an individual's resonant frequency:

1. Paced breathing at the resonant frequency elicits the highest possible amplitude of heart rate oscillations.
2. Only when the subject breathes at his or her resonant frequency does respiration and heart rate oscillations occur in phase (e.g. heart rate rising simultaneously with inhalation and decreasing simultaneously with exhalation).

Vaschillo et al (1983) reported that HRV is maximized at a level that is higher than either lower frequency waves or RSA waves alone through resonant frequency breathing

Cardiac Resonance

The cardiovascular system is known to have resonant characteristics, with a first resonant frequency of .1 Hertz (Vaschillo et al, 2002). Breathing at an individual's resonant frequency is theorized to activate the reflexes of the ANS and trains them (Lehrer et al., 2003, Giardino, Lehrer, & Feldman, 2000). Training these reflexes appears to confer a number of benefits to the system. These include: (1) maximizing respiratory efficiency by making blood more available when oxygen concentration in the alveoli is at a maximum during inhalation (Giardino et al, 2000), (2) decreases in hypoxic ventilatory response and better oxygen saturation (Yasumo & Hayano, 2004), (3) increasing the efficiency of the baroreflexes that indirectly modulate general autonomic and emotional reactivity (Lehrer, 2003), and (4) improving the ability of the cardiovascular system to adapt to circulatory requirements (Langdeau et al, 2000). This results in system-wide energy efficiency and metabolic energy savings. Cardiac resonance has also been associated with psychological benefits such as increased emotional stability and improved cognitive performance. Yet, Vaschillo (1983, 1984) found that the exact cardiac resonant frequency differs between individuals. Age, height, and health are variables that may affect an individual's cardiac resonant frequency. There is a need to determine the precise rate of breathing required for each individual.

Sports Applications

Vaschillo, Visochin, and Rishe (2001) have applied HRV BFB with resonant frequency breathing at the Lesgaft Sport University to 30 elite wrestlers with encouraging success. Out of the 30 wrestlers, half performed 20 minutes of HRV BFB twice per day for 10 consecutive days. The others did not perform any respiratory training. Vaschillo and his colleagues found that when athletes breathed at individual cardiac resonant frequencies, they increased the amplitude of their heart rate oscillations. In turn, heart rate decreased (while HRV increased), blood pressure normalized, and skin temperature increased. Further, the group trained in HRV BFB demonstrated a significant decrease in reaction time, as well as speed of recovery in relaxation of quadriceps muscles, compared to no change in the control group. Using HRV BFB, Vaschillo and his colleagues enabled athletes to return to a state of physiological entrainment, as manifested by a more balanced ANS and cessation of sympathetic dominance in elite athletes under the pressure of competition (Simes, 2004).

Strack et al (2004) also examined the effects of HRV BFB on high school batting performance in baseball. He reported that the HRV BFB group improved significantly more than the control group in batting. In specific, his findings indicated that the HRV BFB group had a higher performance percent improvement and significantly increased the percent of total LF power in the heart rate spectrum.

Also, Raymond et al (2001) compared dance performances of twenty-four Latin and ballroom dancers. Twenty-four participants from a college dance team were randomly assigned to an alpha-theta neurofeedback, HRV BFB, or a no-treatment control condition. Dancers performed in male-female pairs, and each pair was randomly allocated, matching for age, and sex, to one of the three groups. Eight participants did not complete the training, leaving six subjects receiving neurofeedback, four receiving HRV BFB, and eight acting as controls. Those involved in neurofeedback received ten sessions of training over a course of four weeks, replicating a procedure used by Egener et al (2004). A 10-session protocol similar to that designed by Lehrer et al (2001) was used for HRV BFB training. All neurofeedback and HRV BFB sessions lasted approximately 20-minutes. Assessments of dance performance were carried out pre and post-training. Dancers were rated on a standard scale for National Dance Assessments with marks being awarded on a scale of one to five for: technicality, musicality, timing, partnering, skill, performing flair, and overall execution. Two judges rated each dancer. The study provided preliminary evidence that HRV and neurofeedback improved dance performance of individuals as compared to the no-treatment group. The two BFB approaches also generated some discriminate influences. The subscale of “timing” was improved by neurofeedback; while, the subscale of “technique” was improved by HRV

BFB. The dance assessors commented that, given the relatively long time course of dance improvement, even a half-point change was professionally significant.

All three-research studies reported HRV BFB, as safe with no severe side effects. During the first few sessions of training, Vaschillo et al (2001) noted that some subjects had hyperventilated slightly. This was remedied by encouraging them not to breathe so deeply.

Limitations of HRV BFB Sport Research

Due to the limited evidence that HRV BFB can be used to enhance sport performance, the sports community may justifiably question whether the results found by Vaschillo et al (2001), Raymond et al (2001), and Strack et al (2004) can be replicated elsewhere. Such concerns highlight the need for a clear methodology to be developed and evaluated for implementing HRV BFB with athletes. Because HRV BFB is a process that has mainly been applied to clinical populations, some modifications may need to be made for implementing HRV BFB in a sport setting. This requires a willingness to understand characteristics of the athlete population and to consider contextual variables that may obstruct or enhance their acquisition of respiratory skills.

CHAPTER II

CREATING THE EXPLORATORY RESEARCH STUDY

The nature and scope of preparation activities to implement HRV BFB with collegiate athletes is not available in previous sport psychology literature. This chapter, therefore, presents a chronological account of how the author gained approval from key members of the university athletic community to work with a group of collegiate atheletes. A description of procedures used to obtain a referral and approach a Team Head Coach is provided. The purpose and activities involved in an initial meeting with a sports team are also disclosed. The final portion of this chapter introduces practical issues the author faced in implementing the pilot study such as the formatting of sessions and choosing a setting for training. The aim of this chapter is to identify key methodological considerations in preparing to conduct a HRV BFB study in a university setting. The strategies presented, hereinwith, were based on the author's experiences and should be modified to the needs of each setting.

Gaining Support of Key Stakeholders

In order to gain approval to implement HRV BFB with athletes, the author created and submitted a written proposal to the University's Department of Sport Medicine. Constituents of the Department of Sport Medicine included the Athletic Director, Sport

Physician, and a three-member Sport Psychology Team. The proposal described the need, purpose, procedures, and risks/benefits associated with the study. The document was presented approximately six months prior to the anticipated research start date, allowing time for the author to deliberate with key stakeholders. Several meetings were required to review, discuss, and modify how HRV BFB training would operate and which athletes would be involved. This proposal is presented in Appendix A.

Obtaining a Referral

After obtaining approval from the Department of Sport Medicine, the second step was to identify a team with which to work. The support of key stakeholders in the Department of Sport Medicine was needed to accomplish three important goals: (1) to learn what types of athletes have difficulty managing emotions and stress, (2) to become aware of scheduling issues that would preclude athletes from particular sports from being able to commit to seven-weeks of HRV BFB, and (3) to identify which Team Head Coaches would support emotional regulation training for their team members. The key stakeholders met privately, without the author, to discuss such details. Through several weeks of brainstorming, the key stakeholders furnished a referral allowing the author to work with the Rutger's Golf Team. A founding member of the Department of Sport Medicine, Dr. Robert Pandina, initiated contact with Golf Head Coach, Maura Waters.

Meeting with the Head Coach

The author, Dr. Pandina, and Coach Waters met for approximately 45-minutes at the Rutgers' Athletic Center. The objectives of the meeting included: (1) identifying the extent to which golfers needed emotional regulation skills training, (2) assessing the coach's willingness to support the study, and (3) providing the coach information about training procedures and related activities. For approximately 20-minutes, Dr. Pandina and Coach Waters discussed golfers' mental strong points and limitations. Coach Waters indicated that several golfers were able to perform effectively during practice but not during competition. She noted that one bad shot could cause a golfer to perform sub-optimally for the rest of the competition. Coach Waters indicated that she wanted athletes to learn how to manage emotions particularly during sports performance. She offered to discuss the purpose of the BFB training with her golfers. Coach Waters also set up a time for the author and Dr. Pandina to meet with the team. The author gave Coach Waters the letter, presented in Appendix B, to distribute to golfers. This letter introduced the goals of HRV BFB and outlined tasks required to participate in the study.

The Introductory Team Meeting

The 60-minute introductory team meeting provided an opportunity for golfers to learn about HRV BFB. This meeting was held approximately two months before the anticipated study start date. Discussion focused on identifying ways that stress impacts the performance of golfers. In this regard, golfers were asked to share personal examples of how stress and emotions impaired their ability to perform in sport. A PowerPoint presentation, enclosed in Appendix C, was prepared and used to introduce HRV BFB to the golfers. The presentation described the purpose, methods, and responsibilities associated with participating in the study.

How the Meeting Operated

Coach Waters asked all golfers to attend and participate in a team meeting. After approximately a 45-minute PowerPoint presentation about HRV BFB, the golfers were given a tour of the BFB laboratory. During this tour, they were introduced to the setting in which the BFB training would occur. The golfers learned about BFB devices and home-practicing equipment. The tour of the lab concluded with a sample demonstration of a golfer participating in a ten minute BFB session while other teammates observed how his psychophysiological data were recorded. Next, golfers reconvened in the meeting room and procedures for participating in the study were discussed. This included a review of the training format and at-home practice requirements, and emphasized that participation was completely voluntary. Golfers who desired to participate in the study were instructed to fill out a scheduling card (Appendix D). Each golfer also read and signed an informed consent statement (Appendix E). The informed consent provided athletes with clear information on procedures, requirements, and potential risks associated with participating in the study.

Roles in the Meeting

At the request of the author, Coach Waters facilitated athlete involvement in the study. During the meeting, she actively asked questions about the training. Coach Waters prompted golfers to share personal experiences about being unable to regulate emotions on the golf course. She also indicated a desire to engage in HRV BFB training to improve her own golf performance. Through such enthusiasm and interest from a familiar and trusted role model, Coach Waters promoted athlete involvement. At the end of the meetings, all golfers had volunteered to participate in the study.

The author led the meeting and engaged golfers in an interactive presentation. Her main objective, above presenting material about the study, was to clearly delineate the objectives of BFB training. She aimed to identify ways in which the training could benefit each golfer.

A team of researchers, charged with the responsibility of administering BFB during individual sessions, was responsible for showing golfers where the training would take place and what devices would be used. The researchers also conducted the brief BFB simulation with a golfer to demonstrate activities and devices involved in training.

Practical Considerations for Implementing the Study

There were a number of possible formats for conducting the HRV BFB study. These topics cover session format, who to involve, duration of training, and choosing a setting. Anecdotal experiences from the golf pilot study are used to highlight key issues faced in designing an exploratory HRV BFB with athletes.

Massed Versus Spaced Practices

There were several practical advantages to equally spacing time between sessions (e.g. spaced practices) as opposed to meeting more frequently for a shorter training duration (e.g. massed practices). First, spacing sessions approximately seven days apart provided a flexible schedule that could be modified to the needs of the golfers. Secondly, golfers received seven consecutive weeks of training and practice. This decision was driven by past research on the effectiveness of HRV BFB. Lehrer et al (2000) noted that some individuals may have difficulty breathing slowly and training must, therefore, occur gradually. In the massed practice paradigm, golfers would have received more condensed training across a shorter duration to develop skills. Thirdly, golfers reported that the benefits generated by HRV BFB training (e.g. improved attention, increased energy, decreased muscle tension) reinforced their training. At the termination of the study, several golfers asked if they could continue meeting with the trainer to further shape breathing skills. In sum, massed practices may have abbreviated training duration but would not appear to have provided the quality of instruction desired by athletes.

Homogenous Versus Heterogeneous Athletes

All of the participating athletes were golfers; therefore, they were homogeneous with respect to sport. This homogeneity was necessary to develop a standardized measure of sports performance. The author, for instance, collected golf statistics reflecting golfers' performances at competitions. Data was analyzed and comparisons about the extent to which HRV BFB impacted individual and group performance were drawn. It would be difficult to evaluate the effectiveness of HRV BFB on sport performance if athletes performed different sporting tasks. The author also observed how athletes with pre-existing social bonds and frequent contact reinforced each other's participation in the study. Through social behaviors such as practicing breathing skills together at competitions and discussing the benefits of training with other teammates, the athletes' monitored each other's practice and progress in the study. The author expected that social support would have been less likely to develop among athletes from different teams.

Duration of Training and Recording

The pilot included seven consecutive weekly HRV BFB sessions. The training schedule was designed to accommodate the scheduling needs of golfers. They were involved in three recording sessions (sessions 1, 4, and 7) and four trainings (sessions 2, 3, 5, and 6). During this time, the author observed a general trend: golfers demonstrated the ability to increase heart rate variability through resonant frequency breathing by approximately the fifth session. Yet, this observation raised a key concern to the author. If athletes' did not develop resonant frequency skills until approximately the fifth session, then only the third recording measured the effects of breathing skills. That is, the first and second recordings captured baseline data. As such, Lehrer et al (2000) proposes ten-weeks of HRV BFB, allowing sufficient time for the development and application of breathing skills.

Individual versus Group Sessions

Golfers met individually with trainers for HRV BFB sessions. A number of circumstances made it favorable to conduct sessions with individuals rather than groups. In training sessions, the trainer provided a great deal of personalized feedback to the golfer to shape his or her learning. The individualized attention afforded the opportunity for the golfer to ask questions, improve skills, and receive personalized feedback about his or her performance. A one-hour session would not afford enough time to monitor, generate, and dispense personalized feedback to athletes' in-group settings. Further, such inadequate attention to instruction may trump athletes' learning and impact the study's validity. Regular and personalized interaction between trainer and athlete also fosters rapport, a known mediator of client participation. Finally, group sessions would demand impractical scheduling expectations for university athletes, who balance a variety of school and athletic responsibilities, and who have fluctuating schedules and limited availabilities.

Choosing a Setting for BFB Sessions

The choice to conduct all BFB sessions in a laboratory offered pros and cons. The lab's seclusion in an academic building afforded golfers' privacy. The quiet setting offered minimal distractions and interruptions, allowing golfers' to relax. The secure room provided an area to lock and store BFB equipment and data. The main problem of implementing sessions in a laboratory, however, was that the laboratory environment might have been stressful. Golfers had little experience training for sport in a laboratory. They were unfamiliar with the surroundings. Emotional reactivity to this new setting may have explained golfers' heightened physiological arousal, particularly during the first and second sessions. Although the trainer empathically responded to golfers' non-verbal cues of stress with calming words and rest breaks, even subtle forms of arousal may have impacted recordings of physiological responses. There is no empirical evidence that changing to a more familiar setting, such as an athletic training center, would ameliorate this problem. The author expects that the setting in which the athlete would be most comfortable would be the actual site where daily sports practice occurs.

Designing a Relaxing Environment for Skills Training

To limit environmental stressors that could interfere with relaxation training, the author assisted in carefully constructing the training environment. A cushioned chair with a flexible back was used for training athletes. The room temperature was adjusted to approximately 75 degrees. Small decorations adorned the windowsills and walls. Tables and chairs were placed in a format that allowed open space in the middle of the room. Such small considerations were important in creating a comfortable atmosphere where athletes could relax.

CHAPTER III

SKILLS TRAINING

Strategies play a key role in the application of HRV BFB with athletic populations. This chapter highlights key methods, used in the golf pilot study, to gain athlete compliance, participation, and interest in the study. Many of the methods were based on basic learning, reinforcement, and psychotherapy principles.

Starting Skills Training and Recording

Building Rapport

Rapport between therapist and client has been identified as a prognostic indicator of participant retention (Glasgow et al, 2002) as well as post treatment outcome (Hubble et al, 1999). Thus it was necessary to consider the extent to which participation and commitment to training would be a function of the rapport between golfer and trainer. The author's general hypothesis was that golfers who felt understood and nurtured by the trainer would be more likely to participate in BFB sessions and faithfully complete all at-home practices for the duration of the study. As such, the author implemented counseling strategies that have been associated with rapport building and have been shown to be related to session attendance and motivation, during BFB training sessions (Joe et al, 2001). Per the recommendations for building rapport noted by Joe et al. (2001), the author initiated each training session with an open-ended question about the golfer's life.

The typical question asked was "how are things going?" The asking of this question served two primary purposes. It demonstrated the author's interest and concern in the participant's well being. Further, the golfer's response provided personal information that the author could follow-up on in the next session in order to continue the process of building rapport. Other methods used to build rapport included engaging in brief dialogues between breathing practices during the session to insure the golfer's comfort. The author would ask if the room temperature was too hot or cold, if the athlete had any difficulties while breathing at resonant frequency, and congratulated the golfer for his or her efforts throughout the session. Promoting the perception of care, empathy, regard, and interest, the author strived to build rapport with each participant.

Expectancy

Expectancy theory proposes that when an individual believes a treatment will lead to a desired outcome, this likely boosts his or her motivation to actively participate in the treatment (Vroom, 1964). It was, therefore, essential for the trainer to communicate expectancy that HRV BFB training would render improvements in the quality of each athlete's functioning. In this regard, the trainer provided information about her own background, experience implementing the program with clinical populations as well as athletes, and described multiple benefits that have been found to result from training. The trainer pointed out that HRV BFB has been used as an intervention to reduce asthma symptoms (Lehrer et al., 2003), to help Russian cosmonauts adapt to stressors in their environment (Vaschillo et al., 2002), and to improve the performance of athletes training at a Russian Athletic Training Center (Vaschillo et al., 2001). Her goal was to help each athlete understand that HRV BFB is an empirically supported technique to enhance human health and performance and that the benefits of HRV BFB extend beyond sports performance.

Establishing Rules

The practice of establishing rules at the onset of treatment is common to cognitive behavioral treatment for substance use, and a key way to strengthen participant commitment (Miller et al, 1992). It was important to make the rules of participation in HRV BFB sessions explicit from the onset, as well as to discuss possible misconceptions about the program. In clarifying rules for participation, the trainer was direct and asked participants whether they were willing to commit to the following rules. A clear "yes" conveyed the message that the patient understood the importance of training and rules for participation. A sample of handout rules is provided in Appendix F. The specific rules address included:

1. Athletes who drop out of training are out of training. Any individual who misses 2 weeks of scheduled sessions in a row are considered have dropped out of the program and, therefore, cannot re-enter for the duration of the study. For example, if an athlete has missed the second and third weeks of training, he or she could not skip to session #4 during the fourth week of training. At the end of the study, he or she was able to negotiate with the trainer about re-starting the program. While it was technically possible to make-up sessions, it would have been difficult to acquire breathing skills without consistent at-home practice (Lehrer, 2006). Further, it would have been challenging to generate reliable results if athletes in study participated in different durations of trainings with varying intervals between sessions (Vaschillo, personal conversation 2006).

2. Each athlete is required to engage in two, 20-minute, sessions of breathing practice per day while in training. The finding that skill training requires daily practices at home (Vaschillo et al, 1983) was presented at the beginning of the program. Each athlete was informed that, in order to acquire breathing skills, he or she would need to practice breathing at resonant frequency for two, twenty minute sessions each day (Lehrer et al, 2001). The trainer recommended that he or she establish a daily routine in which breathing practice occurred as the first and last activity of the day. The athlete was also informed that after the completion of the study, he or she could maintain breathing skills by only practicing by practicing once or twice a week for ten to twenty-minutes (Vaschillo, personal conversation 2006). In this sense, the at-home practices were presented as a short-term commitment that enabled the athlete to develop a particular skill.

3. Athletes are not to come to sessions under the influence of drugs or alcohol. Alcohol decreases HRV (Bennett et al., 2001; Koskinen, Virolainen, & Kupari, 1994; Reed, Porges, & Newlin, 1999; Rossinen, et al., 1997) and would diminish the value of training sessions. The value of this third rule was reasonably self-evident and, thus, requires little need for extensive discourse. However, it does offer an opportunity to highlight the planning that BFB sessions attendance required of the athlete much of the time. Sufficed to say, that the participant had to make a cognitive choice between the high value of participating in BFB sessions or alcohol or drug use.

4. Athletes who are going to be late or need to re-schedule should call ahead of time. The fourth rule served multiple purposes. First, it was a courtesy to let the trainer know not to wait in the laboratory for the athlete. Second, it communicated to the athletes that promptness was desirable. Finally, it provided information as to why the client was not present. In the author's experience, when an athlete did not come to a session and did not give any explanation ahead of time, the athlete was demonstrating resistance to the program. Lack of confidence in the training procedures was one of the first explanations that jumped to mind, inflexibility to learning new styles to handle stress was another possibility, and perhaps lack of rapport with those who conducted the training was a third. In any case, such explanations offered a vehicle for the trainer to address the root of the problem behavior. To the extent that such issues could be identified, the author and trainer applied behavioral strategies (e.g. reaching out to athlete via phone and/or email, discussing benefits of training, inquiring about the stressors in his or her daily life, refs) to facilitate compliance.

Format and Organization of Session

In the golf pilot study, all four HRV BFB training sessions lasted approximately 45 minutes and all three HRV BFB recording sessions lasted approximately 65 minutes. This timing was reasonably consistent throughout the seven-week study.

Session Start-Up

The first 5-minutes of the session was spent coordinating a time and date for the next session. The trainer's task here was to help the athlete anticipate any obstacles that would impair his or her ability to attend next week's session. In this regard, the trainer helped the athlete review academic and sports schedules to determine if the regular meeting time needed to be changed. By discussing each athlete's needs, the trainer learned more about the challenges the individual faced in academics and sports. Such information was useful in understanding and personalizing how HRV BFB skills may benefit him/her.

Sharing of At-Home Practices

The next activity involved the sharing of "at-home practices." In the pilot study, the trainer collected the golfer's weekly compliance card (Appendix G) and asked for a description of how often he or she practiced during the previous week. The objective was for the trainer to understand the extent to which the golfer practiced regularly and would be able to acquire necessary breathing skills. Golfers were asked to explain any missed practices and/or challenges confronted during practices. Vocabulary was important here. Behaviorists are used to calling such practices, "homework," (Beck, 2005) but the author preferred to think of the daily skills building as a form of sports practice, much like sit-ups or daily jogs. The term, "at-home practices," therefore was used to ask each golfer about his or her daily breathing skills building.

Recording Session Exercises

The 50-minutes after the sharing of at-home practices was devoted to the recording of the athlete's physiological indices while breathing. The content and manner of recording sessions are presented in Chapter 5 and 6.

Training Session Exercises

Following the sharing of at-home practices, approximately 35-minutes was devoted to helping the athlete develop specific breathing skills. Further details about the content and manner of training sessions can be found in Chapters 5 and 6.

Wind-Down

A time at the end of the session for discussing how the athlete felt after resonant frequency breathing was particularly important. The trainer almost always initiated this discussion at the end of the session. It was an opportunity for the trainer to learn about any factors that may have impacted the training and/or recording. The Wind-Down also provided the athlete with a chance to discuss any challenges that he or she confronted while practicing resonant frequency breathing in the lab.

In the pilot study, the trainer spent about five minutes sharing observations about what she noticed during the session. The trainer offered observations about when, during the session, the golfer was breathing at resonant frequency and/or provided observations about why the golfer was not able to breathe at resonant frequency. Further, the trainer often modeled correct form for breathing techniques, such as abdominal and pursed lip breathing, to help the athlete pick up the skill more rapidly. As time progressed, the trainer found that athletes usually became astute observers and were able to describe when they were not able to breathe at resonant frequency during a session and even explain why. At times, the trainer facilitated more in-depth observations and comments (e.g. What do you make of that?). Or the trainer encouraged the athlete to focus on the physiological sensations associated with breathing at resonant frequency (e.g. What did your body feel like?). During the Wind-Down, the trainer offered at least one observation to the athlete, even if that observation was simply to recommend more practice.

Observations were very brief, not exceeding five minutes. Also, care was taken to provide observations that countered unrealistic performance expectations. For example, the trainer often reminded the athlete that breathing skills were like any learned sporting skill and acquired through patience and practice. The idea was, simply, to provide feedback that encouraged athletes to practice at home and keep coming back to sessions.

Dealing with "At-Home Practices" Non-Compliance

The requirements of at-home practice, two 20-minute sessions each day, were formidable at times. In the pilot study, athletes generally completed 90% of all mandated at-home practices. Managing athlete's compliance with at-home practices, however, required great sensitivity and effort from the trainer. The following techniques were key to reinforcing at home practice:

When the Skills Did Not Help

If an athlete reported practicing skills at home but not deriving any benefits from them, the trainer encouraged the client to continue engaging in consistent and daily practices. The trainer validated the athlete's observation by reinforcing that "the acquisition of breathing skills does not happen instantaneously, but develops through substantial time and practice." The trainer also reminded the athlete that the rate of skill acquisition varies from person to person (Vaschillo, personal conversation 2006).

When Athlete Performed More than 90% of At-Home Practices

The trainer's task here was to gently help each athlete analyze his or her lapse in practice (e.g. understand why it happened), to validate his or her difficulty and counter the athlete's tendency to judge oneself negatively, and help him or her develop effective strategies for where and when to practice at-home in the upcoming week. In addition, the trainer had to be adept at alternating attention between analysis of last week's behaviors and focusing on how to improve compliance in the upcoming weeks. Not every missed at-home practice session constituted a problem. However, the trainer's aim was to help identify any environmental or scheduling factors that may have impaired the athlete's ability to engage in at-home practice. This discussion allowed the trainer and athlete to brainstorm strategies, such as altering location or time of breathing practices, to increase skill building.

When Athlete Performed Less than 90% of At -Home Practices

Along with engaging in problem-solving strategies listed in the previous paragraph, the trainer invoked a third strategy for athletes who performed less than 90% of at-home practices. The Head Golf Coach was informed of the athlete's non-compliance and contacted the athlete. The Coach's involvement proved to be an important source of reinforcement. In the pilot study, it helped to increase golfers' compliance with at-home practice.

In-Between Sessions

The "Night Before Training" Phone call

The author found it useful to call each athlete the night before the session to remind him/her of the session, clarify directions, and communicate looking forward to seeing each other. It was also an opportunity for the author to address last-minute scheduling changes (not uncommon for student-athletes who manage school and sports).

Optimum Performance Training Newsletters Via Email

The creation and distribution of weekly optimum performance-training newsletters to athletes served multiple functions. First, the newsletters clarified how athletes could practice the skills at home, how the process has been used with other athletic populations, and reviewed skills taught in weekly sessions. Second, the newsletters, which contained times and dates for each athlete's BFB session in the upcoming week, communicated expectancy that all athletes would participate in and attend sessions. Third, the newsletters also served to make athletes aware that their peers were participating in the process. The author hoped that such awareness would implicitly reinforce athlete practice and training. Six newsletters distributed to golfers in the pilot study are presented in Appendix H.

Food

Each morning, the author provided muffins to the athlete after completing his or her session. The snack was a small token for participation. Yet, it also was a way to reinforce attendance and personalize the training process.

CHAPTER IV

METHODS

This chapter documents methods for evaluating the efficacy of a HRV biofeedback program for collegiate athletes. In this context, information about the target population and parameters for participation are outlined. Data collection instruments are detailed so that the research can be replicated. Further, methods for analyzing data are described.

Program Purpose

The purpose of this study was to design a HRV BFB training program, based on the protocol developed by Lehrer, Vaschillo, and Vaschillo (2001), for implementation with athletes at the University level.

Participants

Five participants were recruited from the Rutgers University Golf Team. This target population consisted of approximately 12 male and female student-athletes. Four of the five golfers completed the entire study. Inclusion criteria included current participation on the Rutgers Golf Team, fluency in the English language, and 20/20 or corrected to near 20/20 vision. Exclusion criteria included any medical, psychiatric, or neurological conditions that would preclude their ability to complete the study or confound the interpretation of physiological assessment.

Confidentiality

Individual results from subjective, physiological, and performance measures were available to participants upon request. Analyses of group results were distributed to the Director of Sports Medicine and Team Head Coach several months after the termination of the study so that individual responses were not identifiable. All procedures followed the ethical principles and standards of the American Psychological Association and the Protection of Human Participants at Rutgers University.

All faculty, students, and staff were instructed in the importance of maintaining subject confidentiality and familiarized with the lab's procedures. ID numbers were assigned to all data records. Hard copies of subject identity information, subject data, and the code linking subjects to responses were stored in separate, controlled- access locations within the laboratory. Electronic data files were maintained on password-protected computers at CAS. All paper files were maintained in secure filing cabinets in a locked office.

Instrumentation

A Power lab (AD Instruments, Colorado Springs, CO) Acquisition System was used to collect electrocardiogram (ECG) and respiration data. ECG data was collected from sensors on right arm and left leg, digitalized at a rate of 1000 samples per second. Beat-to-beat RR intervals (RRI) of the ECG signal are measured. Two respiration strain gauge belts were attached to the participants' upper chest and lower abdomen.

Setting

All HRV BFB sessions were conducted at a University lab. Participants were asked to engage in two, 20 minute, practice-breathing sessions each day at home.

Method

The ten-session format was abbreviated due to scheduling needs of athletes. Each participant met for seven sessions at weekly intervals. The first, fourth, and seventh, sessions served as recording sessions. In each recording session, measures of mood, anxiety, electrocardiogram activity, and respiration were obtained at the beginning and end of biofeedback recordings. The second, third, fifth, and sixth sessions served as training sessions. In addition, consent was obtained for the Team Head Coach to submit performance statistics to the experimenter each week that athletes participated in biofeedback training. Sample performance statistics for the collegiate golf team are presented in Appendix I.

Psychological Measures

1. The Profile of Mood States (POMS). The 65-item POMS (Appendix J) measured six mood states including anger, confusion, depression, fatigue, tension and vigor and yielded one composite score. The POMS possessed high levels of reliability, with alpha coefficients from .80 to .91 (McNair et al, 1971). Further, the POMS has been used extensively in sport psychology research with over 250 sport-related published papers since its introduction (LeUnes and Burger, 1998).

2. Competitive State Anxiety Inventory (CSAI-2). Because the POMS (Appendix K) did not address the full range of positive mood states like confidence and calmness that also influence sport performance (Hanin, 2000), the CSAI-2 was used to assess participants' affect and cognitions about competition. Developed by Martin et al (1983), the CSAI-2 consisted of 27-items; each rated on a Likert scale from one ("not at all") to four ("very much so"). The 27-items represented three 9-item sub-scales including: somatic anxiety, cognitive anxiety, and self-confidence. Each scale yielded a separate score ranging between 9 and 37. Alpha coefficients ranging between .79 and .90 demonstrated a high degree of internal consistency for the CSAI-2 subscales.

Physiological Measures

1. Electrocardiogram (ECG). To measure ECG activity, a negative electrode was attached to the upper part of the right arm, a positive electrode was attached to the lower part of the left leg, and a ground electrode was attached to the upper part of the left arm. Heart rate was recorded from R-R intervals over 10-second epochs.

2. Respiration. To record respiration, a strain gauged was placed around the navel section of the abdomen and also the upper chest (thoracic). As the gauge stretched, the voltage across the tube changed and relative changes in length were measured with a range of 0-100 units of relative strength

Performance Measures

The Principal Investigator determined specific sports performance measures for golfers with the Head Golf Coach, Maura Waters. These measures are depicted in Table 1 and included:

1. Shots. The number of tee shots on any long hole when using a driver.

2. Fairways. The number of plays from the fairway when using a wood.

3. Greens. A statistic measuring tee-to-green proficiency of a player. It attempts to sum-up (in a single number) a player's game up to (but not including) putting.

4. Putts. The number of strokes when the ball is on the green.

5. Individual Place in Tournament. The ranking of each golfer’s performance as compared to the other golfers in the tournament.

Table 1.
A Summary of Measures

1. Psychological	2. Physiological	3. Performance
The Profile of Mood States (POMS)	Electrocardiogram (ECG)	Shots
Competitive State	Respiration	Fairways
Anxiety Inventory (CSAI-2)		Greens
		Putts
		Individual Place in Tournament

Risks/Benefits

Participants were informed that they might receive direct benefits from participating in this study including decreased stress levels and improved sports performance. The risk that subjects could feel hyperventilation due to regulation of breathing was disclosed. Subjects were asked to engage in shallow breathing to prevent hyperventilation.

Analysis

Raw ECG data was sent to a win CPRS software program (Absolute Alien Oy, Finland) via a fiber-optic cable. Raw data was preserved for evaluation of the integrity of the recorded signal, to identify abnormal heartbeats, and for artifact editing. Beat-to-beat RR intervals (RRI) was assessed from the ECG signal. Fourier analysis of heart rate was used to estimate HRV.

All self-report and paper and pencil measures were coded. To facilitate error-free data, all coded instruments were input into electronic files twice, and then compared by SAS programs to identify inconsistencies. Inconsistencies were reviewed and corrected by reference to raw data. Corrected data sets were backed-up and archived. A variable list/codebook that included each measure (e.g., SAS variable names, variable descriptions, and the range of values assigned to each variable) was created.

Preliminary analyses consisted of examining means, standard deviations, and distributional properties of all measures. Due to the small N and restricted power for between subject comparisons, the main analyses consisted primarily of within subjects repeated measures analyses to link intraindividual changes across physiological, psychological, and performance areas. These person-center analyses were determined and conducted in collaboration with a statistical consultant, as they required unique approaches not typically covered in the graduate student quantitative methods curriculum.

CHAPTER V

SESSION-BY-SESSION OUTLINES FOR CONDUCTING HRV BFB WITH ATHLETES

The objective of this section is to detail the guidelines and procedures used to conduct HRV BFB training with athletes in the pilot project study. The seven-session manual delineates the goals, organization, and activities involved in each meeting. In addition, this manual was edited and formalized following completion of the study to incorporate knowledge gained during conduct of HRV BFB training with athletes. To accommodate scheduling needs of athletes involved in study, the HRV BFB training proposed by Lehrer et al (2000) was abbreviated from ten to seven sessions. This seven-session protocol is experimental and has not been fully tested. It is currently undergoing further evaluation.

General Guidelines

1. Generally, the sessions take less than 60 minutes.

2. If the athlete reports sleeping less than six hours before the session or is not feeling well, the session is rescheduled.

3. If the athlete appears tired after any part of the breathing practice, the trainer may offer the athlete an opportunity to rest or take a short break not to exceed five minutes.

4. The actual strategies, such as Buddha belly breathing, represent the author's innovative approach to skill instruction. Such strategies may be adapted according to the age of the athlete or the trainer's personal facilitation style. Based on the author's past clinical experience, creative instruction enhances the athlete's receptiveness to learning and retention of skill.

5. At the end of each meeting, the trainer reviews time and date for next practice session.

6. The athlete should wear short-sleeves and comfortable clothes for all training sessions.

7. The most optimal position for recording a session is with the athlete seated in a chair with legs uncrossed and hands resting on legs.

8. If CO_2 falls below 32, instruct athlete to breathe more shallowly.

Session One: Defining Resonant Frequency

The aim of the first session is to identify the athlete's cardiovascular resonant frequency. In order to determine the resonant frequency, the trainer instructs the athlete to breathe at several frequencies in the area of 0.1 Hz including: 0.108 Hz (6.5 breaths/minute), 0.1 Hz (6.0 breaths/minute), 0.092 Hz (5.5 breaths/minute), 0.083 Hz (5.0 breaths/minute), and 0.075 Hz (4.5 breaths/minute). The frequency at which the heart rate oscillation is the highest and occurs in synchrony with the respiration rate is identified.

Training

I. Instruct athlete to fill-out self-report measures.

A. Profile of Mood States (POMS)

B. Competitive Anxiety Inventory Scale (CSAI-II)

Note to Trainers: Instruct athlete to answer questions according to how they are feeling at the present moment.

II. Orient athlete to rules of skill training

A. Present Appendix G: Guidelines for Optimal Performance Training

Note to Trainer: Presentation of the rules offers an opportunity to clarify any misunderstandings about training and practice procedures. The conversation also provides an opportunity to obtain verbal consent from the athlete to attend weekly trainings and practice daily homework (in addition to his or her written consent obtained at the preliminary team meeting).

III. Describe scheduling for the upcoming seven-weeks.

A. Participation involves seven consecutive weeks of training. B. Explain that in session one, four, and seven, questionnaires will be used to assess mood and anxiety levels. In addition, physiological indicators such as heart rate, pulse rate, and respiration will be measured. These sessions will last approximately 60 to 90 minutes.

C. Indicate that during session two, three, five, and six, each participant will be taught to breathe at his or her own resonant frequency to maximize the peak amplitude of heart rate oscillation using a computer display. These sessions will last approximately 60 minutes.D. The two daily sessions (20-minutes each) of at-home practice are essential parts of training.

E. Ask athlete to discuss as far in advance as possible if he or she cannot attend training so that session can be rescheduled.

Note to Trainers: It is helpful to remind the athlete that today's activities constitute the longest session. Future recording sessions will last approximately 60 to 90 minutes. Other training sessions will take about 60 minutes or less.

Discussion point: Identify a person for the athlete to contact if they need to re-schedule a session.

IV. Orient athlete to purpose of today's session.

A. Appendix L: Breathing at Your Resonant Frequency

Note to Trainer: The purpose of this handout is to give the athlete an idea of how resonant frequency breathing shifts the heart rate and optimizes the body for peak performance. It does not have to be gone over in detail. Trainer may just distribute it, explain that today's goal is to define subject's personal resonant frequency, and have him/her read it between sessions.

Discussion point: Relate learning to breathe at one's resonant frequency to developing a new skill in sport. All rely on practice.

V. Preparations for Recording

A. Conduct calibration

1. Place nose clip on athlete.
2. Instruct him or her to exhale into calibration tube, making the bag fill up with air.
3. When the bag is full of air, instruct athlete to inhale and make the balloon disappear.
4. Repeat five times

B. Fasten abdominal and thoracic belts snugly around athlete's body.

Note to Trainers: Make sure belts are not loose but that they are not so tight that the athlete is uncomfortable.

C. Position electrodes on the lateral area of athlete's upper arms between the muscle and the bone.

Note to Trainers: Dab electrode cream on the center of each electrode to increase conductivity. Refer to signals screen on biofeedback program to insure that the B+ and B- signals are green. If they are red or yellow, the electrodes must be re-positioned to increase conductivity.

VI. Introduce method.

A. Trainer instructs: "Your heart rate goes up and down with your breathing. When you breathe in, your heart rate goes up. When you breathe out, your heart rate tends to go down. These are natural changes in the body that trigger powerful reflexes that control the whole autonomic nervous system (including your heart rate, blood pressure, and breathing). We will train you to increase the size of these heart rate changes. Increasing the size of the heart rate changes will exercise these reflexes and help you to control your body more efficiently.

As part of this training, we will measure your heart rate variability (HRV) and give you information about the swings in heart rate that accompany breathing. That will be the HRV biofeedback. You will use this information to teach yourself how to increase your reflexes that control how your body functions. If you practice this technique regularly at home, you will strengthen the reflexes that regulate the autonomic nervous system. This should help improve your health, your ability to manage stress, and sport performance. Do you have any questions?"

VII. Collect baseline physiology data.

A. Turn on computer programs for CO2 and EKG/Respiration recording.

B. Instruct athlete to breathe normally for the next five minutes.

C. Start recording on CO2 and biofeedback programs.

D. At the completion of the five minutes, terminate recording on both biofeedback programs.

E. Save CO2 and biofeedback program data (file A).

F. Let the athlete know that he or she can relax.

Note to Trainer: A hand-held stopwatch is useful for recording time.

VIII. Help athlete learn how to breathe with the computerized biofeedback program.

A. Set the biofeedback program to six breaths per minute.

B. Instruct athlete to inhale as the pacer ascends the incline and to exhale as the pacer descends.

C. Point to the pacer to clarify where the inhalation and exhalation should begin and end.

D. Instruct athlete to try it.

E. Provide feedback about whether the athlete is accurately following the instructions.

F. During practice, point to increases in HR oscillations at .1 Hz on the frequency display screen.

G. If accurately following instructions, instruct to continue using pacer to guide breathing for the next five minutes.

H. Press record on the CO2 and biofeedback programs.

I. At the completion of the five minutes, terminate recording on the CO2 and biofeedback programs.

J. Save data on CO2 and biofeedback programs (file B).

K. Let the athlete know that he or she can relax.

Discussion point: In all breathing exercises, the most important thing is to breathe in a relaxed way. Breathe easily and comfortable. Do not try too hard.

IX. Identify athlete's resonant frequency also known as the rate of breathing at which respiration rate and heart rate are in synchrony.

A. Explain that the procedure will require athlete to breathe at various rates for approximately three minutes each.

B. Discuss that the tasks should not be difficult and that the athlete should breathe easily and comfortably.

C. Emphasize the athlete should not try too hard.

D. Ask for any questions.

E. Set pacing stimulus for 6.5 breaths per minute.

F. Instruct athlete to start breathing at the rate prescribed by the pacer.

G. Start recording on CO2 and biofeedback programs as soon as it appears that the athlete is breathing at the prescribed rate.

H. Terminate recording on CO2 and biofeedback programs after two minutes and let the athlete know that he or he can relax.

I. Repeat steps A thru H at the rate of 6.0, 5.5, 5.0, and 4.5 breaths per minute, offering the athlete the opportunity to rest in between recordings.

J. After completing this process, save all ten minutes of recording on CO2 and biofeedback programs (file R).

K. Ask what rate of breathing felt most comfortable to the athlete. (Almost all athletes identify their own resonant frequency as most comfortable).

L. Inform the athlete of his or her resonant frequency (e.g. rate at which highest amplitude of heart rate oscillations occur and respiration and heart rate oscillations occur in phase).

X. Instruct Athlete to Practice Resonant Frequency Breathing.

A. Set computer biofeedback device to the athlete's resonant frequency.

B. Instruct athlete to allow the pacer to guide his or her breathing for the upcoming five minutes.

C. Start recording on CO2 and biofeedback programs as soon as it appears that the athlete is breathing at the prescribed rate.

D. Provide positive feedback to reinforce athlete's efforts.

E. Terminate recording on CO2 and biofeedback programs after five minutes and let the athlete know that he or she can relax.

F. Save data on CO_2 and biofeedback programs (file C).

XI. Engage in Baseline Data Collection.

A. Turn off the computer display and instruct athlete to breathe normally.

B. Use CO_2 and biofeedback programs to record normal breathing.

C. Terminate recording on CO_2 and biofeedback programs after five minutes.

D. Let the athlete know that he or she can relax.

E. Save data on CO_2 and biofeedback programs (file D).

F. Detach electrodes from athlete and let the athlete know that he or she has completed the first session.

XII. Assign Home Practice.

A. Remind athlete to practice breathing easily and comfortably (not too deeply) at his/her resonant frequency with longer exhalation than inhalation for two 20 minutes periods each day.

B. Inform athlete how long (in seconds) each breath should last (60 divided by the resonant frequency in breaths per minute).

C. Advise athlete to use the second-hand of a watch to time the breathing cycle.

D. Distribute compliance cards for recording frequency of practice and mood.

1. Appendix I: Compliance Card

Note to Trainer: Posting the compliance card to a mirror, dresser, computer, or other area of constant attention acts as a reminder to train.

Discussion point: Elicit ideas for how and when the athlete will schedule two daily breathing sessions per day.

XIII. Final questions and observations

Session Two: Learning Abdominal and Pursed Lips Breathing

The regulation of heart rate, ability to decrease muscle tension, and increase focus represents important aspects of an optimal sport performance state. The aim of the second session, therefore, is to help the athlete learn to control such autonomic functions through the practice of abdominal and pursed lip breathing. The breathing exercises presented below act as a bridge to those functions of the body which the athlete generally does not have conscious control. No physiological data is recorded during this session.

Training

I. Discuss homework assigned last week.

A. Ask the athlete how frequently he or she practiced, and if it was easy to engage in resonant frequency breathing by counting how long each breath should last.

B. Be sure to collect the compliance cards.

C. Provide athlete with a new card to record breathing practice for upcoming week.

1. Appendix I: Compliance Card

II. Elicit discussion about the at-home training practices.

A. Was the athlete able to complete all at-home trainings?

B. What did they enjoy and/or find difficult about the practices?

C. Does the athlete have any questions about the homework?

III. Review athlete’s understanding and practice of RF breathing.

A. RF breathing requires longer exhalation than inhalation.

B. Athlete is reminded not to breathe too deeply.

C. Athlete is reminded to breathe easily and comfortably.

D. “Do not try too hard.”

IV. Fasten abdominal and thoracic belts snugly around athlete’s body.

V. Position electrodes on athlete’s upper arms.

VI. Practice breathing at resonant frequency with & without the pacer for a total of five minutes.

A. Adjust the computer biofeedback device to the athlete's resonant frequency.

B. Indicate to practice breathing at resonant frequency using the pacer for the next five minutes.

C. Introduce the athlete to the cardiotachometer tracing on the computer display (e.g. red heart rate line). Indicate that when the athlete's heart rate increases, the line also rises. When it decreases, the line goes down.

D. Instruct athlete to breathe at resonant frequency for about two minutes, following the pacing stimulus; direct athlete to use heart rate line to pace breathing for the next three minutes (and turn pacing signal off).

E. Explain that he or she needs to breathe in phase with heart rate. When heart rate goes up, inhale. When it goes down, exhale. Breathe so that the changes in heart rate with each breath are as big as possible.

F. Remind athlete to breathe naturally; to let breathing flow automatically.

G. At the completion of five minutes, let the athlete know he or she can relax.

Note to Trainer: The objective of breathing with the cardiotachometer is to learn how to synchronize breathing and heart rate. Athlete often try too hard or are unsure, at first, how to use the cardiotachometer to control breathing. There is not much need to spend a great deal of time on this skill. The athlete will naturally acquire the ability to breathe at resonant frequency through time and practice. The athlete should appear comfortable and relaxed during training.

VII. Provide instruction and practice for abdominal breathing.

A. Explain that most people breathe from the chest, which is an inefficient way of breathing that causes tension in the body.

B. Describe how "Buddha Belly" breathing will help the athlete to learn to relax and breathe more effectively.

1. Demonstrate relaxed breathing by placing hand on chest and other hand two inches above abdomen.

2. Indicate that when breathing abdominally, only the abdomen expands and contracts during breathing and that the chest remains still.

3. Show athlete how the "Buddha Belly" appears when he or she inhales and disappears when her or she exhale.

4. Ask athlete to place one hand on chest and the other two inches above navel.

5. Practice Buddha Belly breathing with the athlete for several minutes to help athlete get used to the feeling of expanding and contracting the belly.

6. Remind athlete to keep chest still.

Note to Trainer: The athlete should appear comfortable and relaxed during training. If the athlete finds abdominal breathing too difficult, then, the instruction is temporarily abandoned until the next session. At the next session, instead of abdominal breathing, the athlete continues practicing slow and relaxed breathing.

Discussion point: Breathing from the belly can feel foreign at first. Most individuals are familiar only with breathing from the chest. Many athletes find it helpful to lie on the bed to practice abdominal breathing. In this reclined position, an individual can carefully focus on expanding and contracting the abdomen while insuring that the chest remains still. Another strategy is to practice abdominal breathing in front of a mirror to monitor the expansion and contraction of the Buddha belly.

VIII. Practice pursed lips breathing while doing the abdominal breathing.

A. Ask athlete to inhale through nose and then to breathe out through pursed lips.

B. Provide feedback to athlete and praise for doing task properly.

C. Answer any questions about procedures.

Note to Trainer: Exhalation should be longer than inhalation. It is important to note the phase relationship between HRV and breathing, and from it, prompt the athlete to breathe faster or slower, so that the two are in phase. If the athlete’s resonant frequency changes, the athlete is informed about the new frequency (seconds/breaths).

IX. Practice breathing at resonant frequency using the pacer as well as abdominal and pursed lips breathing.

A. Instruct athlete to perform abdominal and pursed lip breathing while using the pacer.

B. Remind athlete that dizziness or lightheadedness may mean he or she is breathing too deeply.

C. Note the phase relationship between HRV and breathing, and from it, prompt the athlete to breathe faster or slower that the two are in phases.

Note to Trainer: Monitor hyperventilation symptoms. The athlete should not feel dizzy or lightheaded. He or she should breathe slowly and shallowly. The athlete should appear comfortable and relaxed.

X. Assign Homework

A. Review abdominal and pursed lip breathing skills

1. Appendix M: Effective Breathing For Performers

B. Remind athlete to continue practicing slow, relaxed abdominal, pursed-lip breathing at own resonant frequency for two, 20-minute, sessions each day using the pacer.

C. Also instruct athlete to practice abdominal breathing while lying on bed or standing in front of a mirror for an extra five minutes per day. Explain that athlete only has to practice extra abdominal breathing this week and until he or she feels they have mastered the skill.

D. Instruct athlete to record at-home practices and mood on the compliance card.

XI. Ask athlete to bring his or her laptop computer to the next training. Make alternative arrangements to install computer biofeedback software if athlete owns a desktop computer.

XII. Final questions and observations

Session Three, Five, and Six: Maximizing Heart Rate Variability

The purpose of the third, fifth, and sixth sessions are for the athlete to learn how to increase the amplitude of heart rate fluctuations that occur in conjunction with respiration. The session usually lasts approximately 60 minutes and can be extended if the athlete desires further instruction or practice.

Each athlete should bring his or her laptop computer to the third session. Computer software will be installed during the session. In addition, a heart rate monitoring device will be provided that attaches to the computer's USB port. If the athlete arrives to the session without his or her laptop, the trainer may continue with training and arrange a time within the 24-hour period to install software. Trainers can instruct athletes who do not own a laptop computer how to install the software. Some trainers have also offered to install the software on the athlete's home desktop to prevent potential practice disruptions.

Training

I. Review homework assigned last week.

A. Ask the athlete how frequently he or she practiced, if he or she was able to practice the additional five minutes of abdominal breathing each day, and if it was easy to breathe from the abdomen.

B. Be sure to collect the homework cards. Provide athlete with a new card to record breathing practice for upcoming week.

II. Ask each athlete for questions about training.

A. How do you schedule your breathing practices each day?

B. Do find yourself become more alert after training in the morning?

C. Are you sleeping better at night after you practice?

1. Appendix I: Compliance Card

Note to Trainers: Small dialogues throughout the sessions help to build a rapport between the trainer and athlete.

III. Fasten abdominal and thoracic belts snugly around athlete's body.

IV. Position electrodes on athlete's upper arms.

V. Orient athlete to pursed lip and abdominal breathing skills taught in the last session and the rationale for their importance.

A. Appendix M: Effective Breathing For Performers

Note to Trainer: This handout is intended to orient the athlete to the skills of abdominal and pursed lips breathing. Review how the abdomen moves while the chest stays still. Remind athlete that the work of breathing never involves the chest. The most important aspect is that the athlete should breathe at their own resonant frequency easily and comfortably, and not to "try too hard."

VI. Instruct athlete to practice abdominal pursed lips breathing at his or her resonant frequency, for five minutes, using the green pacer on the computer display.

A. Worry Thoughts: Explain, "Worries or random thoughts may try to enter the mind right now. If they try to distract, turn your focus to the feeling of your abdomen contracting and expanding.

B. Mindful: Explain, "The more you let your thoughts go, the more you are allowing the muscles in your body to relax."

VII. Give feedback to athlete about breathing practice and praise the athlete for good attempts.

Note to Trainer: Positive feedback is an indispensable part of the training process. Too much feedback, however, can distract the athlete and produce physiological responses that interfere with skill learning. The feedback does not have to be extensive. Discussion point: If athlete is having difficulty, get an idea of what aspects of abdominal pursed lips breathing are challenging. Model the skills. Praise the athlete for doing the method properly. If the athlete finds the skills too difficult, then the method is abandoned for another session.

VIII. Develop athlete's ability to maximize HRV.

A. Explain that breathing at resonant frequency increases HRV .

B. Describe the upcoming five minutes as a time to breathe continuously at resonant frequency.

C. Discuss use of five-minutes (e.g. two minutes for breathing with the pacer and three minutes of breathing while following the heart rate and not the pacer).

D. While athlete follows the heart rate, coach him or her to push the maximum heart rate oscillations even higher and the minimal heart rate oscillations even lower.

E. After completion of five minutes, take a short break, and repeat.

IX. Increase athlete's somatic awareness. Help the athlete draw attention to his or her body's psychological and physiological responses to abdominal pursed lips breathing at resonant frequency. Ask him or her to describe any noticeable changes in the body.

A. Do your muscles feel more relaxed?

B. Do you feel more alert and attentive?

C. How is your mood?

X. Practice with Home Training Device.

A. Install Stress Rx program on athlete's computer, asking athlete to practice breathing for two, twenty-minute, sessions each day using the program.

Note to Trainer: The Stress Rx program is generally not used prior to the third session. The computer program helps the athlete maximize his or her HRV. Yet, initial homework practices, without the computer program, help the athlete master abdominal and pursed lip breathing and develop somatic awareness.

Discussion point: Just like any athletic skill, breathing at resonant frequency can be learned through practice and coaching. As such, the Stress Rx program is a useful device to monitor how and when an individual is breathing at his or her own resonant frequency.

B. Turn on the Stress Rx program and enter password. Discuss program format. Click the bottom of the screen until a small menu unfolds from the bottom. Press the second image from the left to set athlete's resonant frequency, adjust the inhalation (40%) and exhalation ratio (60%), check the box for a two minute baseline, and choose practice time for desired duration. Next, move mouse to the right and click "begin."

C. Instruct athlete to breathe normally and remain still during baseline. Ask athlete at the end of the two minutes to inhale and exhale in synchrony with the biofeedback signal: inhale as the lights go up and exhale as the lights go down. The athlete should use abdominal and pursed lips breathing. Tell the athlete that the inhalation and exhalation together lasts the length of his/her resonant frequency.

Note to trainer: If the lights begin to descend while he/she is inhaling, the athlete should continue to inhale instead of trying to "catch up" with the lights. The most important aspect of this training is to continue breathing slowly and regularly at a comfortable breathing pace. The athlete should be reminded not to "try too hard." If the athlete reports that he/she feels lightheaded, it may be the result of hyperventilation and instruct athlete to breathe less deeply.

D. Direct athlete to practice breathing at-home for two, 20 minute, sessions per day. For the initial ten minutes of each practice, athlete should practice breathing using the pacer; during the following ten minutes, athlete should focus only on the heart rate line and try to maximize the peak amplitudes of his or her heart rate.

XI. Discuss Activities for Session #4

XII. Final questions and observations

Session Four and Seven: Recording Physiological Indices

The fourth and seventh sessions include three types of activities. The first activity involves constructing an interactive dialogue with the athlete about his or her experience practicing breathing skills. The aim is for the trainer to understand the quality of the athlete's at-home practices. Such discussion also serves to build rapport and personalize the nature of the training. The second activity involves measuring the athlete's normal breathing pattern (e.g. baseline recording) before and after biofeedback training. The third activity, the biofeedback training, occurs as the athlete breathes at his or her resonant frequency using the pacer and heart rate line.

Training

I. Instruct athlete to fill out self-report measures

A. Profile of Mood States (POMS)

B. Competitive Anxiety Inventory Scale (CAIS-II)

Note to Trainer: Instruct athlete to answer questions according to how they are currently feeling.

II. Discuss any questions from last week.

III. Review homework practice.

A. Ask whether athlete practiced breathing skills each day.

B. Use therapy-interfering behavior strategies (See Chapter Two of this manual) if he or she did not practice.

C. Highlight and reinforce success.

D. Distribute a new homework card.

1. Appendix I: Compliance Card

IV. Present, discuss, and practice skills for abdominal and pursed lips breathing at resonant frequency.

V. Orient athlete to purpose of today's recording session

1. Appendix N: Resonant Frequency Breathing and Health

VI. Fasten abdominal and thoracic belts snugly around athlete’s body.

VII. Position electrodes on athlete’s upper arms.

VIII. Collect baseline data.

A. Attach electrodes to upper arms.

B. Instruct athlete to breathe normally.

C. Turn on computer programs for CO2 and biofeedback. Turn off athlete’s computer display.

D. Record physiological measures for five minutes.

E. At the completion of the five minutes, terminate recording. Let the athlete know that he or she can relax.

Note to Trainer: Inquiries about the health, mood, and life of the athlete help the trainer interpret baseline data. Information should be noted on the athlete's chart.

IX. Practice Resonant Frequency Breathing with Pacer.

A. Set computer biofeedback program to the athlete's resonant frequency.

B. Instruct athlete to allow the pacer to guide his or her breathing for the upcoming five minutes.

C. Start recording as soon as it appears that the athlete is breathing at the prescribed rate.

D. Provide positive feedback to reinforce athlete's efforts.

E. Terminate recording after five minutes and let the athlete know that he or she can relax.

X. Practice Resonant Frequency Breathing with Pacer and Heart Rate Line

A. Set computer biofeedback program to the athlete's resonant frequency.

B. Explain that athlete will use pacer to guide breathing for two minutes and then will use the red heart rate line to guide breathing for remaining three minutes.

C. Start recording as soon as it appears that the athlete is breathing at the prescribed rate.

D. After approximately two minutes, direct athlete to shift his or her focus to the red line and focus on maximizing heart rate.

E. Provide positive feedback to reinforce athlete's efforts.

F. Terminate recording after five minutes and let the athlete know that he or she can relax.

XI. Return to Baseline.

A. Turn off the computer display and instruct athlete to breathe normally.

B. Use computer biofeedback program for recording.

C. Terminate recording after five minutes and let the athlete know that he or she can relax.

4. Detach electrodes from athlete and let the athlete know that he or she has completed the session.

XII. Final questions and observations.

CHAPTER VI

DISCUSSSION

The general aim of this dissertation was to delineate a method for implementing HRV BFB with athletes in a collegiate sport setting. A detailed understanding of the experimental protocol is being presented so that HRV BFB research can be replicated and evaluated. Within this general aim, several specific aspects of methodology for a pilot study with collegiate golfers were described including: (a) the design of the study, (b) session format and structure, (c) trainer strategies and approaches, (d) methods for research, and (e) session-by-session guidelines. It is hoped that this information will assist in developing more empirically rigorous research identifying the benefits of HRV BFB for athletes of varying ages, skill levels, and sport disciplines.

Summary of Protocol

The theory for the clinical efficacy of HRV BFB to improve sport performance is that frequent high amplitude stimulation of the baroreflexes by breathing at resonant frequency will exercise these reflexes and render them more efficient (Lehrer et al, 2000). While clinical demonstrations have applied this method to treat asthma, depression, fibromyalgia, and several related anxiety disorders, little is known about how HRV BFB can enhance sport performance (Chernigovskaya et al, 1990). Within the last decade, preliminary sport research has suggested that HRV BFB may be useful in increasing the performance of wrestlers, dancers, and baseball players (Vaschillo et al, 2001; Raymond et al, 2005; Strack et al, 2003). Yet, the actual generalizability of this training, or extent to which HRV BFB can benefit athletes of different sports and ages, remains to be defined.

A primary advantage of delineating a process for creating an exploratory research study, as presented in Chapter II, is that researchers may evaluate if the design of the study was sufficient to accomplish the desired outcome. Questions that may be asked include: (1) How did the coach's role impact the athlete's perception of the utility of HRV BFB, (2) What specific strategies were used to educate athletes about the potential benefits of HRV BFB and (3) Are there any specific reasons that a team member may have viewed their participation in HRV BFB training as producing negative consequences? For instance, Yambor et al (1991), reported that male athletes were particularly resistant to sport psychology interventions because they did not want to be perceived as "weak" or in need of help. Athletes' perceptions of HRV BFB and expectancy that it will benefit them may, therefore, impact compliance with training. In this sense, an ideal HRV BFB methodology may aim to increase athletes' perceptions of the utility of training while simultaneously minimizing the costs associated with participation.

To minimize variance between trainer style and approach to working with athletes, guidelines for HRV BFB session format and skills training were enclosed in Chapter IV. Strategies for conducting skills training and recording sessions were delineated, including methods for building rapport and engaging the athlete's motivation for treatment. The general format was enumerated with attention to the length and sequence of activities in sessions. The author also presented ideas for addressing non-compliance and reinforce at-home practice.

Included in Chapter V were methods for collecting and analyzing data. At the empirical level, the population sampled and criteria for inclusion in the study were factors, which may have influenced the transferability of the findings. Additionally, multiple outcome measures were delineated to highlight the need for future research to assess the various psychological, physiological, and performance benefits of HRV BFB for athletes. The reader should note that the devices listed were familiar to the researchers of this study but represent one of several models for monitoring physiological responses. As technology continues to advance and become more cost-effective, it is also possible that portable physiological monitors can be used by athletes to practice HRV BFB before a sport event.

A methodology for conducting a seven-session HRV BFB training and recording format with athletes is proposed in Chapter V. While the actual procedures in each session were based on the protocol developed by Lehrer et al (2000), the format and approach to training was revised so that protocol had the feel of a performance enhancing exercise (as opposed to a clinical treatment). For example, the instructions described learning how to breathe at resonant frequency as an athletic skill that developed over time through practice. The protocol was also detailed in a step-by-step outline, in a manner, that could easily be replicated and evaluated.

Limitations of Protocol

As noted earlier, this manual details methods for a HRV BFB pilot project study with collegiate golfers. Because this was exploratory research, many design considerations were not known in advance of the study. An inevitable consequence of this was that mistakes were made in the process, and lessons were learned along the way. This manual was no exception. The biggest "take home lesson" in this case related to athletes' compliance with training and at-home practices. When starting this dissertation, the author viewed motivation as an important arbiter of athletes' compliance. As such, she implemented several psychological strategies to increase adherence to training and practice. While these tools appeared useful for developing rapport with athletes, they were time consuming and tended to enhance the motivation of athletes who had desired to participate in training from the onset of the study. In hindsight, it may have been more efficient to engender compliance by only including participants who reported difficulty self-modulating anxiety or coping in stressful situations in HRV BFB training. Schwartz et al (2003) suggests that such symptoms may be necessary for motivation and compliance to occur.

The next limitation involves four concerns about measurement. First, the self-report ratings for POMS (e.g. mood) and CSAI-2 (e.g. competitive anxiety) were valuable sources of data, but assessed only two criteria for psychological functioning. For instance, these measures did not capture the progress that some athletes verbally reported in areas such as confidence, interpersonal relationships, and focus. Therefore, the findings obtained from the pilot study may not support significant improvement in psychological functioning due to the omission of multiple assessment criterions.

Secondly, the measures did not assess any behavioral dimensions. For example, indices such as substance use, academic grade point average, or number of skipped sport practices could be important outcome measures to gauge how the development of self-regulation skills impact behaviors. Thirdly, faulty documentation of golf performance may have increased the risk that errors and omissions occurred in sport data management. Although the golf coach was requested to submit weekly performance statistics for all golfers on the Rutgers team, the performance statistics were not submitted until two weeks after the termination of HRV BFB training. Although the focus here is on “honest error,” and does not include the separate topic of fabricating data and results, several aspects of data were missing or otherwise uninterpretable. This form of negligence is part of the learning that occurs in a pilot project study, and is the responsibility of the researcher, but is also unacceptable data for scientific research (Freedland et al, 1992). Lastly, this manual does not propose any type of follow-up measures to help researchers know whether HRV BFB can generate long-term improvements in functioning.

The final limitation involves training duration. Like any skill acquisition process, HRV BFB requires athletes to practice breathing strategies each day. Failure to allow enough time for athletes to engage in enough practice may trump learning and impact the efficacy of HRV BFB. Although Strack et al (2005) has suggested that athletes demonstrate efficacy after only six HRV BFB sessions, it is unknown if the present seven-session protocol allowed enough time for measurable effects on the baroreflex to manifest. Lehrer (2000), for instance, reported that while individuals invariably show large effects within the first few minutes of training, measurable effects on homeostatic control mechanisms that regulate heart rate and blood pressure do not occur until after approximately ten weeks of daily home practice. It may be prudent, therefore, to establish a performance criterion for each athlete to achieve during training. In neurofeedback, for instance, individuals are required to generate a specific level of electrical activity in each area of the brain. Such criterion would demonstrate that each participant has acquired necessary skills through training. It could be argued that, without such measures, recording sessions capture markers of development and not true evaluations of the efficacy of HRV BFB.

Future Directions

One of the difficulties in evaluating golf performance is that several extraneous variables (e.g. wind, air temperature, rain) can impact outcome. Future studies should consider using traditional quantitative golf indicators such as number of shots per round in combination with qualitative indicators of success. Examples of qualitative indicators include but not are limited to: golfers' ranking in tournaments, the par value for the course, and number of golfers playing in tournament. These additional indicators would help researchers define and interpret the meaning of quantitative outcomes.

This manual proposed a method to evaluate the utility of HRV BFB for athletes. Yet, researchers must remember that a long-term outcome study is necessary to confirm if HRV BFB bears enduring effects on psychological, physiological, and/or physical performance. Another possible research paradigm would be to collect pre-baseline performance measures during a fall sport season, train and test them using the protocol proposed in this manual, and then collect post-baseline performance data during the spring sport season. This would provide the opportunity to test the effectiveness of the intervention and provide information about whether HRV BFB produces long-term changes in functioning.

A related area for future evaluation is whether additional instruction should be given to athletes, particularly golfers, for when and how to use self-regulation skills in sport. Vaschillo (2006, personal conversation) hypothesized that daily HRV BFB practice will improve sport performance even if it is not conducted immediately before or during a competition. What remains unclear is if athletes need direct instruction on how to integrate self-regulation techniques into their pre-performance routine and/or sport competition. Golfers in the pilot study, for example, asked for recommendations about how to implement resonant frequency into pre-shot routines.

Further research should explore implementing portable HRV BFB devices, enabling athletes to practice HRV BFB in conditions that approximate sport competition. Athletes must be able to extend their self-regulation skills beyond the lab to improve sport performance. The ability to practice HRV BFB at any location, time, or venue may also improve athlete compliance with at-home training requirements.

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APPENDIX A

PROGRAM PROPOSAL TO DEPARTMENT OF SPORTS MEDICINE

Introduction

Emotional states drive physiological functions and sports performance, particularly in sports like golf where millimeters and milliseconds make the difference between success and disappointment. Unmanaged emotions, however, can quickly override and undo results of countless hours of work and practice. The aim of HRV Biofeedback training, therefore, is to help athletes achieve and maintain emotional mastery. Many individuals have implemented such training to improve physical health and performance outcomes. Professional organizations such as the United States Olympics Committee and U.S. Military Academy at West Point have implemented HRV Biofeedback to enhance performance.

Program Purpose

In order to achieve emotional mastery, each athlete learns to breathe at his or her resonant frequency, of approximately 6 breaths per minute, to maximize heart rate variability and increase coherence between respiration and heart rate. As an athlete learns to breathe at his or her resonant frequency, he or she gains greater control over the body's ability to effectively and efficiently respond to stress.

Training Procedures

Participation involves seven consecutive weeks of skills training. Each training session lasts between 60 and 90 minutes. For homework, the athlete is asked to practice breathing at his or her resonant frequency for two, 20-minute sessions, each day. During lab visits, the athlete is asked to sit comfortably in a chair. Electrodes are attached to his or her arms for physiological measures. During session 2,3,4,5 and 6, we teach the athlete abdominal and pursed lips breathing and how to maximize the peak amplitude of the heart rate oscillation using the computer display. In sessions 1, 4, and 7, we measure the athlete's mood and anxiety via questionnaires. Physiological indicators such as heart rate, pulse rate, respiration, and muscle tension are also recorded through computer devices and a dynamometer. Each athlete is given a biofeedback device to practice breathing skills at home. This device allows the athlete to monitor breathing rates so that he or she can learn how to breathe at resonant frequency. It will also record how often he or she practices each day.

Participants

We aim to train approximately four athletes per ten-week training period. Athletes will be recruited from the University Golf Team. This target population consists of approximately 12 male and female students. All athlete participation will be voluntary.

Setting

All HRV Biofeedback training will be conducted at the Cognitive Neuroscience Lab at the Center of Alcohol Studies at Rutgers University. Participants will be asked to engage in two, 20-minute, practice sessions each day at home.

Benefits/Risks

The risk that an athlete may feel hyperventilation or dizziness due to regulation of breathing will be disclosed at the onset of training. We will institute procedures to diminish the likelihood of this risk. That is, a device will be used to monitor the athlete's carbon dioxide levels to prevent hyperventilation. We believe that the potential risks to participants have been minimized in relation to the importance of knowledge and skills that may result from training.

A Summary of The HRV Biofeedback Training Program

For further clarification, a table outlining the purpose of each of the seven HRV biofeedback sessions is provided.

Session #	Activity
Session 1	Obtaining Initial Estimates of Resonant Frequency
Session 2	Beginning the HRV Biofeedback Training
Session 3	Review of Pursed Lips Abdominal Breathing with Slow Exhalation, and Introduction to Home Training Biofeedback Unit
Session 4	Recording Session
Session 5	Review of HRV Biofeedback Procedures
Session 6	Review of HRV Biofeedback Procedures
Session 7	Recording Session

APPENDIX B

INRODUCTORY LETTER TO GOLFERS

We invite members of the Rutgers golf team to participate in a ten-week study that may help to improve confidence, self-control, and ability to perform optimally under pressure.

The study will involve the use of computer technology to help you learn to regulate breathing and assist you in gaining control of emotions. Such procedures have been used with many Olympic and professional athletes for several years.

Participation in this study is limited to only eight RU golfers at this time. All participants should be available to meet for approximately one hour each week for ten consecutive weeks.

There is no known risk for participating in the study and participation is completely voluntary.

To reserve a spot in the study and learn how you may improve your mental games, please call:

Leah M. Lagos

Graduate Student in Clinical Psychology

(908)-930-6701

APPENDIX C

HRV BIOFEEDBACK POWER POINT

Meeting Outline

- Introductions
- Brief Overview of Program
- OPT Procedures
- Requirements for Participation
- Equipment & Demonstration
- Fill Contact & Scheduling Sheet
- Review & Sign Informed Consent
- Questions

Introductions

- CAS Staff:

Dr. Robert Pandina

Dr. Marsha Bates

Dr. Evgeny Vaschillo

Dr. Bronya Vaschillo

Leah Lagos, Psy.M.

Program Overview

- Emotional states drive physiological functions and performance, especially in sports like golf where millimeters and miniseconds make the difference between success and disappointment.
- As a Rutgers golfer, you can appreciate the satisfying emotional state associated with playing at the peak of your game. You also understand how unmanaged emotions can quickly override and undo results of countless hours of work and practice.
- At the Center of Alcohol Studies, we are offering an exciting new program called Optimal Performance Training. The aim of OPT is to help athletes achieve and maintain emotional mastery.
- Although this process has been found to improve the performance of athletes, we wish to understand the extent to which such training is valuable and practical for collegiate athletes.
- We will be examining the extent to which this training impacts your mood, anxiety, confidence, respiration, heart rate variability, muscle tension, and also golf performance.
- OPT is based on a scientifically validated training method, called Resonance Sinus Arrhythmia Biofeedback, that was developed by Lehrer, Vaschillo, and Vaschillo (2001). This process involves learning to breathe at a particular number of breaths per minute (approx 6 breaths per minute) to maximize heart rate oscillations.

- As you learn to control your breathing and increase your heart rate variability, you will also gain control over your autonomic nervous system (e.g. the part that regulates your anxiety and arousal).
- The methods implemented in OPT have helped many individuals improve physical health and performance outcomes.
- Professional golfers are using this process to increase their golf accuracy, score, and competitiveness.
- Now, this training method is available to members of the Rutgers Golf Team!

Benefits of OPT

- OPT training helps you to gain control over the autonomic nervous system. Breathing at a resonant frequency of approximately 6 breaths per minute helps you to shift the heart rhythm to a smooth and coherent pace and to a positive emotional state.
- We also anticipate that you may feel several additional benefits including:
    - Increased concentration
    - Improved motor coordination
    - Quicker reaction speed
    - Decreased levels of stress and worry

- The ability to maintain a calm and dynamic internal state during stressful situations.

Training Procedures

- Each training session lasts less than 1-hour. For homework, you will be asked to practice breathing at your resonant frequency for two, 20-minute, sessions each day.
- During lab visits, you will be asked to be seated comfortably in a chair. Electrodes will be attached to your arms and legs and allow us to measure your physiological characteristics.
- During sessions 2, 3, 5, 6, - we will teach you abdominal and pursed lip breathing and how to maximize the peak amplitude of your heart rate oscillation using a computer display.
- In sessions 1, 4, and 7- we will use questionnaires to assess your mood and anxiety levels and measure your anxiety indicators such as heart rate, pulse rate, respiration, and muscle tension.

- The two daily sessions (20-minutes each) of at-home practice are essential parts of the OPT program.

Equipment & Demonstration

- You will be given a portable biofeedback device to practice breathing at your resonant frequency. This device will help you monitor your breathing rate so that you can learn how to breathe at your specific resonant frequency. It will also record how often and for how long you practice breathing each day.

- (Dr. Vaschillo demonstration)

Contact & Scheduling Sheet

Name: Age:

Email:

Home Phone:

Cell Phone:

Street Address:

City: State: Zip:

Informed Consent

- Please review the "Athlete Informed Consent Sheet."
- (We have covered this information during today's meeting).
- After you have signed the sheet, please turn into Leah.

Questions

• Thank-you for your participation.

• Should any questions or concerns arise before or throughout the study, please feel free to contact Leah Lagos via email at LeahMLagos@gmail.com.

APPENDIX D

SAMPLE SCHEDULING CARD

Name: Phone Number: Semester:

	M	T	W	R	F
9	**X** Unavailable			X Unavailable	
10	**X** Unavailable	**X** Unavailable		X Unavailable	
11					**X** Unavailable
12					**X** Unavailable
1	**Practice**	**Practice**	**Practice**	**Practice**	**Practice**
2	↓	↓	↓	↓	↓
3	↓	↓	↓	↓	↓
4	↓	↓	↓	↓	↓
5	↓	↓	↓	↓	↓

APPENDIX E

INFORMED CONSENT FORM FOR GOLFERS

As a student-athlete at Rutgers University, you have been asked to participate in a program that teaches you how to breathe at approximately 6-breaths per minute. This is a research study under the direction of Leah Lagos in partial fulfillment of the Psy.D. degree at Rutgers University. Other individuals assisting her include Robert J. Pandina, Ph.D., Research Professor and Director, Marsha Bates, Ph.D., Evgeny Vaschillo, Ph.D., and Bronya Vaschillo, M.D., Center of Alcohol Studies, Rutgers University. These other individuals working as co-investigators or study staff may assist or act for him.

The purpose of this study is to understand how we can design and implement programs, such as Resonance Sinus Arrhythmia (HRV) Biofeedback, to help you deal with stress and anxiety, and potentially improve your athletic performance, although this has not been proven at this time. Approximately 8 individuals will be recruited for participation in this study. The nature of this study will be explained to you carefully. Please interrupt at any time to ask about anything that is not clear or that you don't understand.

1. Your participation in this study will include the following:
    a. The duration of your participation will be seven sessions that will last approximately 1 hour each.
    b. You will be breathing slowly at a rate of 6 breaths per minute. You will be asked not to breathe very deeply because deep breathing may cause hyperventilation, in which case you may feel a bit dizzy or

lightheaded. If you do have these feelings, they will go away right after you stop slow breathing and will not cause you any harm.

c. After being seated in a comfortable chair in our laboratory, electrodes will be attached to your arms and legs to allow us to measure your heart and pulse rate, respiration, and muscle tension. We will measure these physiological characteristics while we teach you how to regulate your breathing and control your heart rate variability.

d. There are no known risks associated with this training; we are only recording your physiological response. New sterile electrodes are used for each participant.

2. This study is compliant with federal regulations. Your participation in this research study, and the information you provide to us, will be kept strictly confidential. You will be assigned an ID#; this number, not your name or any identifying information, will be used on all data you provide to us. However, there is an exception to confidentiality required by law. If you report to us that you are harming, or intend to harm yourself or others, we must examine the seriousness of this information and potentially notify the appropriate authorities.

3. Your participation is entirely voluntary and you may withdraw from the study at any time without penalty. We do not charge or prove compensation for participation in this study. Your decision to participate in the study or to withdraw will have absolutely no impact on any aspect of your sports team participation. The investigator also has the right to withdraw you from the study at any time in such cases as:

a. You came to the session under the influence of alcohol or drugs.

b. You gave us incorrect written data (e.g., about your age, illnesses, disability) that fall under exclusion criteria.

c. You are not able to fill out required questionnaires or obey study requirements (e.g., sit still in a chair for about 1 hour).

4. This study involves the following components:

a. Instruction, during sessions 2, 3, 5, 6 concerning abdominal and pursued lip breathing and how to maximize the peak amplitude of your heart rate oscillation using a cardiotachometer display as biofeedback

b. Gathering information from you, during sessions 1, 4, and 7 concerning pre-competitive anxiety using paper and pencil questionnaires and measuring changes in anxiety indicators such as heart rate, respiration, and muscle tension with non-invasive psychological equipment such as the mobile Stress RX heart rate variability monitor

c. At-home practice in which you are asked to practice resonant breathing for two, 20-minute, sessions each day

5. You may or may not receive any direct benefit from participation in this study. Potentially you could experience stress or anxiety reduction and improved athletic performance, or you could experience no such effects. The indirect benefit of your participation is in contributing to knowledge about how emotional regulation influences stress level and athletic performance. This study will allow us to develop a better understanding of the degree to which HRV Biofeedback can benefit Rutgers' student-athletes.

6. Research results will be available upon completion of the study if you are interested. An analysis of group results will be distributed to the Director of Sports Medicine and Rutgers Athletic Coaches several months after the termination of the study so that your individual results will not be identifiable. Hard copies of subject identity information, subject data, and the code linking subjects to responses will be stored in separate, controlled- access locations within the laboratory

7. Any data from this study used in published and presented materials will be communicated in statistical terms only. Your personal information will in no way be identifiable in these materials.

8. Any questions about this study should be addressed to one of the following investigators:

Leah Lagos	Dr. Marsha Bates	Dr. Robert Pandina
Research Assistant	Research Professor	Research Director
908-930-6701	732-445-3559	732-445-2518

Address: Center of Alcohol Studies, 607 Allison Road, Rutgers University, Piscataway, New Jersey 08854

9. Any questions or concerns about your rights as a research participant should be addressed to:

The Rutgers Office of Research and Sponsored Programs at 732-932-0150 ext. 2104.

Address: Rutgers University Institutional Review Board for the Protection of Human Subjects, Office of Research and Sponsored Programs, 3 Rutgers Plaza, New Brunswick, NJ 08901-8559.

Email: humansubjects@orsp.rutgers.edu

10. You have carefully read and fully understand the above, and affirm that the information you have provided about your age, background, substance use and alcohol use is accurate and truthful. You have received a copy of this consent form.

____________________ ____

Date Name and Signature of Participant

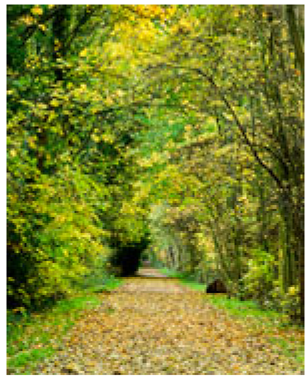
11. I have explained the objectives of the study listed above and indicated any known risks to the above participant. I have assured the participant that I will answer any inquiries concerning the procedures involved. The participant has also been informed that he/she is free to withdraw from this study at any time without penalty.

____________________ ____

Date Name and Signature of Investigator

APPENDIX F

GUIDELINES FOR OPTIMAL PERFORMANCE TRAINING



1. Athletes who drop out of training are out of training.
2. Each athlete is required to engage in two, twenty minute, sessions of breathing practice per day while in training.
3. Athletes are not to come to sessions under the influence of drugs or alcohol.
4. Athletes who are going to be late or need to re-schedule should call ahead of time.

APPENDIX G

COMPLIANCE CARD

Date: ___ to _____ Athlete: ____________ Coach: _______________

Instructions: Practice breathing at your resonant frequency for two, twenty-minute sessions, each day. Please log the time you started and finished each practice session on this card. Also, indicate how you felt on a scale of 1 (least anxious) to 4 (most anxious).

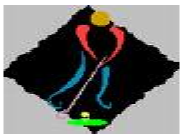
	M	T	W	R	F	S	N
Start Mood	______ ______	______ ______	______ ______	______ ______	______ ______	______ ______	______ ______
Finish Mood	______ ______	______ ______	______ ______	______ ______	______ ______	______ ______	______ ______

Start Mood	________ ________	________ ________	________ ________	________ ________	________ ________	________ ________	________ ________
Finish Mood	________ ________	________ ________	________ ________	________ ________	________ ________	________ ________	________ ________

APPENDIX H

NEWSLETTERS

Week #6 April 29, 2007

1.  Isaac, Jen, Lauren, & Landon - Thank-you! I have appreciated your commitment to training in the last six weeks. Further, I've very much enjoyed working with and getting to know you. I am interested in hearing how OPT has been helpful (e.g. sleep, health, academics, golf, etc). Many people find that this training has multiple benefits. In addition, please let me know if you would like to receive more training about how to transfer these skills to the golf course.

2. Recording Session: We will be meeting with most of you for our seventh session this week. This session is a recording session that lasts approximately 90 minutes. Reminders: (1) Sleep a minimum of 6 hours the night before we meet; (2) Wear a short-sleeved shirt to the session.

PLEASE BRING ALL AT-HOME TRAINING DEVICES TO YOUR NEXT SESSION TO RETURN.

3. OPT Scheduling:

- •Monday at 9 AM- Isaac (Recording)
- •Tuesday at 10 AM- Landon (Training)
- •Tuesday at 11 AM- Lauren (Recording)
- •Wednesday at 9 AM- Jen (Training)

4. Final Team Meeting: The Rutgers Golf Team is scheduled to meet at the Center of Alcohol Studies with Dr. Pandina on Wednesday, May 9th at 10AM. We'd like to talk with all of you about this process, opportunities for future training, and for you to share your experiences with your teammates at this meeting. Mark those calendars.

5. Payment: Those of you who completed all of your homework will receive compensation for your participation. I will try to arrange for these checks to be distributed to you at the Wednesday, May 9th meeting.

Week #5 April 20, 2007

1. At-Home Practices: There's been a change in how we need you to use your computer program. Please adjust the biofeedback program setting to a 10-minute session. You will still practice a total of 40 minutes each day. We are asking you to record each 20-minute session in (two) 10-minute increments.

2. OPT Scheduling: With only two more weeks left for OPT, we ask for your utmost commitment to training and attendance at practice sessions. Next week, we have scheduled:

Wed at 9AM: Jen

Wed at 10AM: Lauren

Friday at 9AM: Isaac

Friday at 10AM: Landon

Should there be any problems with the schedule, please contact Leah immediately.

3. OPT on Film: We wish Lauren lots of luck on her upcoming Journalism Project. She came into film the study and interview our research team this week.

4. Transfer of Skills: At this point, each of you has demonstrated the ability to breathe at your resonant frequency and create an optimal state for performance.

Week #4 April 13, 2007

1. Congrats on having completed more than half of your training. Please make sure to practice while at your away meets.

2. OPT Scheduling: With only two more weeks left for OPT, we ask for your utmost commitment to training and attendance at practice sessions. Next week, we have scheduled: Wed at 9AM: Jen, Wed at 10AM: Lauren, Friday at 9AM: Isaac, Friday at 10AM: Landon. Should there be any problems with the schedule, please contact Leah immediately

3. Homework Compliance: Practicing your breathing skills at home twice per day is key in developing the skills necessary to regulate how your body responds to stress.

- ♦Hint—Consider your daily breathing practice as a form of physical skills building much like sit-ups or daily jogs.

Week #3: April 6 2007

During the third week of training, we provided you with an at-home training device. The Stress Rx Program and ear clip monitor are intended to help you advance your resonant frequency breathing skills. If you have any questions about how to use the device, please contact Leah at 908.930.6701.

In this Issue:

1) Checking-In

2) Why Breathe at my Resonant Frequency?

3) The Stress Rx Program

4) What Should I Bring to OPT Next Week?

5) OPT Schedules

Being My Own Monitor:

For the next few seconds, turn your attention to your breathing. Take note of each breath you are taking. Are you breathing quickly or slowly? Are you breathing through your nose or your mouth? Is your breath deep and rhythmic originating from your belly or is your breath short and shallow starting from your chest? Most athletes who do not pay attention to their breathing may provide at least one, if not all three, of the following answers: quickly, through the mouth, and from the chest. Such habits are negatively correlated with optimal sport performance, particularly for golfers. To prevent tension in your body, enhance your ability to focus, and improve positive emotions---practice monitoring your breathing patterns during practice or before sport performance.

---Is your breathing style going to facilitate or hinder your performance?

Why Breathe at My Resonant Frequency?

By implementing the breathing techniques that you have learned in OPT, you will continue to make powerful changes in your ability to create an optimal psychological and physical state for performance.

The Stress Rx Program

The Stress Rx program is a useful device for you to monitor how and when you are breathing at your resonant frequency. For each practice session, Bronya recommends to engage in resonant frequency breathing for a total of 20-minutes. During the initial 10-minutes, use the pacer to guide your breathing. Continue resonant frequency breathing for an additional 10-minutes without focusing on the pacer; instead, shift your attention to the red heart rate line. Try to maximize the amplitude of the curve (e.g. heart rate).

What do I need for OPT?

1. Homework Card: Indicate how much you are practicing and how you are feeling

OPT Scheduling

Monday @ 9 AM- Isaac

Tuesday @ 9 AM- Landon

Tuesday @ 11 AM- Lauren

Wednesday @ 9 AM- Jen

Week #2: March 30, 2007

We have finished our second week of training and have already noticed improvements in your breathing skills. The more you practice breathing at home, the greater impact this process will have on your golf performance. Should you have any questions about the skills you are learning, please feel free to contact Leah at 908.930.6701.

In this issue:

1) Breathing for Golfers
2) Training the Breathing Process
3) Tips For Abdominal and Pursed Lips Breathing
4) What Do I Need To Bring With Me Next Week?
5) Practicing At Home
6) OPT schedules for next week
7) The Russian Word of The Day

Breathing for Golfers

It is thought by many golfers that the regulation of breathing lends an edge to sport performance. A rhythmic process of expansion and contraction, breathing is one way to find a balance between the sympathetic-parasympathetic nervous systems. This balance enables you to control our ability to control our performance state (e.g. high arousal, relaxation, muscle tension, etc) before and during competition. You can consicously use breathing to influence involuntary processes such as blood pressure, heart rate, circulation, digestion, and even perspiration. Breathing is a practice that literally helps you to gain control over how the body responds to challenge. Therefore, OPT uses breathing techniques such as abdominal and pursed lip breathing to help you gain control over your bodily functions for health and optimal performance. The breathing exercises act as a bridge to those functions of the body of which you generally do not have conscious control.

Training the Breathing Process

According to a recent study in Sweden, 83% of the adult population uses chest breathing (i.e. they only use the top part of the chest). This is a very uneconomical way of breathing as it uses more muscle power than the deeper and more relaxed abdominal breathing. People that use chest breathing take more breaths per minute and as a consequence receive less oxygen and expend more energy. Bronya has taught you a deep and effective breathing that reaches all the way down to the abdomen. Through abdominal and pursed lip breathing, you are stimulating a calming and relaxing effect in our bodies as you take fewer but more effective breaths. Further, this breathing helps you to absorb more oxygen, improve your stamina, decrease your tension, and increase your ability to perform optimally under even the most challenging circumstances!

Breathing Tips

- Place one hand on your chest and the other on your abdomen. When you take a deep breath in, the hand on the abdomen should rise higher than the one on the chest. This insures that the abdomen is pulling air into the bases of the lungs.
- After exhaling through the mouth, take a slow deep breath in through your nose imagining that you are sucking in all the air in the room and hold it for the count indicated by your resonant frequency.
- Slowly exhale through your mouth. As all the air is released with relaxation, gently contract your abdominal muscles to completely evacuate the remaining air from the lungs. It is important to remember that we deepen respirations not by inhaling more air but through completely exhaling it.
- In general, exhalation should be twice as long as inhalation. The use of the hands on the chest and abdomen are only needed to help you train your breathing. Once you feel comfortable with your ability to breathe into the abdomen, they are no longer needed.
- This type of breathing practice helps you to increase your heart rate variability that help you develop skills to be athletes who can perform optimally under even the challenging conditions.
- Remember, the more you practice at home--the more you are developing skills to improve your golf performance.

What Do I Need to Bring With Me to OPT?

1. Laptop Computer: I will be installing a breathing program so that you can practice with the pacer at home. If you don't have a laptop, please let me know. We'll need to make arrangements for me to install the program on your home computer.

2. Homework Card: Indicating how much you are practicing and how you are feeling

Why is Practicing at Home so Important?

- We want you to be able to implement resonant frequency breathing during golf practice and competition.

- However, this is a learned skill and not a skill that you can implement without training and practice.

- The two-twenty minute sessions of daily breathing practice help to develop this skill in your body (much like any skill in golf)

OPT Scheduling

We look forward to meeting with you each week at the same time. As a reminder, I've enclosed the training times below:

Monday @ 9 AM- Isaac

Tuesday @ 9 AM- Landon

Tuesday @ 11 AM- Laurent

Wednesday @ 9 AM- Jen

Wednesday @ 11 AM- Seth

Week #1, March 20, 2007

We have started our first week of training with Isaac, Landon, Lauren, Jen, and Seth. Should you have any questions about the training, please contact Leah at 908.930.6701

In this Issue

1) Overview of Optimal Performance Training (OPT)

2) Who is Using It?

3) Biofeedback Training at Rutgers

4) Practice Tips & Updates

Overview of OPT

OPT involves learning to breathe at a particular number of breaths per minute (approx 6 breaths per minute) to maximize heart rate oscillations. As you learn to control your breathing and increase your heart rate variability, you will also gain control over your autonomic nervous system (e.g. the part that regulates your anxiety and arousal). The methods implemented in OPT have helped many individuals improve physical health and performance outcomes

Who Else is Using it?

Here's Just A Few:

1) Athletes at the United States

Olympics Training Center

2) Italian World Cup Soccer Team

3) Professional Golfers on the Tour

4) Cadets Training at the US Military

Academy at West Point

OPT Scheduling

(We look forward to meeting with you each week at the same time. It is a privilege to have Evgeny & Bronya, expert physiologists who have consulted several Olympic athletes, working with us).

Monday @ 9 AM- Isaac

Tuesday @ 9 AM- Landon

Tuesday @ 11 AM- Laurent

Wednesday @ 9 AM- Jen

Wednesday @ 11 AM- Seth

Practice Tips and Updates

•To maximize the effects of this training, it is important to breathe at your resonant frequency for two, 20-minute sessions each day.

•You can make the breathing something you look forward to---by picking a spot in your room that is quiet, sitting comfortably, and using it as a time to forget your worries and only concentrate on the sound of your breath.

•By holding an AM breathing session when you get up--you prime your body for the day--and by hosting a PM breathing session before you go to bed-- you slow your body down for the day.

•It helps some people to remember to practice if they post the card that I gave them to a mirror, dresser, or computer. (A place where you constantly look).

APPENDIX I

PERFORMANCE STATISTICS

Men's Golf Statistics 2007

Date: 3/31-4/1

Event: Lacrosse Collegiate Invitational

Round 1	Shots	Fairways	Greens	Putts	Place
Landon	79	5	9	33	
Seth	77				
Isaac	82	2	4	34	
Jimmy	82				
Jimmy	88				

Round 2	Shots	Fairways	Greens	Putts	Place
Landon	85	4	6	33	96/104
Seth.	80				67/104
Isaac	81	6	4	27	92/104
Jimmy	79				84/104
Jimmy	76				96/104

Date: 4/6- 4/7

Event: Navy Invitational

Round 1	Shots	Fairways	Greens	Putts	Place
Landon.	83				99/128
Seth	76				23/128
Isaac					
Jimmy	86				118/128
Jimmy.	82				89/128
J.F. S.	91				127/128

Date: 4/14- 4/15

Event: Princeton Invitational

Round 1	Shots	Fairways	Greens	Putts	Place
Landon	84	5	5	40	
Seth	74	9	9	29	
Isaac	79	12	13	36	
Jimmy	78	10	8	31	
Jimmy	82	8	7	32	

Round 2	Shots	Fairways	Greens	Putts	Place
Landon	80	5	5	36	73/78
Seth	75	9	13	34	24/78
Isaac	73	10	13	29	40/78
Jimmy	78	6	11	32	59/78
Jimmy	76	10	11	31	65/78

Date: 4/22- 4/23

Event: Big East Championships

Round 1	Shots	Fairways	Greens	Putts	Place
Landon B.	77				
Seth H.	80				
Isaac L.	85				
Jimmy A	74				
Jimmy H.	82				

Round 2	Shots	Fairways	Greens	Putts	Place
Landon B.	78				
Seth H.	97				
Isaac L.	84				
Jimmy A	77				
Jimmy H.	77				

Round 3	Shots	Fairways	Greens	Putts	Place
Landon B.	73				37/60
Seth H.	74				58/60
Isaac L.	83				60/60
Jimmy A	77				37/60
Jimmy H.	75				52/60

Women's Golf Statistics 2007

Date: 3/23-3/24

Event: Cincinatti Spring Invitational

Round 1	Shots	Fairways	Greens	Putts	Place
Lauren	87	5	8	37	
Jen	91	8	5	33	
Stephanie	90	11	3	33	

Round 2	Shots	Fairways	Greens	Putts	Place
Lauren	79	10	8	32	35/53
Jen	94	7	4	38	52/53
Stephanie	100	6	3	38	53/55

Laurie 77

Laurie 84

Date: 4/3- 4/8

Event: Practice Statistics

Round 1	Shots	Fairways	Greens	Putts	Place
Lauren	81	5	7	32	N/A
Jen	91	5	4	36	N/A
Stephanie	91	9	5	38	N/A

Date: 4/22- 4/23

Event: Big East Championships

Round 1	Shots	Fairways	Greens	Putts	Place
Lauren	79	99	8	31	
Jen	84	6	5	27	
Stephanie	86	6	6	35	
Laurie	82	6	9	31	

Round 2	Shots	Fairways	Greens	Putts	Place
Lauren	80	7	6	31	
Jen	95	5	4	34	
Stephanie	82	6	9	31	
Laurie	91	6	5	34	

Round 3	Shots	Fairways	Greens	Putts	Place
Lauren	80	7	8	31	20/34
Jen	95	8	4	33	34/34
Stephanie	90	11	10	40	33/34
Laurie	82	10	5	31	32/34

APPENDIX J CSAI-2

APPENDIX K POMS

APPENDIX L

BREATHING AT YOUR RESONANT FREQUENCY

• Evidence by Lehrer, Vaschillo, & Vaschillo (2001) indicates that stressful emotions such as anxiety or anger cause your heart rhythm patterns to become irregular and incoherent (See Figure 2). These incoherent heart waves negatively affect your health, brain functioning, performance, and sense of well-being.

Figure 2. Heart Rhythms When Stressed

•On the other hand, heart rhythm patterns that are more ordered and coherent are associated with health and adaptability. As you practice your resonant frequency breathing, you shift your heart rate from the irregular patterns of Figure 2 to the smooth waves of Figure 3. Such coherence stimulates several psychological and physiological effects including increases in positive emotions, improved cardiac output, quicker reaction speeds, and less muscle tension.

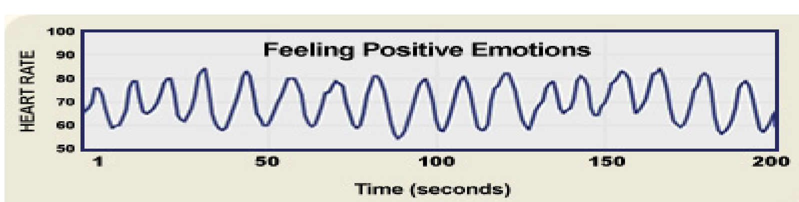


Figure 3. Heart Rhythms When Relaxed

APPENDIX M

EFFECTIVE BREATHING FOR PERFORMERS

Step 1: Pursed Lips

•Inhale slowly through your nose into the bottom of your lungs.

•Pause for a moment, and then exhale fully through your mouth.

•Purse your lips and imagine that you are blowing on a hot spoonful of soup.

•As you exhale, just let your body feel loose and limp.

•It should take you twice as long to exhale as it did to inhale.

Step 2: Abdominal Breathing

•Put one palm two inches about the navel, the other on the chest.

•Breathe in and expand your Buddha belly.

•Let the chest stay relatively still.

•Breathe out and contract your Buddha belly.

•When abdominal breathing becomes easy, try doing it sitting, standing, etc.

Step 3: Putting it All Together

•Inhale through nose and expand the belly.

•Pause for a moment.

•Slow exhale through mouth and tighten the belly.

•Breathe slowly rather than deeply. Exhalation is longer than inhalation.