Investigating the Experiences of Track Athletes during a Season-Long Psychological Skills and Biofeedback Training Program

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THESIS

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TABLE OF CONTENTS

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“The Master sees things as they are, without trying to control them.
She lets them go their own way, and resides at the center of the circle.”

– Lao Tzu, *Tao-te-Ching*

Abstract

The purpose of this study was to explore the experiences of five track athletes (three men and two women, aged 18-33 yrs) during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally. Three key psychological skills were emphasized: focus (Janelle, 2002; Nideffer & Sagal, 2006), arousal control through biofeedback training (e.g., Bar-Eli, Dreshman, Blumenstein, & Weinstein, 2002), and debriefing (Hogg, 2002; McArdle, Martin, Lennon, & Moore, 2010). The program, which consisted of one-on-one initial and final semi-structured interviews with PST-biofeedback sessions in between, was individualized to meet each athlete's needs and progress during the study. Results indicated that the athletes found the program helpful; they perceived an improvement in their ability to focus, debrief, and control arousal in the lab; and, to varying degrees, they transferred those skills into training and competition. The athletes also perceived an improvement in their sport performances.

Chapter One: Introduction

In order to maximize the benefits of regular physical training and achieve consistent performance in training and competition, athletes must integrate their physical, technical, and tactical training with psychological skills training (PST) (Blumenstein, Lidor, & Tenenbaum, 2005; Lidor, Blumenstein, & Tenenbaum, 2007). When designing effective PST programs, sport psychology consultants must consider several skills that influence performance outcomes such as the ability to focus (Janelle, 2002; Nideffer & Sagal, 2006), the ability to effectively manage arousal (i.e., non-directional psychological and physiological activation) and interpret anxiety (i.e., negative cognitive and somatic arousal) as facilitative to performance (Butt, Weinberg, & Horn, 2003; Janelle, 2002; Landers & Arent, 2006), and the ability to debrief, which builds self-awareness, facilitates psychological and emotional recovery, and allows athletes to learn from previous performances and set goals to improve future performances (Hogg, 2002; Kellmann, Bußmann, Anders, & Schulte, 2006; McArdle, Martin, Lennon, & Moore, 2010). For the purpose of this study, focus is defined as the "deliberate investment of conscious mental effort . . . to focus on the task at hand while ignoring distractions" (Moran, 2009, p. 18-19). Arousal is defined as "general physiological and psychological activation . . . from deep sleep to extreme excitement" (Janelle, 2002, p. 238). Debriefing is defined as "an evaluative activity either in training or in competition, with the intended purpose of analyzing existing performance states and determining what might be improved to ensure future performance satisfaction, enjoyment, success, and fulfillment (Hogg, 2002, p. 182).

The design and delivery of PST programs are also important. A number of factors must be considered: the number of psychological skills the PST program contains (i.e., multimodal versus single-skill programs) (Jordet, 2005; Mamassis & Doganis, 2004), the use of a nomothetic

(i.e., data from participants are grouped instead of reported on an individual basis) or idiographic (i.e., results are presented on an individual basis) program delivery (Evans, Jones, & Mullen, 2004; Gucciardi, Gordon, & Dimmock, 2009a), the training age of the athletes (i.e., developing versus elite) (Blumenstein et al., 2005; Mamassis & Doganis, 2004), and the degree of integration of the program with the training phases (i.e., preparation, competition, transition) and their physical, technical, and tactical components (Holliday et al., 2008; Lidor et al., 2007).

Another crucial aspect of athletic performance is the athlete's ability to effectively self-regulate on multiple levels (i.e., psychological, emotional, and physiological) (Bar-Eli, Dreshman, Blumenstein, & Weinstein, 2002; Blumenstein, Bar-Eli, & Tenenbaum, 2002; Jones, 2003; Sinclair & Sinclair, 1994, citing Bandura, 1992; Taylor, Gould, & Rolo, 2008). The challenges inherent in competitive sport often produce anxiety in many athletes, which can easily lead to performance decrements if not managed effectively. Although each athlete's psychological, physiological, and emotional responses to competitive pressure are different, the responses can be well managed if the athlete is aware of his or her own patterns of thoughts, feelings, and behaviour and he or she practices regulating these responses (Gucciardi, Gordon, & Dimmock, 2009b; Hogg, 1998a, 1998b, 2002). For the purpose of this study, the term self-regulation is used in the context of the biofeedback literature, which states that biofeedback is "a technique that facilitates the self-regulation of arousal states" (Blumenstein et al., 2002, p. xi). Furthermore, biofeedback is defined as "a technique that uses instruments, usually with sensors and transducers, which provides information regarding the state of selected biological functions that typically are not under voluntary control. This information is displayed to the individual" (Blumenstein, Bar-Eli, & Tenenbaum, 1997, p. 441).

In addition to the use of traditional PST, biofeedback training has also proven to be a useful assessment and training technique for sport performance enhancement with regard to focus and arousal control (e.g., Bar-Eli et al., 2002; Sime, 2003). Together, skills that enhance athletes' ability to focus and control arousal (Bois, Sarrazin, Southon, & Boiché, 2009; Robazza, Pellizzari, & Hanin, 2004) and their ability to debrief (Hogg, 1998b, 2002) are key components of self-regulation in sport; however, these skills must be developed in a way that takes the demands of the sport and the athletes' idiosyncrasies into account (Bar-Eli et al., 2002; Lidor et al., 2007).

Given the importance of the above-mentioned psychological skills in athletic performance success, the purpose of this study was to explore the experiences of five track athletes during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally. In this study, an individualized PST-Biofeedback training program was developed that included focus strategies (e.g., creating technical focus plans for races), arousal control (e.g., emotional regulation via biofeedback), and debriefing (i.e., after each competition). The biofeedback program included the modalities of respiration, heart rate (HR)/heart rate variability (HRV), surface electromyography (sEMG), and electrodermal activity (EDA). The study was guided by three research questions: (a) How did the athletes experience the psychological skills and biofeedback training program? (b) Did the athletes perceive a change in their ability to effectively self-regulate after the season-long psychological skills and biofeedback training program was completed, and what were their perceptions of the program's influence on their performance? (c) Which elements of the program did the athletes find to be most effective?

Chapter Two: Literature Review

This study explored the experiences of track athletes during a season-long PST-Biofeedback training program. Two primary areas within sport psychology informed this investigation: research on PST programs and research on biofeedback training. The following sections provide a review of the recent research on PST programs (particularly those in applied sport settings), of the psychological skills typically taught in such programs (especially focus, debriefing, and arousal control via anxiety and emotion management), and of biofeedback training. In addition, a discussion of the limitations of past research will show how this study contributes to the field.

Research on Applied PST Programs

The following journals were reviewed to determine the number of PST studies that have been published in the past 12 years: The Sport Psychologist (TSP), Journal of Applied Sport Psychology (JASP), International Journal of Sport and Exercise Psychology (IJSEP), Journal of Sport and Exercise Psychology (JSEP), and Journal of Sport Psychology in Action (JSPA). A total of 25 studies were found that examined the effects of a variety of PST programs on athletic performance and factors relating to performance (e.g., Blakeslee & Goff, 2007; Cotterill, 2011; Dupee & Werthner, 2011; Evans et al., 2004; Fournier, Calmels, Durand-Bush, & Salmela, 2005; Holliday et al., 2008; Lidor et al., 2007; Reeves, Nicholls, & McKenna, 2011; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2001). These studies involved a range of sports including gymnasium triathlon (Thelwell & Greenlees, 2001), curling (Collins & Durand-Bush, 2010), Australian football (Gucciardi et al., 2009a, 2009b), ice hockey (Rogerson & Hrycaiko, 2002), soccer (Jordet, 2005; Reeves et al., 2011), golf (Hill, Hanton, Matthews, & Fleming, 2011),

equestrian (Blakeslee & Goff, 2007), gymnastics (Fournier et al., 2005), and basketball (Lidor et al., 2007), among others. A discussion of these studies' characteristics follows.

Multimodal versus single-skill PST programs. Among the most recent PST studies, the majority adopted a multimodal approach (i.e., introduced more than one psychological skill to the participants) (Blakeslee & Goff, 2007; Blumenstein et al., 2005; Collins & Durand-Bush, 2010; Dupee & Werthner, 2011; Fournier et al., 2005; Gucciardi et al., 2009a, 2009b; Hill et al., 2011; Horn, Gilbert, Gilbert, & Lewis, 2011; Lidor et al., 2007; Mamassis & Doganis, 2004; Pain, Harwood, & Anderson, 2011; Reeves et al., 2011; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2001, 2003; Thelwell, Greenlees, & Weston, 2006; Velentzas, Heinen, & Schack, 2011) as opposed to a single-skill approach (i.e., introducing only one psychological skill) (Aherne, Moran, & Lonsdale, 2011; Calmels, Berthoumieux, & d'Arripe-Longueville 2004; Cotterill, 2011; Evans et al., 2004; Jordet, 2005; Parkes & Mallett, 2011). Given that each athlete may need to work on certain psychological skills more than others, this apparent trend toward providing athletes with multiple skills to learn emphasizes the growing recognition that PST programs should be tailored to meet each athlete's individual needs (Blumenstein et al., 2005; Gucciardi et al., 2009b; Holliday et al., 2008). Some of the most common psychological skills that have been used in multimodal PST programs are imagery, goal-setting, self-talk, arousal control, and focus. Only 6 of the 25 studies used a single-skill approach (e.g., imagery, pre-performance routines, and mindfulness).

Several of the PST studies showed improvements in performance (i.e., perceived or actual improvements) and/or psychological skills relevant to the present study (i.e., focus, arousal control, and reflection, which is necessary for debriefing) (e.g., Blakeslee & Goff, 2007; Blumenstein et al., 2005; Dupee & Werthner, 2011; Evans et al., 2004; Fournier et al., 2005;

Lidor et al., 2007; Mamassis & Doganis, 2004; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2001). Specifically, the skill of focus was stated to have improved in several studies (Blakeslee & Goff, 2007; Calmels et al., 2004; Dupee & Werthner, 2011; Evans et al., 2004; Fournier et al., 2005; Gucciardi et al., 2009a, 2009b; Hill et al., 2011; Thelwell & Greenlees, 2003). Secondly, the skill of reflection (also referred to as "self-monitoring" by Gucciardi et al., 2009b, p. 324 and "personal reflections" by Collins & Durand-Bush, 2010, p. 345) was used or improved in several PST programs (Collins & Durand-Bush, 2010; Dupee & Werthner, 2011; Gucciardi et al., 2009b; Hill et al., 2011; Parkes & Mallett, 2011; Reeves et al., 2011). Previous research has shown that reflection is required for athletes to effectively debrief after their races (Hogg, 1998b). Finally, arousal control, often via emotional regulation, relaxation/activation, or changing from a debilitative to a facilitative interpretation of competition anxiety, was enhanced through a variety of methods in several studies (Dupee & Werthner, 2011; Fournier et al., 2005; Gucciardi et al., 2009b; Hill et al., 2011; Mamassis & Doganis, 2004; Thelwell & Greenlees, 2003).

An example of performance improvement resulting from a single-skill PST program is Evans and colleagues' (2004) case study of an imagery training program with an elite rugby player. During the course of the intervention, the player went from being a second-string to a first-string player and was named the Most Improved Player in his club at the end of the season. Fournier and colleagues (2005) conducted a 10-month, multimodal PST program (i.e., relaxation, self-talk, goal-setting, focusing, and visualization) with young elite gymnasts (aged 11-13 years) and found that the gymnasts who had undergone the PST program improved their performance five percent more than the control group in three out of four events (i.e., bars, beam, and floor). Similarly, Blumenstein and colleagues (2005) described the case of an elite judoka who indicated

that he felt "satisfied with his psychological readiness" (p. 22) heading into the 2000 Olympics as a result of his mental preparation and biofeedback training during a two-year psychological preparation program combining PST with biofeedback. In terms of team sports, the coach and athletes of an elite curling team in Collins and Durand-Bush's (2010) feel-based self-regulation intervention indicated that they felt the intervention improved both their team cohesion and performance. The Olympic-level athletes and coaches in Dupee and Werthner's (2011) bioneurofeedback (BNFK) training intervention indicated that BNFK training improved the athletes' ability to manage their arousal levels, focus in competition, and contributed to improved performances.

Research approaches to PST programs. Despite the fact that there are similarities between athletes in terms of the psychological skills they use, each athlete has unique, sport-specific needs related to his or her role within a particular sport. As a result, many authors have argued that it is important to design PST programs that accommodate individual needs (Blumenstein et al., 2005; Holliday et al., 2008). The majority of recent studies on PST programs have used idiographic research designs (e.g., single- and multiple-case studies), which allow subtle, individual changes in performance and performance-related factors to be seen (e.g., Collins & Durand-Bush, 2010; Evans et al., 2004; Hill et al., 2011; Parkes & Mallett, 2011). Other authors have used an experimental design but retained some of the benefits of idiographic research by using true or modified versions of a single-subject multiple-baseline across-individuals design (e.g., Blakeslee & Goff, 2007; Calmels et al., 2004; Fournier et al., 2005; Gucciardi et al., 2009a; Jordet, 2005; Pain et al., 2011; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2001, 2003; Thelwell et al., 2006). Specifically, this type of experimental design

allows small, individual changes to be detected because each participant's results are reported individually.

One of the most detailed and informative studies, from an idiographic perspective, was the aforementioned rugby case study by Evans and colleagues (2004), which detailed the nature of one player's current imagery use and his response to an imagery training program. The 14-week program was conducted during the competitive season (plus a six-month follow-up) and consisted of a collaborative process between the participant, the coach-researcher, and a sport psychologist (i.e., the coach-researcher's mentor and supervisor). Both qualitative (i.e., semi-structured interviews and diary use) and quantitative data (i.e., scores from the Sport Imagery Questionnaire or SIQ) were obtained. The qualitative data allowed the authors to provide a rich, detailed, and reflexive account of the subtleties of the participant's experience of, and response to, the program. Examples include *why* he preferred certain types of imagery and *how* certain imagery content was used for different functions. The authors concluded by emphasizing the need to individualize interventions to maximize effectiveness (Evans et al., 2004).

A similar study to Evans and colleagues (2004), both in terms of the collaboration between a researcher and consultant and the use of an idiographic research design, was conducted by Collins & Durand-Bush (2010). The purpose of this study was to investigate whether an elite curling team (i.e., four women and their male coach) could improve their team cohesion and performance through participating in a facilitated learning process designed to help them self-regulate their individual and collective felt experiences. Given the multidimensional and context-sensitive nature of feel, using a multiple-case study design enabled the authors to document both the individuals' and team's unique perspectives and lived experiences. In their three-phase, 24-week intervention, Collins and Durand-Bush gathered data via individual

interviews with the athletes and coach; feel-based group intervention sessions that were based on the Resonance Performance Model (RPM) (i.e., a model describing the self-regulatory process of determining how one wants to feel, preparing to feel that way, overcoming obstacles to desired feelings, and revisiting desired feelings); observations recorded as field notes; and, finally, a questionnaire given to the team and coach at the end to assess the perceived effects of the intervention on team cohesion and performance. The researcher and consultant also engaged in regular debriefing sessions to compare their perceptions and interpretations of the intervention. Results showed that the intervention positively influenced both team cohesion and performance.

In keeping with the benefits of idiographic research, several authors have called for more qualitative research in applied sport psychology to provide a deeper understanding of *how* athletes use psychological skills, not just when and where they use them (Evans et al., 2004; Gucciardi et al., 2009a). It is perhaps especially beneficial to use idiographic research designs when studying the effects of PST programs on elite athletes, because athletes at this level sometimes exhibit a ceiling effect and do not show large degrees of improvement because their performance levels are already reasonably high (Jordet, 2005).

Elite versus developing athletes. The majority of the PST program studies in the last 12 years have involved adult elite athletes (e.g., Blumenstein et al., 2005; Dupee & Werthner, 2011; Evans et al., 2004; Hill et al., 2011; Jordet, 2005; Lidor et al., 2007). However, there is a growing interest in furthering our understanding of how similar programs, appropriately modified, can improve the performance of developing athletes (Fournier et al., 2005; Jordet, 2005; Rogerson & Hrycaiko, 2002). Rogerson and Hrycaiko (2002) and Mamassis and Doganis (2004) are both examples of authors conducting research involving youth-aged athletes. Rogerson and Hrycaiko examined the influence of a PST program, consisting of centering and

self-talk, on young hockey goaltenders' (aged 16-18 years) performance in competition. Mamassis and Doganis examined the effects of a PST program on tennis juniors' (mean age = 13.2 years) pre-competitive anxiety, self-confidence, and perceived performance. Mamassis and Doganis found that their program was effective in improving anxiety direction (i.e., from debilitative to facilitative), increasing confidence, and improving perceived performance (i.e., participants rated their physical feelings; quality of technique, timing, and rhythm; concentration; amount of effort exerted; mental attitude and thoughts; level of self-confidence during the match; and compared his or her actual and expected performance). Similarly, Reeves and colleagues (2011) found that a coping effectiveness training intervention produced at least small changes in coping self-efficacy, coping effectiveness, and subjective performance in 13- to 14-year-old soccer players. Social validation data showed that all participants felt the intervention improved their coping knowledge and awareness, their coping confidence and skills, and their performance. As mentioned, Fournier and colleagues (2005) conducted their season-long PST program using 11- to 13-year-old female gymnasts. Each psychological skill (i.e., relaxation, self-talk, goal-setting, focusing, visualization) was introduced to athletes in a separate block (three to eight sessions long), and the athletes' performance in competition (via their projected scores, actual scores, and national ranking) and proficiency at using the psychological skills (via the OMSAT-3©) were measured. In addition to the performance improvements noted earlier, the results indicated that the athletes in the PST program improved their psychological skill usage for relaxation, activation, imagery, focusing, and refocusing.

Structure and delivery of PST programs. A key aspect of PST program implementation is the length of the program and the degree to which it is integrated into the athletes' existing training. Research has been equivocal regarding the effects of longer versus

shorter programs since both longer studies, ranging from six months (Mamassis & Doganis, 2004; Rogerson & Hrycaiko, 2002) to two years (Blumenstein et al., 2005), and shorter studies, ranging from three days to four weeks (Blakeslee & Goff, 2007; Gucciardi et al., 2009b; Thelwell et al., 2006) showed improvements to performance and performance-related variables (e.g., anxiety direction and confidence). However, participants of Gucciardi and colleagues' (2009b) two-week intervention felt overwhelmed by the amount of information presented, suggesting that longer interventions may provide a more suitable learning experience.

The authors of several recent studies have argued that a deficiency in past research and practice in sport psychology is the lack of integration between psychological and physical preparation (Blumenstein et al., 2005; Holliday et al., 2008; Lidor et al., 2007). According to Sinclair and Sinclair (1994), if PST programs are not deliberately integrated into everyday training, athletes' "mental skills will develop randomly and haphazardly" (p. 23). To address this shortcoming, Blumenstein and colleagues (2005) and Lidor and colleagues (2007) have provided examples of how long-term PST programs (i.e., a year or more) can be integrated with physical, technical, and tactical training. Furthermore, Gucciardi and colleagues (2009b) recommended that PST programs need to be individualized and should proceed from general to specific (i.e., basic psychological skills are first learned out of context (e.g., at home or in a lab) and then, gradually, sport-specific psychological skills are learned and applied in real-life competitive contexts), which is best achieved over a longer time-frame.

In summary, the last 12 years have seen a number of studies conducted on PST programs in a variety of sports (e.g., Blakeslee & Goff, 2007; Dupee & Werthner, 2011; Evans et al., 2004; Hill et al., 2011; Rogerson & Hrycaiko, 2002). These programs have been mostly multimodal (e.g., Mamassis & Doganis, 2004; Reeves et al., 2011; Thelwell & Greenlees, 2001), with a few

single-skill designs (e.g., Calmels et al., 2004; Evans et al., 2004; Jordet, 2005), and have employed both nomothetic (e.g., Aherne et al., 2011; Gucciardi et al., 2009a) and idiographic (e.g., Evans et al., 2004; Hill et al., 2011; Thelwell et al., 2006) research designs. Many of the studies have examined adult, elite athletes (e.g., Blumenstein et al., 2005; Dupee & Werthner, 2011; Jordet, 2005), but some have investigated the influence of PST programs on younger, developing athletes (e.g., Mamassis & Doganis, 2004; Reeves et al., 2011). Finally, several authors have called for psychological training to take the key training phases and their physical, technical, and tactical objectives into account (Blumenstein et al., 2005; Holliday et al., 2008; Lidor et al., 2007). In addition to research on PST programs, there has been extensive research on the specific psychological skills taught in such programs.

Psychological Skills

There are a number of psychological skills that have been identified over the last 25 years as important for athletic success: focus, imagery, goal-setting, arousal control, distraction control, pre-competition and competition planning, debriefing, and self-talk. For the purpose of this review, three key skills will be explored in-depth: focus (e.g., Landin & Hebert, 1999; Orlick & Partington, 1988; Stoate & Wulf, 2011; Wilson, Wood, & Vine, 2009), arousal control (e.g., Cohen, Tenenbaum, & English, 2006; Edwards, Kingston, Hardy, & Gould, 2002; Hanton, Wadey, & Mellalieu, 2008; Hogg, 1998a; Janelle, 2002), and debriefing (e.g., Hanrahan, Pedro, & Cerin, 2009; Hogg, 1998b, 2002; McArdle et al., 2010).

The skill of focus. Focus is the "deliberate investment of conscious mental effort in processing information that is important . . . at a given moment" and "the ability to focus on the task at hand while ignoring distractions" (Moran, 2009, p. 18-19). In his discussion of attention, concentration, and thought management, Moran also put forth five principles of effective focus:

(a) Athletes have to decide to concentrate; it does not happen by chance, (b) Athletes can concentrate on only one thought at a time, (c) Athletes' minds are focused when there is no difference between what they are thinking and what they are doing, (d) Athletes lose their focus when they focus on factors that are outside of their control, (e) Athletes should focus outwards when they get nervous. True focus is when the athlete focuses "on actions that are specific, relevant to the task at hand and, above all, under his or her own control" (p. 20).

Empirical evidence for the importance of focus. Previous research in sport has demonstrated that the ability to focus is a crucial skill for performance success (Bell & Hardy, 2009; Bois et al., 2009; Greenleaf et al., 2001; Jackson & Csikszentmihalyi, 1999; Moran, 2003; Nideffer & Sagal, 2006; Orlick & Partington, 1988; Wulf & Su, 2007; Young & Pain, 1999). For example, the nature of an athlete's focus can affect both the quality and accuracy of skill execution (Moran, 2009). In addition, Moran (2003) indicated that competitive anxiety disrupts focus by inducing worry, self-evaluation, and hypervigilance. Therefore, focus may be one of the skills that differentiate elite from non-elite performers (Meyers, Bourgeois, LeUnes, & Murray, 1999). For example, Meyers and colleagues found that elite equestrians (i.e., United States Equestrian Team athletes who had qualified for the Olympic Trials) displayed much better focus than their sub-elite counterparts.

Previous research has also shown that even when an athlete *is* focused, the object of his or her focus can impact performance positively or negatively. According to Moran (2003), focusing too much on the technical execution of skills can damage performance because it leads experienced athletes to overthink well-learned, automated skills. Similarly, focusing too much on oneself can also be detrimental to performance by leading to excessive self-consciousness (Moran, 2003). In a similar vein, Oudejans, Kuijpers, Kooijman, and Bakker (2011) investigated

the mechanisms of drastic performance declines (i.e., choking) by determining whether expert athletes (i.e., international and high-level national athletes who had been competing at their highest level for a mean of 5.0 years) focus more on performance-related worries (e.g., doubts) or skill execution when performing under pressure. Interestingly, when the expert athletes in Oudejans and colleagues' study choked (or felt they were about to choke), they focused far more on distracting *thoughts* (e.g., performance worries/doubts) than skill *execution*; therefore, the ability to focus in spite of distractions is essential. In light of their results, Oudejans and colleagues recommended that "psychological skills training (e.g., relaxation, imagery, and centering) can help athletes to learn to control their anxiety, thoughts, and focus of attention" (p. 70). These findings are consistent with previous research on the influence of athletes' skill level on focus and performance. Perkins-Ceccato, Passmore, and Lee (2003) found that low-skilled athletes (i.e., golfers with a mean handicap of 26) seemed to perform better when they focused internally (i.e., on their form during skill execution); however, high-skilled athletes (i.e., golfers with a mean handicap of 4) were better off focusing externally on movement outcome (e.g., focusing on the trajectory of the golf ball rather than on the kinaesthetic feeling of the shot itself). These results were also supported by Stoate and Wulf (2011), who found that an internal, body-movement focus was detrimental to performance in expert athletes (i.e., swimmers who had been competing for an average of 10.2 years). However, Wulf and Su (2007) showed that an external focus improved performance in *both* skilled (i.e., university golfers with a mean handicap of 1.3) and novice golfers (i.e., undergraduate students with little or no prior golfing experience).

Research on the influence of PST programs on focus. Moran (2009) has noted that although athletes consider focus to be very important, few allocate training time to improving it.

Given this finding, PST programs are an excellent medium to target the skill of focus, and several studies have demonstrated the benefits of PST programs on focus. For example, Mallett and Hanrahan's (1997) study supports the benefits of using cue/trigger words for improving focus and performance. In their study, 12 elite 100m sprinters (mean personal record of 10.86sec) completed eight 100-meter sprint trials under control (i.e., no specific focus) and experimental conditions (i.e., the use of three specific race cues). Results revealed that the sprinters ran both faster and more consistently when they used the specific race cues, providing support for having a task-relevant focus. Similarly, Dugdale and Eklund (2002) investigated the nature of focus in the phenomenon of ironic processing, which occurs when attempts to control one's thoughts ironically result in more attention being given to the unwanted distraction. In their first study with Australian Rules Football, results showed that ironic processing errors occurred when athletes were told *not* to focus on specific cues (i.e., they focused *more* on those cues). Interestingly, the second study showed that ironic processing was largely reduced in participants who were also given a task-relevant cue (i.e., the ball) on which to refocus their attention. Similar to Moran's (2003) suggestions, these findings support the benefit of having a specific, task-relevant focus versus thinking of what not to do (Dugdale & Eklund, 2002).

Other PST program studies have demonstrated that certain psychological skills (e.g., self-talk and the planning of pre-performance routines) can be used to aid focus (Hanton et al., 2008; Hill et al., 2011; Landin & Hebert, 1999). Specifically, self-talk can help athletes achieve and maintain focus on the task at hand (Landin & Hebert, 1999), and pre-performance routines were said to increase athletes' focus on upcoming performances and prevent distraction (Hanton et al., 2008). Similarly, Hill and colleagues found that elite golfers' focus improved when they used pre-shot routines:

> The PSR [pre-shot routine] has helped me focus. . . . If I have gone through my routine, I then focus on the swing feeling. I think, "I have done everything I can control now. There is no chance that it could go anywhere other than where I wanted it to. (pp. 481-83)

These studies have implications for using self-talk and pre-performance routines to improve focus by directing athletes' attention to specific, controllable, task-relevant actions, and increasing the likelihood of total absorption in the task (Moran, 2009).

The skill of arousal control. A second key psychological skill for athletic performance is arousal control (Arent & Landers, 2003; Bois et al., 2009; Gould & Udry, 1994; Jones, 2003; Perkins, Wilson, & Kerr, 2001; Taylor et al., 2008; VaezMousavi, Barry, & Clarke, 2009). Arousal is a multidimensional construct that refers to a non-directional (i.e., neither positive nor negative) physiological and psychological activation state (Gould & Udry, 1994; Landers & Arent, 2006). Specifically, Janelle (2002) defined arousal as "general physiological and psychological activation . . . from deep sleep to extreme excitement" (p. 238). Several theories have been put forth to explain the arousal-performance relationship including drive theory (Spence & Spence, 1966), the inverted-U hypothesis (Oxendine, 1970), individual zones of optimal functioning (IZOF) (Hanin, 1980), the cusp catastrophe model (Hardy & Fazey, 1987), multidimensional anxiety theory (Martens, Burton, Vealey, Bump, & Smith, 1990), processing efficiency theory (Eysenck & Calvo, 1992), and reversal theory (Kerr, 1993). Of particular relevance to this study is Hanin's IZOF approach because it acknowledges the individual differences between athletes in terms of their optimal arousal states. Furthermore, the IZOF model comprises more emotions than just anxiety (e.g., positive and negative, high- and low-energy emotions), leading to individualized optimal mood profiles. If emotional intensity increases above or below an athlete's optimal level of arousal, performance decrements occur.

Therefore, to perform optimally, athletes should become aware of their emotional patterns and the subsequent consequences of those patterns for performance.

The influence of arousal on performance. Robazza and colleagues (2004) stated that "to enhance performance it is necessary that an athlete is aware of his or her optimal and dysfunctional zones, able to distinguish optimal from less than optimal states, and able to enter and stay in the optimal zone during performance" (p. 381). Furthermore, it seems that expert athletes "are capable of regulating emotional (e.g., anxiety) fluctuations and their physiological manifestations to a greater extent than novices, or even experienced but non-expert performers" (Janelle, 2002, p. 245). Although arousal, as a non-directional activation state, does not determine whether behaviour is negative or positive, it can be associated with emotions such as anxiety (i.e., negative cognitive and somatic arousal), which often does influence behaviour (Davis & Sime, 2005; Janelle, 2002). Specifically, anxiety levels can greatly influence the efficiency and effectiveness of athletic performance (Han et al., 2006; Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008). Therefore, athletes who cannot interpret their anxiety as facilitative to performance are more likely to perform poorly (Hanton et al., 2008).

An example of how anxiety influences athletes' performances is Wilson and colleagues' (2009) investigation of the effect of anxiety on the attentional control of soccer penalty kickers. The authors subjected the participants to low- and high-anxiety conditions during penalty kicks, and the findings indicated that anxious kickers' gazes became more central (i.e., they fixated on the goalkeeper sooner and for longer), resulting in decreased shot accuracy (i.e., the ball was shot more within the goalkeeper's reach), thus demonstrating that anxiety can have a negative impact on performance effectiveness via disrupted attentional control. Indeed, the penalty kickers were less successful in scoring goals in the high-anxiety condition. Hanton and colleagues (2008)

investigated the influence of advanced psychological strategies on competitive anxiety. The overall results of their study showed that the four advanced psychological strategies (i.e., pre-performance routines, overlearning of skills, simulation training, and cognitive restructuring) enabled athletes to change the *direction* of their cognitive and somatic anxiety (i.e., they interpreted anxiety as facilitative). However, only two of the strategies (i.e., overlearning of skills and cognitive restructuring) reduced the *intensity* of cognitive anxiety symptoms (i.e., worry, negative thoughts). The mechanisms for these effects were a "heightened attentional focus, feelings of familiarity, increased effort and motivation, an ability to rationalize with competitive anxiety, and perceived control over anxiety-related symptoms" (Hanton et al., 2008, p. 388). Interestingly, none of the advanced psychological strategies reduced the intensity of *somatic* anxiety (i.e., the perceived physiological symptoms of anxiety/arousal). One explanation could be that "many athletes report that heightened levels of arousal facilitate performance" (p. 475). Similarly, a golfer in Hill and colleagues' (2011) study on the influence of a multimodal intervention on choking did not completely eliminate his anxiety, but rather used a pre-shot routine to manage it: "I am still anxious [but] doing my PSR [pre-shot routine] . . . distracts me from the anxiety'" (p. 481). However, Jones (2003) specified that although high arousal can increase performance on tasks requiring anaerobic power (e.g., sprints), too much arousal can impede performance on fine motor control tasks (e.g., archery).

Overall *emotional* regulation, as part of arousal control, is also crucial for athletic success (Cohen et al., 2006; Hogg, 1998b; Robazza, Pellizzari, Bertollo, & Hanin, 2008). In their multiple-case study of female varsity golfers, Cohen and colleagues (2006) implemented individually designed PST programs to enhance emotional self-regulation. The programs incorporated a variety of psychological skills (i.e., attentional control, imagery, relaxation and

activation, self-talk, automaticity, resistance to disruption, and emotional control) and were designed based on the athletes' emotional profiles and typical psychological skill usage. For example, one participant's program focused on increasing her emotional control so she could regulate her physiological arousal. The participant was encouraged to increase her awareness of her emotions, interpret her arousal symptoms as positive, and use relaxation/activation strategies to regulate emotional arousal. Interpreting anxiety as facilitative is crucial to increasing an athlete's sense of control, confidence, and the avoidance of performance decrements (Hanton et al., 2008; Neil, Mellalieu, & Hanton, 2006; Wadey & Hanton, 2008). Furthermore, the results of Cohen and colleagues' study point to the importance of individualizing PST programs.

Further support for building self-awareness of one's optimal arousal state comes from Hogg's (1998a) prerequisites for emotional control: (a) awareness of the emotions that impact performance either positively or negatively, and (b) a belief that emotions can be controlled and changed. Using athletics as an example, Hogg summarized the importance of emotional awareness and regulation as follows:

> The track and field athlete who knows which emotions enhance performance, and can spot the events that trigger them, will also know what to expect and, consequently, be in a better state of emotional control to execute a successful performance. (p. 41)

The skill of debriefing. A third critical factor in optimal performance is debriefing (Hogg, 2002; Kellmann et al., 2006; McArdle et al., 2010). According to Hogg (2002, citing Hogg, 1998b)

> Debriefing occurs when athletes and coaches are engaged in an evaluative activity either in training or in competition, with the intended purpose of analyzing existing

> performance states and determining what might be improved to ensure future performance satisfaction, enjoyment, success, and fulfillment. (p. 182)

In his discussion of post-performance debriefing for track and field athletes, Hogg (1998b) suggested a six-step debriefing model. Step one involves selecting the best time, place, and occasion for debriefing, followed by mental recall of the event. A process of analysis through self-reflection takes place in step two and leads to a growing self-understanding and awareness. In step three, the athlete and a significant other (e.g., a coach) share performance information to analyze and learn from it. In step four, the need for change is determined (if applicable), decisions are made, and new strategies are developed for subsequent performances. These proposed changes lead to step five: resetting goals, which results in renewed motivation. Finally, step six involves monitoring subsequent performances for improvements (Hogg, 1998b). In terms of performance evaluation, effective debriefing should leave athletes with a sense of "how they are progressing and where they stand relative to their performance goals" (Hogg, 2002, p. 182).

Benefits of debriefing. Engaging in regular, systematic debriefing has a number of psychological and performance-related benefits. First, debriefing can provide a sense of closure for an athlete after competition (Kellmann et al., 2006). After an effective debrief, the athlete is able to move forward and work toward revised goals with renewed motivation and self-confidence (Hill et al., 2011; Hogg, 1998b). Ideally, debriefing will involve two-way communication and strengthen the trust between athlete and coach (Hogg, 1998b). In keeping with closure, another benefit of debriefing is that it promotes "mental and emotional recovery in athletes and, consequently, helps them perform on a higher level" (Hogg, 2002, p. 491). Psychological recovery occurs when the athlete is able to quickly return to "normal

psychological and emotional states after intensive training and competition" (p. 182). If proper debriefing is not carried out, especially after a disappointing performance, the athlete may take unprocessed negative thoughts and emotions into the next performance (Hogg, 2002). Interestingly, some research has shown that athletes and coaches did not see psychological/emotional recovery as objectives of debriefing; rather, recovery was viewed as purely physical, and any psychological benefits were seen merely as by-products of debriefing (McArdle et al., 2010).

Another important benefit of debriefing is that it helps increase athletes' self-awareness (e.g., of mistakes and strengths). According to Sinclair and Sinclair (1994), "awareness is the beginning of all learning. . . . one must develop the ability to control the psychological factors that cause the level of performance to vary" (p. 18). Hogg (2002) supported this view by stating that "the debriefing process can help athletes develop their self-knowledge and understanding and provide insights into what must be done to reach the next level of performance" (p. 182). This self-knowledge is gained by receiving and reflecting on feedback that is both descriptive (i.e., what happened during the competition) and normative evaluative (i.e., expectations for performance compared to others or to standards). Hanrahan and colleagues' (2009) study of recreational salsa dancers supports this benefit. The results of their nine-week study indicated that structured weekly reflection (via a form with a Likert scale) was perceived to be beneficial by increasing the dancers' self-awareness of their strengths and weaknesses, focusing their learning, and improving perceived performance. However, Hogg cautions that building self-awareness does not necessarily mean the athlete will take action: "Self-awareness is only meaningful when athletes can use it to make changes" (p. 188).

Factors affecting debriefing. Although debriefing is a useful skill, it is not without challenges. Unsurprisingly, performance outcome can influence an athlete's willingness to debrief (Kellmann et al., 2006; McArdle et al., 2010). If the performance was sub-standard, an athlete will likely experience negative emotions and may be reluctant to debrief what happened. However, athletes may also be unlikely to debrief systematically after a successful performance because they do not see the necessity (Kellmann et al., 2006). The athlete's personality can also influence debriefing. Specifically, an athlete who is overly self-critical, who is a "dysfunctional perfectionist" (Hogg, 2002, p. 193), or who worries excessively about how his or her performance appears to others can present difficulties (Hogg, 2002). In addition, athletes may be reluctant to communicate honestly with their coach if they fear that the coach will use that information against them (Hogg, 2002). Therefore, it can be helpful for an independent party (e.g., a sport psychologist) to facilitate debriefing. Finally, athletes who are regressing, in a performance plateau, or who lack confidence also present specific challenges (Hogg, 2002).

In sum, debriefing is a skill that can help athletes develop a greater sense of self-awareness and can be quite beneficial. Despite the challenges of engaging in regular, systematic debriefing, it is worth the effort because, as Hogg (2002) stated, "The next performance is really only as good as the lessons learned from the previous one" (p. 196). In addition to post-race debriefing, there are other methods that consultants can use to help athletes increase their self-awareness and facilitate on-going learning in practice and competition. Biofeedback is one of these methods and will be discussed in the following section.

Biofeedback Training in Sport Contexts

In the last 30 years, biofeedback has received increasing research attention as an assessment and training tool for psychophysiological self-regulation in both clinical and sport

contexts (Bar-Eli et al., 2002; Blumenstein et al., 1997; Dupee & Werthner, 2011; Hassett et al., 2007; Prapavessis, Grove, McNair, & Cable, 1992; Raymond, Sajid, Parkinson, & Gruzelier, 2005; Schwartz & Andrasik, 2003; Swanson et al., 2009). Schwartz and Andrasik (2003) defined psychophysiology as "the study of the interrelationships of physiological and cognitive processes (p. 5). In their book *Brain and body in sport and exercise*, Blumenstein and colleagues (2002) indicated that, "a major application for biofeedback is detecting and helping in the management of psychophysiological arousal, especially overarousal" (p. 37). This demonstrates a clear link between biofeedback training and the psychological skill of arousal control discussed earlier. According to Blumenstein and colleagues, the implications of biofeedback for arousal control in sport performance are based on the "psychophysiological principle":

> The relevance of biofeedback interventions to athletic preparation is evident in the 'psychophysiological principle' presented by Green, Green, and Walters (1970), which states that every physiological change is accompanied by a parallel change in the mental and emotional state and, conversely, every change in the mental and emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state. Thus, biofeedback can be a powerful tool for physiological change, increasing individual awareness and control over the body. (Blumenstein et al., 2002, p. xi)

Based on this principle, it seems clear that biofeedback training is a natural complement to psychological skills training involving focus and debriefing, because learning physiological self-regulation requires that an athlete be able to focus on relevant bodily cues; reflect on his or her patterns of cognitions, emotions, and behaviours; and, therefore, come to understand their interrelationship with and influence on performance. A number of physiological modalities can be targeted in order to improve awareness and control over one's physiology and

mental/emotional states: respiration, HR/HRV, sEMG, peripheral body temperature, and EDA (Blumenstein et al., 2002).

Respiration and heart rate (HR)/heart rate variability (HRV). When the modalities of respiration and HR are monitored together, and the person being monitored breathes at approximately six breaths per minute, heart rate tends to synchronize with the breath (i.e., it increases during inhalation and decreases during exhalation) (Vaschillo, Vaschillo, & Lehrer, 2006). This phenomenon is called respiratory sinus arrhythmia (RSA) (Yasuma & Hayano, 2004) and represents a change in the time interval between heart beats; it is also known as HRV (Yasuma & Hayano, 2004). There is evidence to suggest that biofeedback training in HRV can produce changes in the functioning of the autonomic nervous system (e.g., changes to the baroreflex and heart rate). This is especially true when HRV training is paired with a breathing rate at the cardiovascular system's resonant frequency, which is often around six breaths per minute (Vaschillo et al., 2006). Essentially, breathing at this rate creates a rhythmic fluctuation in the time interval between heart beats (i.e., HRV), which is associated with a balance between the sympathetic and parasympathetic nervous systems and results in a state of recovery (Davis, Sime, & Robertson, 2007).

An example of biofeedback research using HRV is Raymond and colleagues' (2005) study of the influence of electroencephalographic (EEG) and HRV training on dancers using a three-group design (i.e., two experimental groups and one control group). Both the EEG and HRV groups received approximately the same number of training sessions ($M = 9$), each of which lasted about 20 minutes. Results showed that both the EEG and HRV groups improved their technical and overall dance performance more than the control group (as rated by judges who were blind to the condition). Due to the small group sizes (i.e., six, four, and eight

participants in each group), the authors emphasized that their study was exploratory but offered further support for the use of HRV biofeedback as a complement to PST (Raymond et al., 2005).

The respiration modality was also used by Bessel and Gevirtz (1998), who compared the influence of breathing retraining and cognitive (i.e., thought control) techniques on the anxiety of 31 gymnasts over an 8-12 week field-setting intervention. As in Raymond and colleagues' (2005) study, the results of Bessel and Gevirtz's intervention demonstrated a significant increase in performance in the intervention groups compared to the control group. Interestingly, there was no decrease in state anxiety in either intervention group, yet they still showed increased performance. As noted in sport psychology research (Hanton et al., 2008), it could be that a certain amount of anxiety is necessary for optimal performance, and the athletes did not interpret anxiety as debilitative.

Surface electromyography (sEMG). Surface electromyography (sEMG) is a "measurement of the electrical activity preceding muscle contraction" (Blumenstein et al., 2002, p. 38) and it is used as a biofeedback modality to teach greater awareness of and control over muscle tension. Since increased muscle tension is often associated with performance decrements (Dupee & Werthner, 2011), sEMG biofeedback is useful to assess whether (and where) athletes carry muscle tension.

There have been several research studies conducted using sEMG biofeedback either alone or in combination with other modalities (Blais & Vallerand, 1986; Cummings, Wilson, & Bird, 1984; Dupee & Werthner, 2011; Kavussanu, Crews, & Gill, 1998). Specifically, Blais and Vallerand (1986) investigated the influence of sEMG biofeedback training on the muscle tension, anxiety, and performance of 10- to 13-year-old, highly trait-anxious boys before and between matches in a simulated competitive event. Results showed that the experimental group

was better than the placebo group at reducing sEMG in the targeted muscle (i.e., the frontalis muscle). However, this effect diminished when the competition became more stressful (e.g., after a loss). The authors stated that "these results suggest a certain threshold of precompetitive stress for which the biofeedback group could manage their sEMG; beyond that threshold no difference occurred" (p. 299).

Of interest to the present study is that Blais and Vallerand (1986) found that their participants could *transfer* the skills learned during biofeedback training to the competitive environment. This is important because one of the criticisms of biofeedback research is that the self-regulatory skills learned in the laboratory are not readily transferrable to competition settings (Crews, Lochbaum, & Karoly, 2001). Based on their study's results, Blais and Vallerand indicated that sEMG biofeedback may be an effective means of improving one's awareness and control of muscle tension in targeted muscle groups, although increasing muscle tension control may not reduce anxiety or arousal, or improve performance (Blais & Vallerand, 1986).

In contrast to Blais and Vallerand's (1986) study, which used only sEMG biofeedback, Bar-Eli and colleagues (2002) combined several modalities with sEMG in their biofeedback and mental training program for 38 young swimmers (i.e., 11-14 years). Specifically, they used HR, sEMG, and EDA to teach self-regulatory skills to the participants using three of the five steps in the Wingate 5-Step Approach (see Blumenstein et al., 1997). The study consisted of experimental and control groups, the former undergoing the biofeedback and mental training and the latter (to control for the Hawthorne effect) completing only relaxing activities (i.e., listening to quiet music, observing nature movies, and playing table games) in addition to their regular training. After an initial baseline test of their swimming speed and technique, the participants underwent a 14-week intervention composed of 38 sessions (lasting approximately 35 minutes

each) during which they were taught self-regulatory skills such as autogenic training and imagery, and they were introduced to the biofeedback modalities. Technique and speed on a 50m freestyle swim were evaluated again at the mid-point and end of the intervention. Unlike Blais and Vallerand's study, in which *both* the biofeedback and placebo groups improved their performance, the technique ratings (as graded by expert judges) and swimming speed of the participants in Bar-Eli and colleagues' study improved more in the *experimental* group than the control group. One explanation for the difference between the two studies' results could be that Bar-Eli and colleagues ensured that the most responsive biofeedback modality was selected for further training, whereas only one modality (i.e., sEMG) was offered in Blais and Vallerand's study. Therefore, the greater individualization in Bar-Eli and colleagues' program could have enhanced the program's effect on the biofeedback group's performance.

Another study that has examined the influence of different combinations of biofeedback modalities on performance and performance-related variables is Kavussanu and colleagues' (1998) study of the influence of multiple versus single measures of biofeedback on free throw shooting performance. Their study consisted of 36 intermediate basketball players who completed 60 free throws during a pre- and post-test. The participants were randomly assigned to either the multiple-measure biofeedback group (i.e., EEG, sEMG, and HR), the single-measure biofeedback group (i.e., sEMG), or the control group. In addition to measuring free throw shooting performance, the authors also measured the participants' perceived control over their thoughts, HR, and muscle tension, and their self-efficacy to successfully make specific numbers of shots. They hypothesized that perceived control and self-efficacy (measured using a three-item and a four-item inventory, respectively, which were developed specifically for the study) would mediate the relationship between biofeedback and performance. However, results

indicated that all groups' free throw shooting performance increased pre- to post-test, and only self-efficacy was a significant predictor of performance. Nevertheless, when Kavussanu and colleagues examined the free throw shooting performance within the two biofeedback groups, they found that those participants with the best mastery of the three biofeedback modalities (i.e., those who achieved statistically significant maximum and minimum changes from baseline on sEMG, EEG, and HR) had better performance than those who had the least mastery. This effect was observed regardless of the type of biofeedback provided (i.e., single modality versus multiple modalities).

Peripheral body temperature. The temperature modality provides thermal feedback about an athlete's peripheral body temperature (Blumenstein et al., 2002). Specifically, the sensor (i.e., a thermistor) is attached to the athlete's finger, which then determines the degree of blood circulation in the finger; depending on the athlete's level of sympathetic or parasympathetic activation, the blood vessels in the finger will vasoconstrict or vasodilate, respectively. The changes in blood vessel diameter regulate the degree of blood flow to the extremities and change peripheral temperature as a result (Blumenstein et al., 2002). For example, when the sympathetic nervous system is activated, the peripheral blood vessels contract, which causes a corresponding drop in peripheral body temperature. This response is typically seen when a person is tense and stressed. In contrast, when a person is relaxed and sympathetic nervous system activity decreases, the peripheral blood vessels relax and the peripheral body temperature increases (Blumenstein et al., 2002). Citing Zaichkowsky and Fuchs (1988), Blumenstein and colleagues (2002) provided temperature ranges that indicate an athlete's overall arousal level: 18-21^{o}C for high sympathetic arousal (i.e., the stress response), 32-35^{o}C for low sympathetic arousal (i.e., a state of relaxation/recovery).

Unlike sEMG, HR/HRV, and respiration, peripheral body temperature is typically not the modality of focus in most biofeedback training programs in sport. However, it is often used during baseline assessments to determine how athletes respond to, and recover after, various stressors (e.g., Arave, 2012; Dupee & Werthner, 2011). Despite its relative lack of popularity, some biofeedback studies in sport have included peripheral body temperature in their training protocols (Edmonds, 2012; Galloway, 2011; Kappes & Chapman, 1984; Peper & Schmid, 1983). For example, in his 2012 case study, Edmonds (2012) worked with a male university 400m sprinter who was struggling with anxiety, tension, and underperformance in training and competition. Using the Wingate 5-Step Approach (Blumenstein et al., 1997), Edmonds designed a biofeedback intervention that used sEMG, EDA, and peripheral body temperature to help the athlete learn "how to regulate his negative affective states, improve his confidence, and ultimately, his performance" (p. 222). Over the course of the three-month intervention, the sprinter primarily used sEMG biofeedback, progressive relaxation, excitation and relaxation exercises, and autogenic training with imagery to increase his awareness and control of muscle tension, cognitive and somatic anxiety, and physiological arousal. These skills were then transferred from the lab setting into training and, finally, into actual competition. Results showed that the sprinter's perceived cognitive and somatic anxiety decreased dramatically pre- to post-test, and his self-rated confidence also increased significantly. Furthermore, his actual performance also improved, and he ran a personal record in the 400m by the end of the season.

Galloway (2011) also used the Wingate 5-Step Approach in his multiple-case study of the influence of biofeedback training on six tennis players' serve accuracy. However, despite introducing each participant to sEMG, EDA, peripheral body temperature, and HR modalities during the first phase of the program, most participants selected sEMG and EDA as their

preferred modalities for the remaining four phases of the program. Results showed that players' overall serve accuracy increased during several of the phases; however, performance did not improve for several athletes between baseline and phase one (in which the athletes are first introduced to the biofeedback equipment in the lab) and phase four and five (in which the athletes transfer their self-regulatory skills from training to actual competition). The author suggested that the slight performance decreases seen between phases four and five were likely due to the athletes adjusting to the challenges of applying their newly acquired self-regulatory skills in actual competition.

Electrodermal activity (EDA). Also referred to as skin conductance (SC) or galvanic skin response (GSR), EDA is measured on the fingers and is an indication of the electrical conductivity of the skin (Blumenstein et al., 2002). That is, when the sweat glands on the skin are more active, the sweat produced contains salts that conduct electricity; therefore, more active sweat glands equal greater electrical conductivity on the skin's surface and a higher EDA reading. Of interest to sport performance is the meaning behind the EDA reading. When athletes' arousal levels rise, the increased sympathetic activity causes the sweat glands on the hands to secrete more moisture, which in turn raises the electrodermal reading (Blumenstein et al., 2002). Because EDA increases or decreases in response to changes in psychophysiological arousal (e.g., one's emotional reaction to an event or a thought), it is a good way to determine how well athletes can regulate their emotions (Blumenstein et al., 2002). However, it is important to note that "these instruments measure sweat gland activity, and statements regarding skin conductance and emotionality (anxiety, fear, anger, and so forth) are inferences from one's own theoretical perspective" (p. 41). Nevertheless, it has been suggested that EDA is a useful modality to teach state anxiety regulation.

An example of research investigating the effect of EDA biofeedback training in sport is Peper and Schmid (1983), who conducted a two-year biofeedback training program with the U.S. national rhythmic gymnastics team. Their program was designed to demonstrate how cognitive and physiological indices are connected, determine stressful aspects of the athletes' performances using imagery and EDA biofeedback, monitor relaxation, and facilitate concentration training. Although they used peripheral body temperature, sEMG, and EDA, they focused mostly on EDA. For example, the athletes spent two weeks practising EDA regulation using a hand-held device while visualizing their routines. The objective was to visualize the entire routine without increasing their EDA, which would suggest an emotional reaction to whatever they were imagining. To train concentration, the athletes worked in pairs in which one athlete, who was connected to the EDA device, visualized her routine while her partner tried to distract her. The objective was to visualize the entire routine without increasing EDA. Results showed that EDA combined with imagery, relaxation training, and attention control training improved the gymnasts' awareness and control of their physiological and mental states. Most participants indicated that using the EDA device enhanced concentration, decreased arousal, and enabled them to dissociate emotionally from external and internal stimuli (Peper & Schmid, 1983).

Similar to Peper and Schmid (1983), Edmonds, Tenenbaum, Mann, Johnson, and Kamata (2008) also investigated EDA biofeedback training, but combined it with HR biofeedback and measures of perceived arousal and pleasure in the task. Specifically, they attempted to determine the individual affect-related performance zones (IAPZs, which are the feelings and emotions associated with an athlete's optimal performance state, including physiological responses) for each participant and examined the efficacy of biofeedback training on participants' ability to

attain their specified arousal zones. After a pre-test race in a driving simulator, participants were randomly assigned to one of three conditions: optimal, poor, and attention control (i.e., they did not receive biofeedback training, but they did get attention from the researchers to control for the Hawthorne effect). Participants in the "optimal" group were taught their optimal performance ranges in terms of HR, EDA, perceived arousal, and perceived pleasure. In contrast, the "poor" group was trained to get into their poor range of the aforementioned variables. Importantly, the participants did not know whether the range to which they were assigned was considered optimal or poor for performance. In the post-test, participants were asked to get into their IAPZs (i.e., the predetermined ranges for EDA and HR). Furthermore, their perceived arousal and pleasure with the task were measured during the trials. Results showed that all participants increased their HR, EDA, and perceived arousal during the trials, while perceived pleasure decreased. However, there were subtle differences in the participants' IAPZs (both in terms of *perceived* arousal and pleasure and *actual* HR and EDA); this supports the notion that individuals respond differently to stress and have differing optimal performance states. In terms of performance, participants in the "optimal" arousal group showed the largest and most consistent gains. Overall, the authors stated that "biofeedback . . . was revealed to be a useful and effective tool to train individuals to self-regulate" (p. 770).

Limitations of Previous Research

Given the current state of the literature on PST programs and biofeedback training, there are a number of areas that require further investigation. One shortcoming particularly related to the present study is the research design of previous PST program studies given the prevalence of nomothetic and/or cross-sectional studies (Marks, 2008). Although nomothetic (i.e., group-based) experimental studies allow researchers to determine whether the overall impact of their

PST programs were statistically significant, they do not allow individual changes or change over time to be seen. Conducting more idiographic (e.g., case study) research would help resolve this issue. This study attempted to address this limitation by using a multiple-case study to obtain an in-depth view of five track athletes' experiences and perceptions regarding the PST-Biofeedback program.

There have also been limitations in previous biofeedback studies. Particularly relevant to this study are the concerns expressed by Gould and Udry (1994), who urged researchers to conduct longitudinal, season-long studies because most sport psychology consultants agree that learning psychophysiological self-regulatory skills "are the result of long term efforts" (p. 484). Again, this study attempted to address this concern by ensuring the PST-Biofeedback program was conducted across an entire competitive season. To date, few empirical studies have examined the influence of a combined PST-Biofeedback program on athletes' psychological, emotional, and physiological self-regulation and/or performance (e.g., Bar-Eli et al., 2002; Bessel & Gevirtz, 1998; Blumenstein et al., 2005; Cummings et al., 1984; Lidor et al., 2007). In light of this, and the aforementioned limitations of previous research, this study was designed to address some of these limitations by conducting a PST-Biofeedback training program in an ecologically valid context with athletes training and competing in athletics. As mentioned, the following research questions were addressed: (a) How did the athletes experience the psychological skills and biofeedback training program? (b) Did the athletes perceive a change in their ability to effectively self-regulate after the season-long psychological skills and biofeedback training program was completed, and what were their perceptions of the program's influence on their performance? (c) Which elements of the program did the athletes find to be most effective?

Chapter Three: Methodology

Research Design

Epistemology. This study used a constructivist epistemology, in which meaningful reality is constructed in the mind of the individual (Crotty, 1998; Light & Wallian, 2008). According to the tenets of constructivism, meaning is not contained inherently within an object or event, and as such it cannot be "discovered" impartially in the way objectivists state that it can. The meaning-making process occurs as a result of the interaction between an object and its observer, with both contributing to the interpretive process (Crotty, 1998). Constructivism was appropriate for this study because the purpose was to explore the experiences of five track athletes during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally. Therefore, this study required an epistemological viewpoint that was based on the idea that each person's interpretation of his or her world is valid and unique.

A multiple-case study approach. Given that constructivism was the epistemological standpoint of this study, a multiple-case study approach was considered appropriate since each participant's account of his or her experience would be considered valid. Merriam (2009) defines case study research as "an in-depth description and analysis of a bounded system" (p. 43). Creswell (2007) expands on this by providing a detailed definition:

> Case study research is a qualitative approach in which the investigator explores a bounded system (a *case*) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving *multiple sources of information* and reports a case *description* and case-based themes. (p. 73)

According to Creswell (2007), a case study approach is appropriate when "the inquirer has clearly identifiable cases with boundaries and seeks to provide an in-depth understanding of the cases or a comparison of several cases" (p. 74). In this study, the cases were individual athletes who were clearly identifiable, had boundaries, were made up of specific components (i.e., their thoughts, feelings, and actions), and were studied within a "bounded system" (i.e., their training and competition environment). Furthermore, the focus of this study was to achieve an in-depth understanding of each case and to compare across cases, which is in line with Creswell's case study criteria.

Credibility, dependability, and transferability in case study research. Several authors have offered criteria for evaluating qualitative research. For example, Lincoln and Guba (1985) have suggested the terms credibility, dependability, and transferability. With regard to credibility (i.e., are the researchers studying what they think they are studying?), Merriam (2009) states that qualitative research operates on the assumption that "reality is holistic, multidimensional, and ever-changing; it is not a single, fixed, objective phenomenon waiting to be discovered, observed, and measured as in quantitative research" (p. 213). Some of the strategies offered by Merriam for increasing credibility in qualitative research are (a) triangulation, (b) member checks, (c) researcher reflexivity, (d) peer review, and (e) adequate engagement in data collection. Triangulation in this study was achieved by using the multiple data sources of interviews, observations at competitions, and biofeedback training data. The interviews were sent back to the athletes for their comments, and no changes were requested. The researcher achieved a level of reflexivity by taking extensive notes about her thoughts on, impressions of, and assumptions about research and consulting, and her work was checked by the consultant, who is an experienced researcher in the field. Finally, adequate engagement in the data collection was

achieved because the researcher was present at 43 of the 51 PST-Biofeedback sessions, attended several of the athletes' competitions, and conducted the final interviews. The consultant carried out all of the PST-Biofeedback sessions, attended several of the athletes' competitions, and conducted the initial interviews.

In terms of dependability, Merriam (2009) indicates that "human behavior is never static, nor is what many experience necessarily more reliable than what one experiences" (p. 220). In essence, "replication of a qualitative study will not yield the same results, but this does not discredit the results of any particular study" (p. 220). Merriam goes on to say that the more important issue is "*whether the results are consistent with the data collected*" (p. 220, italics in original). That is, given the data collected in a *particular study*, do the results make sense? If they do, that study can be considered dependable. There are several strategies that can be used to improve dependability in qualitative research: (a) triangulation, (b) peer review, (c) reflexivity, and (d) the audit trail. As mentioned, the first three strategies were used in this study. The fourth strategy was also used since the researcher kept extensive notes during the data collection and analysis processes. The audit trail is a detailed description of how the study was carried out, including how decisions were made. By requesting and reading this "log" (Merriam, 2009, p. 223), "independent readers can authenticate the findings of a study" (p. 222).

The final criterion used to evaluate qualitative research is transferability. Merriam (2009) indicated that "in qualitative research, a single case or small, nonrandom, purposeful sample is selected precisely because the researcher wishes to understand the particular in depth, not to find out what is generally true of the many" (p. 224). The qualitative researcher does not know the situations to which the reader will attempt to apply his or her research findings; however, the researcher can provide a detailed enough description of the study's context to allow the reader to

be informed when making generalizations. Merriam argues convincingly that the process of transferring knowledge from a particular situation to similar situations is what people do in everyday life. This study included rich description and a variable sample of athletes (e.g., in age, event type, level of experience, and personal background) to enhance the transferability of the results (Merriam, 2009).

Participants

Once ethical approval was obtained from the University of Ottawa's Office of Research Ethics and Integrity, the head coach of an athletics club was contacted and given information pertaining to the purpose, nature, and procedures of the study. The head coach was the person with whom the consultant formed rapport before participants were recruited.

The athletes. Five participants were selected from this athletics club using purposeful sampling. According to Creswell (2007), purposeful sampling is a technique used when "the inquirer selects individuals and sites for study because they can purposefully inform an understanding of the . . . central phenomenon in the study" (p. 125). Given that the purpose of the present investigation was to explore the experiences of track athletes during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally, it was appropriate to seek out participants at an athletics (i.e., track and field) club. The participants were three men and two women aged 18-33 years with four to nine years of experience in athletics. The athletes raced one or more of the following events: the 100m, the 100m hurdles (i.e., 100mH), the 200m, the 400m, and the 1500m. Three of the athletes were university students, and two athletes had completed undergraduate or graduate degrees and were training full-time. All five athletes had international racing experience, including competitions such as the International University Sports Federation

(FISU) World University Games, the Junior and Senior Pan/Parapan American Games, the Commonwealth Games, the IAAF/IPC Junior and Senior World Championships in Athletics, and the Olympic Games (either as a full team member or as an alternate) (see Table 1).

The consultant. The consultant in this study was an experienced practitioner and researcher in the field of sport psychology, and she had 28 years of experience as a mental performance consultant with elite athletes. Furthermore, the consultant had six years of research and applied experience in conducting biofeedback assessment and training in sport. For example, leading up to the Vancouver 2010 Olympic Winter Games, the consultant provided biofeedback training to several of Canada's Olympians in order to enhance their self-awareness, self-regulation, and performance. The role of the consultant in the present study was to *facilitate* each athlete's learning process (e.g., help him or her learn from his or her races through systematic debriefing) and provide an individualized PST-Biofeedback training program. Specifically, the consultant's role was not to teach the athletes the psychological skills in a pre-packaged way, but rather to ask the kinds of questions that would facilitate the athletes' reflective processes so that they could identify what was already working for them and, based on debriefing after each race, what needed to be improved. Although the consultant did not tell each athlete what he or she needed to focus on in terms of technique, she did provide guidance about the skills of focus, arousal control, and debriefing as they related to performance.

The researcher. The researcher in the present study was a graduate student who was studying with the consultant, who was a university professor. In addition to her graduate-level training in qualitative research methods, the researcher had also completed instruction in biofeedback training. Her role during the study was primarily to take field notes during the athletes' interviews and PST-Biofeedback sessions, process the audio recordings of the sessions

and interviews (i.e., transcribe the interviews and take field notes on the session recordings), and analyze the interview transcripts. However, she did help set up the biofeedback equipment during the PST-Biofeedback sessions, and she also conducted six of Dennis' seven respiration-only biofeedback sessions.

Instruments

The initial semi-structured interviews, which occurred prior to the start of the PST-Biofeedback program, were conducted by the consultant (see Appendix A). These interviews were conducted by the consultant because she was administering the PST-Biofeedback program, and conducting these interviews enabled her to begin building rapport with each athlete. The researcher conducted the final interviews upon completion of the program (see Appendix B). The final interviews were conducted by the researcher in order to avoid the possibility that the athletes would respond in a socially desirable manner with the consultant (Spector, 2004). Semi-structured interviews allow the interviewee more freedom to respond according to his or her own concerns and interests, and they allow the interviewer to enter into the interviewee's psychological and social world as much as possible (Smith, 2008). All interviews were audio-recorded, transcribed verbatim, and the data in the interviews were sent to the participants for member-checking (three of the five athletes replied, but no changes were requested). To improve the likelihood of obtaining quality data, the interviews were conducted in a location that was comfortable for the participants (i.e., a private room at the university or the athletics club).

Biofeedback training was carried out using a ProComp Infiniti encoder and the relevant biofeedback sensors for each of the five modalities. Respiration was measured indirectly using a strain gauge around the participant's abdomen, HR/HRV was measured using a photoplethysmograph, which provides an indirect measure of heart rate, sEMG was measured

using electrodes placed on the athlete's trapezius or masseter muscles, peripheral body temperature was measured using a sensor placed against the skin on the volar surface of the index finger, and, finally, EDA was measured using two sensors at the base of the index and ring fingers on the hand opposite the one with the temperature sensor. The physiological data obtained from the sensors was displayed in real-time on a computer screen using the BioGraph Infiniti® biofeedback software. Based on whether the values on the computer screen for each biofeedback modality increased or decreased, the consultant determined each athlete's psychophysiological self-regulatory proficiency and progress throughout the program. Further details regarding the specific purposes of each modality are provided in the following sections.

Finally, participants were provided with a form for creating an effective race focus (see Appendix C) with questions designed to promote post-race debriefing: how the race went, what the athlete was thinking, feeling, and doing before and during the race, the athlete's focus before and during the race, and what the athlete felt he or she learned from the race.

Procedures

Study phases. The study consisted of three phases (see Table 2). The first phase was an initial group session on May 14th, 2011 with the head coach of the club, the selected athletes and their coaches, the consultant, and the researcher to discuss the nature and purpose of the study. This session lasted approximately 60 minutes. First, the consultant briefly described her own sport background, her training and competencies as a practitioner, and her consulting philosophy, and then the psychological skills and biofeedback information were reviewed. The consultant also asked the coaches and athletes if they had any questions or concerns and prompted them to begin reflecting on their training and past performances.

Phase two, which started two weeks after the initial group meeting, began with an initial in-depth interview with each of the five athletes. In general, the purpose of the initial interviews was to gather information about the athletes' backgrounds, recent best and less-than-best races, how they felt they currently prepared psychologically for training and competition, and what they felt they needed to work on psychologically. After these initial interviews the PST-Biofeedback training program was initiated.

The PST-Biofeedback programs for each of the five athletes varied in length, but collectively they extended from May 2011 to April 2012, depending on the timing of each athlete's initial interview and the number of PST-Biofeedback sessions in his or her program. This time-frame encompassed the outdoor season (i.e., approximately May to September) and the indoor season (i.e., approximately October to April). The number of PST-Biofeedback sessions for each athlete ranged from 7 to 13, and the sessions involved discussions of a variety of psychological skills and pertinent issues (see Appendix D). Most of the sessions included both PST and biofeedback components; however, 17 sessions (across all five athletes) consisted only of PST (e.g., those conducted at competitions) or biofeedback (e.g., when additional biofeedback sessions were deemed necessary to practice a specific modality).

The PST-Biofeedback sessions that took place in the lab ranged between 40 and 120 minutes, and the brief, on-site PST sessions at competitions ranged from 5 to 15 minutes. The number of PST-Biofeedback sessions each athlete completed was determined by each athlete's training and competition schedule, his or her individual needs, and by the study's timeline. Furthermore, the biofeedback training was only conducted in the lab, so delays were sometimes incurred when an athlete was unable to come to the lab.

Because the PST-Biofeedback program occurred during the competitive season, the basic structure of each session after the initial interview was as follows: (a) target the skill of debriefing by debriefing any previous races (i.e., discuss what occurred and what that might mean for the next weekend of racing), (b) target the skill of focus by revising what needed to be the focus for the next race and write a focus plan based on that, (c) discuss any other topics the athlete felt were necessary (e.g., coaching issues, injuries, health), and (d) target the skill of arousal control by conducting a biofeedback training session lasting 30-45 minutes, on average.

Based on what each athlete said he or she needed to work on in the first interview, the PST sessions were individualized. As the program progressed and debriefing occurred after each of the athletes' races, the skills that were discussed and trained in the sessions evolved. However, the biofeedback program was largely similar for all five athletes. That is, all five modalities were trained in each biofeedback session to enable the athletes to begin to learn how to self-regulate physiologically. Furthermore, the consultant and researcher took note of the baseline values of all five modalities during the first session of each athlete's program in which biofeedback was included so that they could follow each athlete's progress. Unlike the initial and final interviews, the audio recordings of the PST-Biofeedback sessions were not transcribed verbatim; however, the researcher did take field notes. The purpose of the field notes was to provide an accurate description of each athlete's progression through his or her PST-Biofeedback training program. Further details about the number, type, and nature of each athlete's PST and biofeedback sessions are provided in the results section.

The third phase consisted of an in-depth final interview with each of the five athletes to explore their experiences with the PST-Biofeedback training program; perceived changes to their performances or their ability to focus, control arousal, and debrief; which aspects of the PST-

Biofeedback program they perceived to be most helpful; and, finally, what they felt they needed to continue to work on from a psychological perspective.

Biofeedback training. Throughout the program, one-on-one biofeedback sessions were conducted with each participant (nearly always in conjunction with a PST session) to educate them in the use of biofeedback for increasing self-awareness and self-regulation of their physiological, psychological, and emotional arousal. During and after the sessions, field notes were taken to record the conditions in the room, what occurred during the session (including number values for each modality) and any particularities that may have influenced the data (e.g., if it was a particularly hot day, the participant's peripheral body temperature might be higher than normal). As mentioned, the biofeedback training involved all five modalities. This was because every athlete responds differently in each modality (Gould & Udry, 1994).

The biofeedback modalities were trained in the following order: respiration and HR/HRV together, sEMG, peripheral body temperature, and EDA. The reason for presenting the modalities in this order is that athletes and their coaches typically use information pertaining to respiration, HR, and muscle tension to help them design and evaluate their training loads (Bar-Eli et al., 2002); therefore, they are more likely to understand and connect with modalities like respiration, HR/HRV, and sEMG than with peripheral body temperature and EDA, which do not feature prominently in the everyday training of most athletes. The purpose of each modality was specific, but the overall objective was to increase the athletes' awareness and management of their physiological arousal. The main purpose of the respiration and HR/HRV modalities was to teach the athletes to breathe at six breaths/min so their HR and respiration came into coherence (i.e., the sympathetic nervous system was down-regulated). The objective of sEMG was to help the athletes become aware of any muscle tension in their shoulders or jaw and train them to

release that tension. For peripheral body temperature, the goal was to raise their peripheral body temperature to promote a deep sense of relaxation. To raise peripheral body temperature, most athletes focus on abdominal breathing at six breaths per minute or create a sense of warming the hands and relaxing the arms and shoulders. Finally, the purpose of EDA was to show athletes how events and thoughts influence their emotional responses, which manifest through the sweat response in the hands and is indicative of a rise in arousal. The overall goal was for each athlete to be able to activate and de-activate each modality at will.

A modified version of the original Wingate 5-Step Approach to mental training with biofeedback (Blumenstein et al., 1997) was utilized for this study. Briefly, the 5-Step Approach was modified as follows: In contrast to Blumenstein and colleagues' (1997) study, all five biofeedback modalities were introduced to the athletes during their first session in Step 1 (i.e., Introduction). Furthermore, the athletes in this study were shown in their first session how to activate and deactivate their physiological systems, both with and without visual and auditory biofeedback from the computer screen (i.e., alternating between open eyes and closed eyes). In contrast, Blumenstein and colleagues taught relaxation (via autogenic training) and excitation (via imagery) to their athletes before asking them to use those skills while watching the biofeedback screen. For this study, Step 2 (i.e., Identification) was not used because the biofeedback training protocol was essentially the same for all five athletes. That is, no single biofeedback modality was singled out for addition training. Step 3 (i.e., Simulation) was also carried out differently than the original Wingate 5-Step Approach. Blumenstein and colleagues simulated competitive stress in the lab by showing the athletes multiple videos of themselves performing in a variety of competitions. Later, they gradually increased the arousal levels of the athlete by manipulating the sensory information in the videos (i.e., sound and image), the level of

importance of the competition, and the degree of success achieved by the athletes in the video. However, the primary means of simulating competitive stress in the laboratory during this study was to have the athletes visualize their races in an attempt to raise EDA (i.e., induce the stress response psychologically). Steps 4 and 5 (i.e., Transformation and Realization) were both carried out in this study; however, unlike Blumenstein and colleagues' study, the athletes in the present study applied their psychophysiological self-regulatory skills to training and competition without the aid of portable biofeedback equipment or video, and they still came to the laboratory to continue their biofeedback training and debrief their races. Step 5 in this study was similar to Blumenstein and colleagues' Realization step due to the natural progression within the athletes' competitive season from relatively low-pressure local competitions to high-pressure national and international competitions. In this way, one of the principles of the 5-Step Approach, namely that it should "guide the athlete through situations with a gradual increase in difficulty or complexity" (p. 449), was upheld.

Data Analysis

For the purpose of this study, the quantitative biofeedback data were not formally analyzed to determine the degree of change in each athlete's psychophysiological and emotional self-regulatory ability. The primary aim of the biofeedback training was simply to raise the athletes' awareness of their psychophysiological and emotional responses, and, later, to help them learn to regulate those responses in the lab, at practice, and in competition. However, as mentioned, all of the athletes' interviews were transcribed verbatim and analyzed via thematic analysis (Braun & Clarke, 2006) using the NVivo9 software (QSR International, 2010). According to Braun and Clarke (2006), thematic analysis is "a method for identifying, analyzing and reporting patterns (themes) within data" (p. 79), and they provide six steps for analysis:

familiarization with the data, generation of initial codes, the search for themes, the review of themes, the definition and naming of themes, and the production of the report.

Familiarization with the data began with the transcription of the interviews and multiple, "active" (Braun & Clarke, 2006, p. 87) readings of the transcripts to gain a sense of what was happening in the data, including initial meanings and patterns related to the athletes' perceptions of and experiences with the PST-Biofeedback program, their opinions regarding changes to their self-regulatory abilities and performance, and which aspects of the program they found most helpful. The transcripts were read deductively and inductively; that is, both the research questions and prior research on PST and biofeedback training programs informed the analysis as well as the athletes' accounts of their experiences. Pope, Ziebland, and Mays (2000) suggested that combined inductive-deductive analysis is useful for applied qualitative research, which fits this study's methodological approach. However, in this study there was also an emphasis on latent themes that did not necessarily fit pre-existing research or the research questions. For example, all five athletes' final interviews produced content related to their current training, competitions, and/or coaching situations, but this content did not always align with either the research questions or previous PST/biofeedback literature. Finally, any initial impressions and notes about the data were recorded as notes in the NVivo program to serve as part of the audit trail for the analysis. The second step involved generating initial codes from the data based on the research questions and the notes made during the data familiarization stage. During this step, coding involved "*organising* your data into meaningful groups" (p. 88), a process that was guided by the data (i.e., inductive) and by previous research (i.e., deductive). Once the data set was collated into initial codes, the next stage involved searching for themes. Here the analytic focus became broader, rising from the level of codes to the level of themes (Braun & Clarke,

2006). Each code was considered in terms of what theme it might fit under. Hierarchical visual representations on the NVivo screen were used to help clarify the relationship between codes and themes and between themes and subthemes. The next phase began when an initial list of themes had been created and involved the refinement of those themes. The themes were reviewed and checked against data extracts to ensure that they accurately represented the data. This step involved two levels of refinement: checking the coherence of the themes against the individual coded data extracts, and checking the coherence of the themes against the data set. At this stage, the data set was re-read to check for coherency and code any missed data that were relevant to the emerging themes. Finally, a thematic map was created for each athlete to give a visual representation of the major themes and subthemes in his or her interview. The thematic maps were created to provide the researcher with another method of conceptualizing the information in the athletes' final interviews, and they were composed of lines and circles indicating the levels of themes and subthemes within each athlete's final interview. The second last phase involved defining and naming the themes; it began when the thematic maps from the previous phase were considered coherent with the data set. This stage required that a name and definition be created for each theme so that the essence of what each theme was (and was not) was clear (Braun & Clarke, 2006). For example, the theme "arousal control" was defined as all codes and subthemes pertaining to the athletes' experiences with and perceptions of the biofeedback training component of their PST-Biofeedback programs and their ability (or lack thereof) to apply the biofeedback training to control their arousal in practice and competition. Table 3 provides a coding example (i.e., the theme, subthemes, codes, and data extracts) for the theme "arousal control". The last stage involved the creation of the written report, which consisted of the selection of quotes to illustrate each theme and the relation of the quotes and themes to the

research questions and literature. Importantly, Braun and Clarke (2006) state that the written report “needs to go *beyond* description of the data, and make an *argument* in relation to your research question” (p. 93). In other words, it is not enough to summarize and describe the findings; one must provide an in-depth analysis of their meaning and implications.

Chapter Four: Results

The results of this study are divided into the following two sections: (a) an overview of the PST-Biofeedback program as a whole and a description of each athlete's specific program, including how it helped him or her learn to self-regulate psychologically, emotionally, and physiologically and (b) the athletes' experiences with and perspectives on the PST-Biofeedback program. Please note that each athlete has been given a pseudonym.

The PST-Biofeedback Training Program

Initial interviews. As mentioned, the consultant conducted an initial interview with each of the five participants between the end of May and the beginning of July 2011. The two primary purposes of the initial interviews were to discuss the athletes' recent best and less-than-best races, including why they felt the races went well or poorly, and, based on that discussion, to explore what the athletes felt they needed to work on from a psychological standpoint to be better prepared for the current season.

During her discussion with each athlete about recent best and less-than-best races, the consultant asked each athlete to determine what he or she had done (or not done) to produce successful versus sub-optimal races. Collectively, the athletes felt they created their best races when they did the following: focused on what they needed to do instead of becoming distracted by competitors or external events; felt confident instead of worried about the race; thought less instead of overanalyzing the race; used simple, technical cues words; and maintained a consistent pace by using competitors to motivate them to keep pushing during the race. For example, one athlete said that she felt she ran well in her best race because she was "really focused; I wasn't worried about anything. I was very confident going in" (Amanda). Another athlete said he raced his best when he thought less instead of more: "I think sometimes you just have to think *less*,

because if you're thinking too much then it just throws everything off" (Chris). Finally, Leah had used cue words like "drive" and "execute" to create and maintain speed during her best races.

In contrast, the athletes identified a number of factors and behaviours that contributed to their less-than-best races: making technical changes to their races right before a competition, going out too fast or letting competitors control their race strategies, feeling too nervous, being distracted by their competitors, and "shutting down" mentally during the race. For example, one athlete said of a recent suboptimal race, "I felt that I let other people in the race force my run, and I didn't do what I needed to do" (Scott). Similarly, Leah also allowed her competitors to influence her race during her 100m final at the Senior National Championships, "The girl on my right had a really good start, and I was watching her, and then she started to pull away, and then I saw the rest of the field was in front of me and all my technique went out the window".

Based on their discussions with the consultant about what they had done in successful races and in suboptimal races, the athletes each identified what they wanted to work on psychologically to be better prepared for the current season. These factors included (a) "blocking out outside stressors" (e.g., funding, time standards) (Amanda), (b) narrowing or pinpointing their focus on one cue instead trying to think of too many at once, (c) improving their imagery abilities, (d) improving their ability to use technical cues during their races instead of "trying to muscle it down the track" (Chris), (e) focusing on the task at hand during a race instead of becoming distracted by competitors, and (f) learning to "fight through that pain [at the end of the race]" (Dennis). The following section will outline the nature of each athlete's PST-Biofeedback program.

The individualized training programs. Amanda was an 18-year-old sprinter who had just finished her first year of undergraduate studies at the time of her initial interview. Her PST-

Biofeedback program lasted from May to November 2011, was composed of 10 sessions (3 with biofeedback), and she raced in a total of six competitions during that time. Four of Amanda's sessions were at the lab, three were on-site at competitions, and three were conducted via email or Skype. Amanda indicated in her initial interview that she wanted to work on focus and blocking out outside stressors such as concerns regarding funding and making time standards. Furthermore, she confided that she was dissatisfied with her current coaching and training situation and wanted to learn to be more assertive with her coaches when she felt there was a problem. Therefore, one of the key components of Amanda's PST-Biofeedback program was helping her discover which cues she wanted to use during training and competition in the 100mH and then training to focus only on those cues. Furthermore, the consultant had several discussions with Amanda about her coaching situation and her decision-making process regarding seeking out a new coach and training group. Due to her relative youth and inexperience, the consultant frequently assisted Amanda during her competitions while she learned to manage her focus and arousal level.

In terms of psychological regulation, Amanda developed a better ability to focus on specific cues to help her train and compete more effectively. For example, Amanda indicated during her final interview that she was consciously choosing to focus on only one cue at a time during her training runs and communicated as much to her coaches:

> Because a lot of stuff was happening last year, my mind was going crazy. I find this [program] really focused it, and I can use these skills now at practice when all the coaches are telling me what to do. I told [coach], "I'm going work on quick steps, and once I get that then I'll work on my arms". So I can channel what I want to be doing during certain runs.

In a similar vein, Amanda also improved her ability to manage her emotions. With the help of the consultant, who corresponded with her via text message on numerous occasions, Amanda was able to manage a number of difficulties at an international competition and, as a result, was able to race to a personal best. Specifically, the consultant reminded Amanda of her focus plan and indicated that race delays and other unforeseeable distractions are a normal part of international competition:

> The day of the competition I couldn't get the right cadence [during my warm-up]. It was freaking me out, but I took a minute, regrouped, and said, "Okay, you need to focus on going into the hurdles quickly". Then the race got delayed for an hour because there was a traffic accident and athletes couldn't get [to the track]. I also wanted to get on the track and do a few warm-up runs, but then they closed the track by the time I got my spikes on, and I was like, "What the hell?!" So I went and did some breathing and thought, "I need to be calm because I need to forget what happened and treat this like a real race even though it doesn't feel like it". Just staying focused on getting out and being aggressive over the hurdles worked, and I set a new personal best.

Similarly, Amanda was able to refocus between races at a competition that took place halfway through her PST-Biofeedback program. With the consultant, who was present at the race, Amanda debriefed her heat from earlier in the day because she was not satisfied with how she had run. Based on the debrief, the consultant prompted Amanda to restate the two key things on which she wanted to focus when running over the hurdles. Amanda replied that she wanted to focus on the cue words, "aggressive, attack" and "quick hands, quick feet" for the final. Not surprisingly, debriefing was a key component of Amanda's program because she wrote more on her debriefing form than any other participant.

Regarding her physiological self-regulation, Amanda showed a good understanding of the benefits of using respiration and sEMG training even though she only had three biofeedback sessions. For example, during the aforementioned brief debriefing session between the 100mH heat and final, the consultant pointed out that Amanda was getting tense and reminded her to breathe and relax her shoulders. Amanda was able to do this quite well. Ultimately, her ability to manage herself physiology helped her think more clearly about her focus cues. A second example occurred prior to and during the Junior National Championships. Specifically, Amanda demonstrated that she was able to get herself into a more appropriate performance state:

> I emailed [my coach] and said, "If I don't run fast at Junior [Nationals], then I'm not going to go to PanAms because there's no point in representing Canada with a bad time". That's the mentality I had going into Juniors, but then I turned it around and was just like, "Okay, you can still do this; you just have to be focused and not freak out about whatever else is going on around you". I knew I was capable of running faster than what I had been doing. I was frustrated, and that's why I feel like this [program] helped because I could use the breathing and the skin conductivity to get into a state where I could race fast and not worry about what's going on around me. I just felt like [the program] helped a lot.

Unfortunately, Amanda's PST-Biofeedback program could not continue past August 2011 because she moved to a new city to work with a new coach. There was a final PST wrap-up session in November 2011 after her move, but it was conducted via Skype and did not have a biofeedback component.

Scott was a 22-year-old sprinter who had just completed his third year of undergraduate studies when he became a participant in this study. His PST-Biofeedback program extended from June to December 2011 and encompassed seven competitions. Scott's PST-Biofeedback program

consisted of 10 PST sessions, 9 of which included biofeedback, and all of his sessions took place in the lab. One of the components of Scott's program was the creation of a clear focus plan for each race, which would help him regulate psychologically during training and competition. As with the other athletes, the consultant started by asking Scott what he felt he needed to work on psychologically, and later sessions focused on fine-tuning the cues he wanted to focus on to run well in his races. At the end of his PST-Biofeedback program, Scott spoke of the importance of focusing on what he had rehearsed in practice and not becoming caught up with his competitors:

> If I let other people get in my head, worry about somebody else, or think about doing different things than I do in practice, I won't run well. It was good last year to be able to try to put everything aside and go run, and I found I got better at it. It's like, "Hey, it's a new day. I'm ready to go, and I'm going to run the best that I can today".

Scott also understood that being psychologically "on" all the time leading up to his race wasted energy and resulted in him not being ready to race when he got to the starting line: "When I have a big meet, I can't be focused on running the whole time [leading up to the meet], because by the time it comes time to race, I'm tired." One aspect of Scott's running on which he felt he needed to work was relaxation. Therefore, a key component of Scott's program was to help him determine the cues he needed to focus on to maintain relaxation before and during his races. For example, the way Scott described his approach to training and racing suggested that he understood the relationship between emotions, physiology, and performance:

> When you're tense, nervous, excited, or too amped up, you don't get anything done as well as if you approached it *relaxed* and calm. That's an approach that's really helped me. Before [this year] I could never sit down [before a race]; I felt like I always had to

> keep moving. Now I feel much more relaxed and am enjoying the moment in practices instead of being too amped.

Another key aspect of Scott's PST-Biofeedback program was debriefing, which helped him to learn from each of his races. For example, Scott indicated during early sessions that he sometimes felt "rushed" in his races and said, "I let other people *force* my run". In June 2011, during his first PST-Biofeedback session after the Senior National Championships, Scott discussed with the consultant how he needed to work on learning how to run well from any lane. At the National Championships he had drawn an outside lane for the final, and because he was not able to see his competitors for much of the race, he waited to see where his competitors were and was then passed in the last 100m. After debriefing that final, Scott and the consultant discussed racing from different lanes, and what he might want to focus on if, for example, he was in lane eight versus lane two.

The biofeedback aspect of Scott's program always involved all five modalities. Initially, Scott seemed to have a good basic awareness of his physiology (e.g., he knew he carried tension in his shoulders), although he needed to work on controlling it (e.g., in early sessions he had some difficulty in bringing his EDA down and accurately controlling his muscle tension in his shoulders). Over the course of the biofeedback training, Scott improved his management of his physiology and emotions. For example, Scott learned to use respiration for recovery before competitions and became quite capable of using it to quickly calm himself down before a race.

> I feel I don't have to sit down [and breathe] for six minutes to calm down. The breathing techniques have really helped me control my arousal level, and my anxiety or arousal is not as high as it would have been in the past. For track I don't have to be amped up and

> gritting my teeth; I have to be more calm and relaxed because then I keep my shoulders down and I let my body do the work.

Scott had a total of eight PST-Biofeedback sessions leading up to the Pan American Games (seven of which included biofeedback). Three of those sessions occurred in close proximity to one another in order to help Scott finalize his mental preparation for the international competition. During the last session prior to the Pan American Games, Scott showed progress in his ability to let go of intruding thoughts. For managing sEMG, Scott used the phrase "shoulders to the ground" to help him decrease his shoulder tension.

Chris was a 26-year-old sprinter who held a bachelor's degree and was training full-time during the study. Over the course of his PST-Biofeedback program, which lasted between June 2011 and March 2012 and totalled seven sessions (all at the lab and all with biofeedback), Chris competed in 10 meets. During his initial interview, the consultant asked Chris what he would have done differently to have a better race in a recent suboptimal 100m. Chris answered that he would "go through [his] checkmarks instead of standing up right away [out of the blocks] and just trying to muscle it down the track". Given Chris' response, and the fact that he said he did not often use visualization to help him prepare for competition, one of the key aspects of Chris' PST-Biofeedback program was to refine his current focus plan and introduce visualization into his training routine to help him regulate psychologically in competition. For example, Chris used visualization at an indoor competition during the latter part of his PST-Biofeedback program to improve the transition phase of his race:

> I used visualization this weekend when I was warming up [for my race], and it was good. I visualized my race from zero to thirty [meters], and then visualized slowly transitioning instead of popping right up. I feel like I executed the different phases in the race, and I

> won the competition. There have been times this year when my transition has failed because I've come up right away, but the transition was very smooth, and once I got up I separated from the rest of the group, and then I maintained [my lead].

Regarding his ability to regulate emotionally, Chris described how he was using the respiration modality of his biofeedback training to help reduce stress and calm down in practice:

> Functionally [I use] the breathing before or in between sets in practice. I can go into the corner and [breathe], and it shows that even under stress, if I just close my eyes or excuse myself from the rest [of my training group] and think about calming down, I'm able to do that. I can come from a point of stress to being calm and peaceful before a run.

Later in his program, the consultant addressed additional areas on which Chris felt he needed to work (e.g., doubts about the benefits of certain aspects of his physical training). More specifically, Chris was not feeling satisfied with his results during the season, but neither he nor his coach could pinpoint the reason for his suboptimal race times. During his second session, in which he and the consultant debriefed his races from the Senior National Championships, Chris told the consultant that he viewed his upcoming races as a way to "showcase" and "redeem" himself from the suboptimal races he had had at Nationals. Notably, he felt that one of the reasons he had underperformed at Nationals was that he had put too much pressure on himself. The consultant pointed out to Chris that he needed to focus on his race instead of simply telling himself not to become distracted by his competitors. Ultimately, while participating in the relay team selection camp for the Senior World Championships, Chris decided that he simply wanted to "go out there and have fun" and not overthink his training or races. His response demonstrates that Chris was beginning to understand how to regulate his emotions in the competitive setting.

Although Chris had fewer biofeedback sessions (n = 7) than all but one of the other athletes, and at one point there were three-and-a-half months between his fifth and sixth sessions due to his travel and competition schedules, he demonstrated a good ability to regulate his physiology in the lab particularly in terms of achieving respiration-HR coherence and regulating his EDA. For example, Chris showed a marked improvement in his respiration-HR coherence and respiration rate during his second biofeedback training session. Specifically, he breathed at less than half the respiration rate he had shown during his first session (and only slightly faster the desired breathing rate), even without the aid of the respiration pacing music. Chris' ability to achieve good respiration-HR coherence continued throughout his program, even though he admitted that he rarely practised his respiration with the music at home. Furthermore, Chris also demonstrated early and continued success in regulating the EDA modality. For example, even while looking at the biofeedback screen (which often produces an EDA response opposite to the desired direction due to the evaluative nature of viewing one's progress), Chris was still able to bring his EDA down (i.e., decrease his arousal level). He was seemingly unaffected by the changing number values or the sound and visual effects associated with the EDA training screen. Given that fluctuations in EDA are associated with emotional reactions to stimuli, Chris' early ability to regulate EDA could suggest that he already had good internal emotional control.

Leah was a 24-year-old sprinter who held a master's degree and was training full-time during the study. Her PST-Biofeedback program lasted from July to September 2011, was comprised of 11 sessions (9 with biofeedback), and encompassed five competitions. All but one of Leah's 11 sessions took place at the lab, the other being conducted via Skype during a training camp overseas. Like Amanda, Leah moved to a new city to train with a different coach; therefore, her PST-Biofeedback program ended earlier than Scott, Chris, and Dennis' programs.

In her initial interview, Leah said she wanted to work on focusing better during her races and adhering to her race focus plan instead of allowing her technique to go "out the window". Therefore, the main emphasis of Leah's program was placed on helping her develop her psychological self-regulatory ability through simple, effective race focus cues and practising them daily in training. The consultant explained to Leah that focus is active; it must be cultivated. Therefore, the consultant helped her develop a simple routine to use in training: solidify in her mind what she wanted to focus on, visualize it, breathe, and then do the run without any further analysis.

Given that Leah had often been told that she overanalyzed her running, an example of her progressing ability to regulate psychologically can be seen in the following excerpt. In it Leah describes how she focused her attention on one particular cue/feeling during the final selection process for the relay team for the Senior World Championships:

> When we were at the final World Championships [selection camp], we were doing passes on the warm-up track, and the Americans [and] Jamaicans were all doing their own relay stuff. At first I suppose I was getting distracted watching them. I remember the consultant had said, "Focus on one thing", so that day I was focusing just on how my ground contact felt when I was slowing down, when I was taking off, and when I was setting up. That was what I was thinking of for every run and nothing else. No arms, no "My teammate's a bit too far back", just my ground contact and nothing else.

However, Leah was not always successful in pinpointing her focus on one specific technical cue during her training runs:

> Sometimes, even though I was telling myself, "Okay, focus on this", the second I took off everything just went to crap, and I was thinking about all these other things too. But occasionally it did work, and I saw some benefit from it.

Although emotional regulation was not as much a part of Leah's PST-Biofeedback program as psychological regulation, she did demonstrate an ability to better regulate her emotional reactions to events during the program. For example, during her fifth session, Leah was debriefing a recent race and indicated that she had rectified an emotional mistake that she had made during the Senior National Championships earlier in the season. In particular, Leah did not allow herself to get upset, as she had at the Nationals, when she came up out of a bad start and saw that several competitors were ahead of her. Although her time in the most recent race was not what she had hoped it would be, Leah said, "I went through all the steps we talked about: the three race phases and the breathing before [the race]".

Furthermore, during her sixth session, and with the help of the consultant, Leah was able to calm her anxiety and focus on the positives just prior to an important international competition. Specifically, Leah corresponded with the consultant while at the final team selection training camp for the Senior World Championships. Due to her increasing level of anxiety about the impending team selection, the consultant helped Leah refocus on herself.

Later in her program, during her ninth session, Leah made the connection between biofeedback training in the lab and managing her emotions in competition. In particular, Leah noticed in the lab that her peripheral temperature was more difficult to regulate when she observed and judged her results on the computer screen instead of doing the task with her eyes closed. She compared that phenomenon in the lab to her experience in competition: "It's just like

on the track at Worlds when I saw other athletes and was comparing myself to them. It's the same as this [temperature modality]."

Similar to the other athletes, Leah's biofeedback program involved all five modalities. In terms of physiological regulation in competition, Leah did not speak about the benefits of biofeedback training as much as the benefits of discussing focus. However, her physiological regulation in the lab setting did show improvements throughout her program. For example, Leah said early in her program that she found sEMG the hardest modality to manage. She could tell, based on seeing video of herself racing, that she held tension in her shoulders, but she could not feel it. However, her ability to lower her shoulder tension in the lab improved in later sessions.

Leah also demonstrated an ability to breathe at a relaxed rate for recovery by her fifth session, and by her eleventh and last session, she was able to breathe at the desired rate without the music. Furthermore, she said that her breathing "was just automatic, and [she] wasn't losing [her] breath like [she] normally [does]". In terms of regulating the EDA modality, Leah noticed during her fifth session that she was more able to manage EDA when her eyes were closed; in contrast, her EDA was highly variable when she was viewing the screen and could see her progress. In response, the consultant pointed out that the improvement in Leah's EDA management once her eyes were closed indicated that the goal of trying to lower it produced an emotional response (i.e., she judged her progress). Finally, Leah showed during her last session that she was learning to refocus on the correct physiological cues (i.e., her respiration) when she became distracted while trying to raise her peripheral body temperature. Note that this enabled her to raise her peripheral body temperature without the help of the music for the first time:

> I kept on counting [my breaths]. I think when my temperature came down the first time I lost count, and I was probably looking at [the screen], but I just went back to counting and didn't look at the numbers.

Another aspect that was addressed within Leah's program was her dissatisfaction with her physical training last season and how she felt that had affected her results in the current season. The consultant helped Leah explore ways to communicate with her coach about her concerns, and they also discussed the possibility of Leah moving to a new city to train with a different coach, which she ultimately decided to do. Although Leah's PST-Biofeedback program ended in September of 2011, she continued to have intermittent contact with the consultant via Skype and email. This correspondence continued through the Olympic Trials in June 2012, in which Leah set a new personal record and qualified for her first Olympic Team. Shortly after her successful qualification at the Olympic Trials, Leah wrote to the consultant, "I owe a lot to you; I was thinking of your words before the final". This was a clear affirmation of the benefit of the program for Leah because she had successfully applied what she had learned during her PST-Biofeedback program to help her perform well during a crucial race. In the following weeks, and during the 2012 London Olympic Games, Leah continued to correspond with the consultant to solidify what she had learned.

Finally, Dennis was a 33-year-old para-athletics middle-distance runner who was enrolled in a Master's program throughout the study. Dennis' PST-Biofeedback program spanned from July 2011 to April 2012, was composed of 13 sessions (i.e., 6 PST-Biofeedback sessions and 7 respiration-only biofeedback sessions), and encompassed four of Dennis' competitions. Seven of Dennis' sessions were done at the lab, but five of the respiration-only sessions were conducted by the researcher at Dennis' home to provide a more familiar and

comfortable setting. After Dennis' discussion with the consultant, during his initial interview, about his recent best and suboptimal races, Dennis specified that he wanted to work on not getting distracted or "shutting down" during his 1500m races. In a similar vein, Dennis wanted to learn to "fight through" the inevitable pain he felt at the end of the 1500m. Accordingly, the emphasis of Dennis' PST program was to build on his previous successful races and devise a simple focus plan to help him regulate psychologically during races and maintain an acceptable pace. Furthermore, a plan was created to help Dennis focus on something more task-oriented than the physical pain of the race.

Psychologically, Dennis' was better at regulating his focus during races when he followed the plans he had made with the consultant. For example, Dennis ran a very successful 800m race during the study by following his focus plan despite distractions:

> For my best 800m this season, the race plan was to go out strong and aggressive for the first 200m, relax and maintain that speed for 400 meters, and then bring it home for the last 200m. It was windy; the wind reading was +4.4 seconds, and there was no other male close to my time, so I was running alone with my guide. There were definite distractions, but I was so focused on following that race plan that it turned out be a personal best time.

However, Dennis was not always able to follow his plan. Indeed, he realized partway through his race at the Senior National Championships that he was not running the intended pace, which resulted in negative thoughts:

> At Nationals, it was the exact same situation [as my best 800m race], but I was really nervous, the wind was actually stronger than +4.4 seconds, and there was no one close to my time again; all the guys were faster than me because it was an able-bodied race. The wind was distracting, I was a lot more nervous, and I wasn't under control. We had the

> race plan of going out in 84 seconds and maintaining [that pace], then trying to pick that up. We executed the first lap, and then the wind became too much; I felt the wind, my legs felt like rubber, the guys were pulling away from me, and when we came around for the second lap we were off the race plan. My guide even said he felt like there was a moment where I said, "This isn't worth it".

Dennis was also experiencing several health issues throughout the program (e.g., illness and injury), so the PST and biofeedback components of his program were also aimed at helping him recover more effectively on all levels (i.e., physiologically, psychologically, and emotionally) between training sessions and competitions. For example, because of the high level of stress in Dennis' life during the program, and the resulting recurrence of illness, the consultant decided after his third session to provide him with several biofeedback sessions devoted entirely to the respiration modality, which would facilitate psychological, emotional, and physiological recovery (i.e., focusing on the breath, letting go of intruding thoughts and troublesome emotions, and increasing respiration-HR coherence). This is because the respiration modality is tangible, easily controlled, and linked closely to the regulation of the other modalities (Lehrer & Vaschillo, 2008; Lehrer, Vaschillo, & Vaschillo, 2000). Of the five athletes, Dennis had the most room for improvement in the respiration modality, and his biofeedback program was modified to match that need (i.e., seven respiration-only sessions to help him bring his physiological systems into recovery through breathing at six breaths per minute, which is the respiration rate at which the greatest HRV is typically achieved).

By his fourth session, Dennis indicated that he was using respiration to help him fall back asleep when he woke up during the night. Although he indicated in his sixth session that he sometimes became annoyed when practising his breathing outside the lab, he also said that he

was using it in class and in everyday situations. During his ninth session, which included all five modalities, Dennis' respiration-HR coherence was still fairly low, but his breathing pattern and rate were improving. Encouragingly, Dennis indicated during his eleventh and twelfth sessions that the breathing was becoming more automatic and said, "I find the [pacing] music very calming now". Finally, Dennis' respiration-HR coherence, peripheral temperature regulation, and EDA regulation were best during his last session with the consultant. Specifically, Dennis was able to raise his peripheral body temperature and lower his EDA without the aid of the respiration pacing music, which he had most often required during previous sessions.

Specifically in terms of emotional regulation and recovery, another key component of Dennis' PST-Biofeedback program was debriefing. In particular, Dennis found that debriefing his races with the consultant helped him begin to let go of unsuccessful races and identify the positive aspects of his races. Such changes suggest that he was beginning to improve his emotional regulation:

> When I was running with an injury, not in the best health, and not sleeping, I was not going to perform my best. I would be quite down after my races, so to sit and debrief them, pull out the positives, and realize that, considering the circumstances, it wasn't that bad was good. I'm able to pull out some positives, which I wasn't doing before. Debriefing probably helped me let go [of bad races] more than before.

The biofeedback training also began to help Dennis learn to calm himself down, not only in sport but in his life in general. Specifically, Dennis said that the program helped him learn to "relax my body and my personal life" and, from a physiological and emotional perspective, it had helped him "control my heart rate and my nerves".

Similar to Amanda and Leah, Dennis also struggled with his coaching situation; therefore, part of several PST sessions was devoted to working through Dennis' thoughts about his coach, his athletic career, and possibilities for the future. Given that Dennis was visually impaired, a unique feature of his training and competitions was his working relationship with his guide. In this relationship, too, there were challenges; therefore, the consultant spent time helping Dennis navigate those setbacks (e.g., making sure that both he and his guide were in agreement about the focus plan for each race).

In summary, the PST and biofeedback sessions with the athletes varied in number, due mostly to the athletes' availability; however, for some athletes, additional sessions were deemed necessary to fulfill certain needs (e.g., recovery through respiration or preparation for an upcoming major competition). While the PST portion was individualized to meet each of the athlete's needs, there were similarities in that all five athletes needed to work on the skill of focus and most sessions were guided by a debrief of a previous competition. Three of the five athletes faced coaching problems, and, for two of those athletes, the solution was to move to new locations to train with different coaches. For the most part, the biofeedback sessions were run similarly, given that each athlete needed to learn how to improve his or her psychological, emotional, and physiological arousal. In the next section, themes from the athletes' final interviews are presented with supporting quotes to give an in-depth account of their experiences with and perceptions of the PST-Biofeedback program.

From Skepticism to Openness: The Athletes' Overall Perceptions of the Program

At the beginning of each athlete's final interview, he or she was asked about his or her overall impressions of the PST-Biofeedback program in order to answer this study's first research question: "How did the athletes experience the psychological skills and biofeedback

training program?" All five of the athletes found the majority of the program components helpful, interesting, and relevant to their training and performance contexts. For example, two of the five athletes felt that having someone outside their performance context with whom they could talk was beneficial (i.e., debriefing their races with the consultant or discussing their training and coaching contexts with her). Amanda said, "I liked having someone to talk to outside of all this mess". Similarly, Chris indicated that "a big thing was being able to come in, and [the consultant] was just friendly enough to ask about how training was going and how I was feeling about it. Sometimes coaches don't really talk to you, and so it's good to talk to somebody about practice." The other athletes felt the PST-Biofeedback program was helpful and, while they had some suggestions for improvement, said they would recommend it to other athletes:

> I was glad to be part of it and found it very interesting. I loved getting hooked up to [the biofeedback equipment] and seeing what I could and couldn't control in my body. I found it helpful to learn how to calm myself down because I'm a person who gets very stressed out. The only thing I would change is to have the meetings more consistently, but I know I was hard to meet with sometimes. I think [the program] is a valuable learning piece for athletes trying to achieve high levels. (Dennis)

Despite some initial uncertainty about what the program would entail, Scott felt that the program benefited him early on:

> I really liked [the program]. At the beginning I was a little bit unsure of what was going to happen, but I really thought that it was done well, and it was really good for me personally towards my track. I remember that I went to Florida [at the beginning of the program] and raced, and then I came back and was like, "It's working! I ran so fast!"

Like Scott, Chris experienced initial skepticism towards the program; however, Chris' opinions towards mental training at the outset of the program were much less positive than Scott's. Nevertheless, Chris' opinion of the program, and of mental training in general, improved by the end of the study:

> Honestly, I was kind of skeptical coming in because [the consultant] is similar to a psychologist, and when you think about a psychologist, you think that something is maybe wrong with the person who is going to see a psychologist. I also did not want to do [the program] when you came [to the group meeting] and said 'intervention'. I thought interventions were for people who had problems. However, [the consultant] was good, and it opened up my mind to knowing that going to see a sport psychology consultant doesn't mean that there's something wrong with you; it can open up different avenues for you in terms of your training and performances. So I thought it was a good experience, and I would recommend it for people if they are up to it. (Chris)

Similarly, Leah's opinion of mental training was not very positive before the program, but her view changed markedly by the end, to the point that she regretted not being able to continue regular sessions with the consultant after moving to a new city:

> When I started out I told [the consultant] that my idea of psychological training was sitting down on a Freudian couch with someone telling you to believe in yourself, but [the consultant] really showed that there's a science to it in terms of the techniques of clearing your mind and how that can help your recovery and focus. I definitely saw some results; it's just too bad I moved away because I would have liked to continue.

Unlike the three aforementioned athletes, Dennis and Amanda seemed to be open to the program from the beginning. For example, Amanda confided in the consultant early on about her

dissatisfaction with her coaching and training situation, and she felt the program helped her focus in life and at practice: "A lot of stuff was happening last year that had my mind going crazy. I find this [program] really focused it, and I can use those [focusing] skills now at practice."

The Athletes' Experiences with the PST-Biofeedback Program

During their final interviews, each athlete was asked to comment on his or her experience with the specific elements of the program: understanding focus, creating and using cues within race focus plans, debriefing, and arousal control through biofeedback training. These questions were designed to answer the research question, "Did the athletes perceive a change in their ability to effectively self-regulate after the season-long psychological skills and biofeedback training program was completed, and what were their perceptions of the program's influence on their performance?"

Developing focus through creating plans for races: "You have to have a plan". All five athletes found the discussions on the skill of focus and the development of focus plans for their races to be a helpful tool. The key perceptions of the athletes regarding the focus plans was that the program helped them achieve the following: make the concept of focus more concrete, focus on what *they* needed to do (i.e., one or two relevant cues) while blocking out distractions, help prevent the mind from wandering, know what to do in different race situations, and learn that focus is an active process (i.e., it does not just "happen"). Amanda said, "I find I'm not focusing on the competition as much as I used to. I'm focusing on me and what I have to do." Similarly, Scott indicated that, "I've been good at focusing [before the program], but now I feel that I'm doing better at focusing on the right things at the right times." Chris acknowledged the importance of creating a focus plan early in the season and sticking to that plan regardless of what happens in the race:

> It's always good to have a plan, and coming to see [the consultant] actually made me sit down and think about it. You can't just go into the race and say, "I'm just going to run"; you have to have a plan and stay focused on it and not panic when something happens in a race. Right from the beginning of fall season you have to have a plan.

Leah pinpointed the fact that focus needs to be actively created:

> [The consultant] was telling me that I have to focus on one thing to clear my head. Just saying, "Clear my head" and doing nothing isn't going to clear my head. When I say, "Focus", I have to do something to focus; it doesn't just happen. That was one thing I took away from the meetings, and I also use that in my training.

Dennis also felt that he learned from using the focus plans, that his best races had been when he had created and successfully executed a focus plan, and he said he now went into every race with a plan since he had learned how to create them more precisely: "I definitely learned from creating plans, and it's something I do all the time now; I go into every race with a plan."

Debriefing for learning and emotional recovery. All five of the athletes stated that the skill of debriefing was helpful as a learning tool. They felt it enabled them to analyze their races by reflecting after a competition, discover what they did and did not do well, and make plans for the next competition. For example, Amanda said, "I felt the reflection was good because it focused on what I was feeling before the race, during the race, and what I can do better for the next one. I was actively analyzing what went down".

Scott indicated that he had previously reflected on his games in hockey and continued to use his training journal to learn from his track races. Furthermore, he felt that the consultant had refined his ability to use debriefing as a learning tool:

> I did reflection when I played hockey. I said what was good and what was bad, but people can guide you toward the right ways to reflect, which [the consultant] was able to do. I can say, "That was good, but this is bad!", but I still didn't write *how* the first thing was good or *why* I'm going to be able to change something. Now I write what I'm going to do at races in my journal, and then I write how they went.

Furthermore, several athletes recognized the importance of focusing on the positives and not simply talking about the negative aspects of their races without determining what could be done differently for the next race. Specifically, Scott indicated that "there are some negative things in my races, but those are the things I would write down to learn from". Although Chris felt that identifying the positive parts of his races was most important, he recognized the need to address suboptimal aspects as well:

> It's not that you overlook the cons, you have to look at your race and see what you did not do, but it should not overshadow the positive. If there are a lot of cons in the race you definitely have to fix that, but you should focus on the positives first."

In addition to pulling the positives from his races through debriefing, Dennis acknowledged that debriefing had helped him begin to recover emotionally and psychologically from his suboptimal races, which were particularly hard to deal with given that the study occurred during the lead-up to the London Olympic and Paralympic Games:

> This was an Olympic year, and I'm very hard on myself, so when I had a bad race there were more severe consequences than any other year. So to sit and debrief them and realize that, considering the circumstances, it wasn't that bad and pulling out the positives was good.

Finally, it was interesting to hear that Chris felt the coaches should debrief with their athletes more often: “I feel like even coaches need to debrief with their athletes. I find it disappointing when coaches don’t”.

Arousal control. Overall, all five athletes became more aware of the interrelationship between their physiological state, their cognitive processes, and their performance in training and competition; furthermore, each of the athletes became more skilled at managing at least one physiological system (i.e., modality) within the lab setting. In addition, all of the athletes described how they were able to transfer their physiological self-awareness and self-regulatory ability from the lab to training and/or competition.

Amanda indicated that the respiration training helped her relax when she was “freaking out”, but she also used it to energize her for her training runs when she was feeling sluggish:

> I found the breathing helps me relax if something is freaking me out. I just try to calm down and think about what needs to be done. I also [breathe in my chest] before some runs to get a bit of energy.

Scott felt that he was more relaxed, both in general and in track, as a result of the biofeedback training, and in particular the respiration training. In addition, he grew more capable of regulating his arousal levels:

> I just feel that I’ve become more relaxed and am just letting myself run. I do the breathing through the week before the race to help me recover, and I can just stay calm and do what I’m going to do. I definitely have to keep staying with the breathing.

Although Chris did not practice his breathing very much outside the lab, he was able to control his heart rate and respiration very well during his sessions, and he also applied the breathing training to his practices to recover faster between sets:

> Even though I didn't [practice] it a hundred percent, I felt the breathing was great and it definitely did help me. It's something that you can definitely use for training; it's not something that you have to be a rocket scientist to grasp.

Chris was aware that he carried shoulder tension while running prior to starting the training, yet he described how the sEMG was very relevant to the 100m sprint:

> I definitely know I have tension built up. It's not a good trait; you have to be relaxed, because with relaxation comes speed. It's about how well you respond to someone coming up on you in a competition. Do you get your shoulders up and start running? Or do you get your shoulders down and trust that if you relax you won't have to worry about that person? We worked on it a little bit [in the lab]. Outside of [the lab] I really didn't work on it much, but I guess I tried to bring down the tension in my shoulders.

Interestingly, although Chris said that he was aware of the importance of relaxation for speed prior to the program, he admitted that he did not have a complete understanding of the theory behind biofeedback training:

> I thought [the biofeedback] was cool. [The consultant] was talking to me about what each [modality] represents, but I guess I didn't grasp it a hundred percent. It's just not my field, but I thought it was good to know that it's a good skill to help with your recovery.

Leah, like all the other athletes, found the breathing training useful to help her recover, and she used it to help her fall asleep while napping between work and training.

> I definitely saw some results, especially with the breathing. I still do it now. I work in the early mornings, and when I take a nap before training I use that breathing to do recovery, which sends me to sleep really quickly.

The respiration modality was Leah's way of working on the other modalities in addition to helping her focus: "The breathing is something tangible you do to relax or to focus. I think the temperature [modality] went hand-in-hand with breathing; if I could get my breathing right, my temperature went up". However, Leah found some modalities easier to transfer than others:

> The breathing and the skin conductance were the most helpful. I don't really remember the other three, to be honest. I know the jaw [sEMG] was useful, but relative to the others, I think it was the least useful for me. I haven't been able to work on that outside the lab environment.

Finally, Dennis also found the respiration training very helpful to facilitate relaxation, slow his heart rate, and fall asleep, and he also used it to prevent himself from wasting energy by overthinking his races too far in advance of the competition:

> The main thing was learning the breathing. I found the breathing music very helpful. I sometimes have problems falling asleep or not being able to get back to sleep, so putting on the breathing music and thinking of relaxing my face, shoulders, and whole body helped. I have also used it if I've been feeling wound up before a performance and the race isn't until the evening. I've done the breathing during the day and it's calmed me.

Regarding the other biofeedback modalities, Dennis felt that the sEMG had enabled him to become more aware of his shoulder tension during runs and before competition. However, he indicated that he had not applied the temperature modality outside the lab; furthermore, skin conductance was a modality that Dennis struggled to control both in and out of the lab setting:

> I found that learning to relax my muscles could be helpful. Even before races just shaking my arms out and knowing that feeling that my muscles are relaxed versus tense. I notice on runs now that I'm more aware of when my shoulders are tensing up, and I'll take the

> time just to shake my arms out. I've never put temperature to use I don't think, and I feel I have little or no control over skin conductance. I know I have a fear-based sweat response, but I don't feel that really changed as a result of [the program]. I think I found it tough to control even in the lab.

"The program could only help". As mentioned, the ultimate objective of the PST-Biofeedback program was to facilitate the athletes' ability to self-regulate psychologically, emotionally, and physiologically so that they were able to perform more consistently in training and competition. Though all of the athletes found the program helpful to varying degrees, not every athlete could say that it influenced his or her performance on a consistent basis.

One athlete who did feel it helped her performances was Amanda. Despite the fact that she experienced several frustrations and suboptimal races during the course of the PST-Biofeedback program, the consultant helped her decide to continue racing until the end of the season. At the Junior Pan American Games, which were at the end of Amanda's season, she set a new personal record despite some setbacks leading up to the race (e.g., race delays, a suboptimal warm-up, feeling intimidated by her competitors). In response to the aforementioned distractions, Amanda said, "I just went off and did some breathing to calm down. Then I set a personal best, and it was one of the best races of my season".

For Scott, Chris, Leah, and Dennis, the program was beneficial from a learning perspective, but some of their race results during the program were not as good as they had hoped, often because of physical and technical training issues. For example, Scott felt that certain aspects of his winter training (e.g., running on a high speed treadmill), which took place prior to the study, had a negative influence on his performance results during the summer: "We ran on the treadmill last winter, and I found that it didn't help. I wasn't confident in my running;

I wasn't able to execute technique-wise." Similarly, Leah also felt that her physical training had a significant influence on her suboptimal races; however, as mentioned, she felt that the PST-Biofeedback program helped her in other ways:

> Unfortunately, the season was already going downwards when we brought [the consultant] on board, so the program could only help. My physical training had more of an effect, and I think my confidence level was the biggest factor. I base my confidence on my training, and I hadn't seen the right results building into the competition phase; deep down I knew my preparedness level could have been better.

Scott did see positive changes to his running as the study progressed, but he felt they were due to many factors, not simply his involvement in the PST-Biofeedback program:

> I definitely think that these techniques and meetings with [the consultant] have been one of the main aspects of how I've changed, but it's tough to pick direct aspects that caused the changes. I also think I've been maturing as an athlete and learning, through my mistakes, about what not to focus on. My family and coach have also played a part.

As mentioned, despite being frustrated with her race results during the study, Leah successfully qualified for the 2012 Olympic Team six months after her final interview; she accomplished this in part by applying what she had learned in her sessions with the consultant to her race at the Olympic Trials. Although Chris felt that the program had not changed the way he refocused in competition, it did help his performances during the indoor season later in the study. Specifically, he was able to use debriefing to create a focus plan for his races that he used in conjunction with visualization to improve a technical aspect of his race. This change enabled him to run several fast indoor races.

> Visualization and debriefing were two key things. During the indoor season I was seeing [the consultant] more often, and I ran my fastest time in the last three years. Seeing her helped me in terms of having somebody to help me visualize. I even tried visualizing the different race phases this weekend. The transition was very smooth, and I won the competition.

For Dennis as well, the program influenced his performances more in the latter part of the study, during his indoor season. In particular, Dennis felt that factors he experienced during his outdoor season (e.g., overall fatigue and an injury) had mitigated the influence of the program earlier on. However, Dennis felt the program would have had more of an impact on his race results if he had not experienced such extreme fatigue and a persistent injury during the study.

> I had a lot of mitigating circumstances during my outdoor season that made it hard to assess if the biofeedback was helping me in the performance context, but I think it's helped me learn to relax my body and personal life. The program did help me come into my indoor season strong, and then I hit a lull. In saying that, I've run quite a few good races lately, and definitely some of the stuff I learned, such as the breathing and the race plan, goes into play. I'm running with a different guide and we debrief after every race.

Breathing, Focus Plans, and Other Favourite Program Components

Each athlete was asked to comment on the study's third research question during his or her final interview: "Which elements of the program did the athletes find to be most effective?" Although each athlete had unique reasons for preferring one aspect of the PST-Biofeedback program over another, there were certain commonalities. Specifically, all five athletes found the respiration training to be one of the most helpful aspects of the program. As mentioned, the respiration training enabled the athletes to more effectively regulate their arousal levels, for

instance by knowing how to recover between sets in practice, helping them fall asleep for a nap before training, or calm down when stressed. For example, Scott said, "I loved the biofeedback; that's what makes me be able to shut it down and bring it back to neutral."

Amanda, Scott, and Dennis deemed using focus plans for their races one of their favourite parts of the program. For Amanda, the focus plans were useful "to get everything organized", and to help her "focus on one thing at a time". Dennis felt that "my best races have been when I've executed a race plan", and Scott said, "I liked creating a plan; we created a plan for everything. Those things have started to become more second-nature". Chris and Amanda both indicated that having the consultant to talk to was particularly helpful to them. As mentioned, Amanda felt that the consultant was "outside of all this mess", as opposed to other key people, such as her coach. Similarly, Chris felt that "it's good to talk to somebody about certain things you may like and certain things you may not like in practice". Previous literature in counselling supports this finding. Notably, the quality of the relationship between the consultant and the client (i.e., the athlete) is essential in determining intervention success (Corey, 2009; Ivey, Ivey, & Zalaquett, 2010). Debriefing was identified by Chris and Dennis as another helpful aspect of the program. Chris stated that, "You definitely have to have that self-awareness of the different races that you compete in. I feel debriefing is very good for identifying what went wrong or what you did well". Dennis said that "I was somewhat distracted during my outdoor season, but I definitely found the debriefing helpful".

Leah also felt that the focusing concept called "Big Circle, Little Circle" that the consultant introduced to her during her first session was a helpful tool:

> [The consultant] had that little Venn diagram, the Big Circle being things that are out of your control and in the Small Circle are things that are inside your control, things that

you can work on. So really it's being able to compartmentalize everything and how to do that. First of all, the consultant made it clear that I need to focus on certain things at certain times, and then how to focus on those things.

Finally, Chris regarded visualization as one of the most helpful parts of the program. He was one of three athletes who were asked by the consultant to use visualization in conjunction with the other aspects of the program to help them race more consistently. Regarding visualization as a tool for training, Chris said, "Visualization and debriefing are definitely two key things that I feel have helped. I was never one to really do visualization, but after doing it with [the consultant] it was good". As mentioned, Chris successfully used visualization to help him improve the transition phase of his race in competition.

At the end of their final interviews, all the athletes were asked what aspects of the PST-Biofeedback program they felt they needed to continue to work on in order for them to race and train well consistently. Not surprisingly, all of the athletes again identified the respiration training as a key technique they wanted to continue using. In addition to the respiration modality, at least one athlete identified each of the following techniques for future use: creating and using focus plans, debriefing races to perfect those plans, and visualizing.

Chapter Five: Discussion

The purpose of this study was to explore the experiences of five track athletes during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally. The specific research questions under investigation were as follows: (a) How did the athletes experience the psychological skills and biofeedback training program? (b) Did the athletes perceive a change in their ability to effectively self-regulate after the season-long psychological skills and biofeedback training program was completed, and what were their perceptions of the program's influence on their performance? (c) Which elements of the program did the athletes find to be most effective?

Overall, the results indicated that the athletes (a) found the program to be helpful, interesting, and relevant to their training and competitive contexts (and the two athletes whose views of mental training were negative at the outset changed their opinions by the end of the program), (b) developed a better understanding of and ability to use effective focus plans for their races, (c) were better able to debrief after their races in order to learn from successes and mistakes, and (d) were more capable of regulating their physiology in the lab and, to varying degrees, in training and competition, than at the beginning of the program. The following sections will discuss this study's results in light of these research questions and the extant literature in sport psychology and biofeedback. Specifically, the following topics will be addressed: how this study's results support and expand on existing research in applied PST programs and biofeedback training, the implications of the results for applied practice, this study's limitations, and suggestions for future research.

One of the key findings of this study was that all five athletes who participated found creating and implementing focus plans to be useful because it helped them (a) make focus more

concrete; (b) focus on themselves and the task, which enabled them to block out distractions more effectively; (c) plan for different race situations (e.g., how to respond when a competitor is challenging one's lead); and (d) understand that focus must be actively created and regularly monitored (i.e., it does not just "happen"). Therefore, the importance of focus for consistent performance, which has been demonstrated in many previous studies (e.g., Bois et al., 2009; Greenleaf et al., 2001; Moran, 2003, 2009; Orlick & Partington, 1988; Wulf & Su, 2007) was supported by this study's results. As mentioned, Leah did not race as she had hoped at the Senior National Championships, which occurred before she became involved in this study. At those championships she was focused on the fact that her competitors were ahead of her off the start instead of being focused on what she needed to do to race well. This supports Moran's (2009) contention that "athletes lose their concentration when they focus on factors that are outside their control" (p. 24) and Oudejans and colleagues' (2011) finding that expert athletes choke under pressure more so because they focus on performance-related worries (e.g., doubts, potential outcomes) than skill execution (e.g., consciously monitoring their technique). In accordance with Moran's (2009) suggestion that true focus occurs when an athlete focuses "on actions that are specific, relevant to the task at hand and, above all, under his or her own control" (p. 20) and Oudejans and colleagues' contention that cue words should "not be overly complex" (p. 86), the athletes in this study were encouraged to use cues in their focus plans that were simple, specific, relevant to the task, and, above all, within their control. Appropriately, results showed that the athletes found the focus plans helpful for clearing their minds of distractions and focusing on one or two task-appropriate cues instead of their competitors or other uncontrollable variables.

The focus plans in the present study were designed to provide the athletes with cues on which to focus to help them perform well on a consistent basis. Furthermore, the consultant

emphasized that the technical cues were stronger and more focused on "what to do" than merely saying, "Don't focus on my competitors". This phenomenon is supported by previous research; for example, Dugdale and Eklund's (2002) investigation of ironic processing in Australian Rules football showed that although participants became *more* aware of the umpires in game video clips when *instructed not to* pay attention to them, this ironic processing effect was largely reduced in the group of participants who were also given a task-relevant cue (i.e., the ball) on which to focus when their attention became fixed on the umpires. These findings provide further support for having a specific, task-relevant focus.

Similarly, Hill and colleagues' (2011) research on pre-performance routines, which are extensions of an athlete's focus plan for a race, also support the benefit of focus plans for alleviating the athlete's tendency, under stress, to focus on distractions and/or the outcome. The authors' intervention to alleviate choking in elite golfers was partly composed of pre- and post-shot routines. Hill and colleagues' results showed that the routines helped athletes focus on something other than outcomes. Similarly, the focus plans in this study gave the athletes something specific on which to focus other than external (e.g., competitors) or internal (e.g., negative thoughts) distractions.

A second key finding was that the athletes in this study found the skill of debriefing useful for learning and developing a sense of self-awareness by actively analyzing, on a regular and on-going basis, what went well in their races and what did not. Three athletes also specified that debriefing helped them pull out positive aspects of their races, learn from their mistakes, and move on rather than dwelling on the negatives. These findings support previous research on debriefing in sport. Specifically, Hanrahan and colleagues (2009), Hogg (1998b, 2002), and McArdle and colleagues (2010) have demonstrated that debriefing is an effective tool to

facilitate increased self-awareness, more focused learning, and performance improvement in athletes. Hogg (1998b) identified goal-setting (or re-setting) as a key element of effective debriefing. This study's findings support this structure because the athletes worked to improve their focus plans and training approaches based on the debriefs of their races. Similarly, the athletes in McArdle and colleagues' study indicated that they would set short-term process goals during debriefing to improve future performances. Although several studies, such as that of McArdle and colleagues, showed that recovery was associated exclusively with physical training and debriefing was associated primarily with learning and confidence building, at least one athlete in the present study found that debriefing helped him begin to let go of and recover emotionally and psychologically from suboptimal races. This is supported by Kellmann and colleagues (2006) who contend that debriefing can aid athletes in releasing negative thoughts.

Interestingly, the results of McArdle and colleagues' (2010) study showed that both athletes and coaches perceived debriefing to be a two-way collaborative performance evaluation. Specifically, the authors stated that the "athletes interviewed indicated the importance of collaboratively evaluating their performance with their coach" (p. 324). However, several of the athletes in the present study indicated that their coach was sometimes not present for major competitions; therefore, the coach could not comment on his perceptions of and suggestions for those races either immediately after or in the days following the race, which prevented effective debriefing from occurring between coach and athlete. In addition, one athlete specified that he wished coaches would debrief with their athletes more often. Given the combined results of this study and McArdle and colleagues' research, it seems evident that coach-athlete debriefing is crucial. Nevertheless, this study's results also showed that it can be beneficial for athletes to have a third party with whom to debrief. As mentioned, Amanda and Chris found it helpful to speak

with the consultant precisely because she was external to their performance context. One potential explanation for this observation could be that for some athletes "the quality, openness and honesty of the debrief was constrained due to the perceived power of the coach" (McArdle et al., 2010, p. 329).

The consultant-athlete debriefing in this study was designed to provide the athletes with a structured way to reflect on and learn from their races. Although all five athletes were provided with a debriefing form for creating an effective race focus, not all of them used it on a regular basis as an adjunct to the face-to-face debriefing sessions with the consultant. For example, Amanda wrote a lot on her form, whereas Chris said, "I didn't use it that much, to be honest". Chris' relative lack of use of the written debriefing form is in line with McArdle et al.'s (2010) finding that "none of the athletes indicated the use of written [debriefing] aids or tools" (p. 325). However, this could simply be because some athletes may learn best through face-to-face debriefing, and the present study provided both options: the written form and face-to-face dialogue.

The main purpose of the biofeedback training in the present study was to first increase the athletes' awareness of their psychophysiological systems and then increase their ability to manage those systems. A third key finding of this study was that the athletes became more aware of their psychophysiological patterns, more able to control their physiology in the lab, and were beginning to successfully apply at least one modality to control their arousal during training and competition. These findings support previous research on biofeedback training in sport contexts, which has also demonstrated that biofeedback training can be used alone or integrated with PST to help athletes learn to regulate their arousal and anxiety levels (e.g., Beauchamp, Harvey, & Beauchamp, 2012; Davis & Sime, 2005; Edmonds, 2012; Edmonds et al., 2008; Galloway &

Lane, 2005). For example, Edmonds (2012) conducted a biofeedback intervention (composed of sEMG, EDA, and peripheral body temperature) with a 400m sprinter who struggled with poor performances in training and competition. Similar to Scott in this study, Edmonds' biofeedback intervention enabled the sprinter to run in a more relaxed way.

Of the five biofeedback modalities used in this study, the athletes found respiration to be the most applicable and useful because it helped them relax and recover before, during, and after training and competition. Previous research has also shown that respiration training is a valid and easily understood type of biofeedback training in sport contexts (e.g., Bessel & Gevirtz, 1998; Blumenstein et al., 2002; Blumenstein, Breslav, Bar-Eli, Tenenbaum, & Weinstein, 1995). In addition to being the favourite modality of most of the athletes, they began to see that respiration was the key to the other modalities. Specifically, Leah felt that if she breathed properly, the other modalities would move in the desired direction for recovery. The athletes' perception of respiration as a key aspect of biofeedback, and the link Leah made between it and the other modalities, is warranted. Previous studies have demonstrated that respiration plays a pivotal role in the variations of heart rate and HRV, and this relationship is also linked to other autonomic nervous system functions (e.g., the baroreflex) (Lehrer & Vaschillo, 2008; Lehrer et al., 2000; Vaschillo et al., 2006). For example, Vaschillo and colleagues (2006) stated that the "amplitude of HR oscillation is sometimes very sensitive to small changes in breathing rate around 0.1 Hz [i.e., six breaths/minute]" (p. 139), which supports the notion that respiration biofeedback at one's resonant frequency is a key component in learning to regulate other physiological systems.

Although sEMG was not considered by the athletes to be the most applicable modality, three of the athletes stated they became more aware of their muscle tension (most often in the shoulders) by the end of the program. Peripheral body temperature and EDA were not considered

to be the most transferrable modalities in this study. There is partial support for this view from previous biofeedback research. For example, Bar-Eli and colleagues (2002) used EDA as one of three modalities in their study on the influence of a combined PST and biofeedback program on 11- to14-year-old swimmers' performance. In order to build on what the athletes already knew (i.e., the swimmers used heart rate to monitor training load and recovery), Bar-Eli and colleagues introduced the three modalities in their study in the following order: HR, sEMG, and EDA. The order of the modalities in Bar-Eli and colleagues' study mirrors the perceived relevance of the modalities to training given by the athletes in this study. That is, HR (with respiration) was considered most relevant, followed by sEMG, with EDA being ranked the least transferrable and easy to control.

A fourth finding of the present study provided partial support for the performance-enhancing effect of using focus plans with technical cues words. Some previous research has demonstrated performance increases from the use of technical cue words (MacPherson, Collins, & Morriss, 2008; Mallett & Hanrahan, 1997). Specifically, the 100m sprinters in Mallett and Hanrahan's (1997) study ran both faster and more consistently when they used specific race cues, providing support for having a task-relevant focus. Similarly, MacPherson and colleagues' (2008) multiple-case study demonstrated that an elite javelin thrower was differentiated from three international standard (i.e., sub-elite) javelin throwers by the fact that the elite thrower used a holistic, rhythmical cue, which generated less movement variability (i.e., more consistent/overlapping movement patterns). Despite the apparent performance benefit of using technical cues as part of focus plans for races, only one of the five athletes in this study, Amanda, indicated that she was satisfied with her performance at the end of the study. However, three of the athletes made international teams during the study. One possible explanation for the

relative lack of performance improvement seen during the study, at least from the athletes' perspective, could be that other factors beyond focus were having a significant impact. For example, three of the five athletes indicated that they were dissatisfied with some aspect of their current or previous winter physical training, and those three athletes said they felt that their training was negatively impacting their technique, fitness, or both. Another reason for the lack of performance improvement seen during this study could be performance decrements due to injury or illness. Two of the five athletes struggled with moderate to severe injuries and/or illnesses during the study, which likely had a negative impact on their overall performance.

Biofeedback has also been shown to help improve performance through enhanced arousal control, which encompasses the psychological, emotional, and physiological aspects of self-regulation. As mentioned, Edmonds' (2012) implemented a biofeedback training protocol with a 400m sprinter who typically got tight during his races, and this tendency was mirrored by the struggles of one of the athletes in this study, who said he was "tight as a drum" when he first started athletics. The results of Edmonds' study showed that the athlete improved by more than three seconds in the 400m, a large performance improvement. Unfortunately, not every participant in this study was able to improve his or her overall performance during the program. Specifically, Amanda finished her season with a personal best time; however, Scott qualified for and raced at the FISU Games but did not perform as well as he had hoped, and Chris, Leah, and Dennis did not feel satisfied with their outdoor season performances during the program. However, Chris and Dennis improved their performances during the indoor season while they were still part of the study, Scott felt better about his running at the time of his final interview, and Leah qualified for the Olympic Team six months after the end of her PST-Biofeedback program. One explanation for the apparent delay in performance benefits from the program, at

least from the biofeedback perspective, could be that it takes time to transfer the skills learned in the lab to practice and, eventually, from the practice environment to high-level competition (Galloway & Lane, 2005). The eventual performance improvements seen in the athletes in this study, along with the results of Edmonds' research, suggest that biofeedback can help improve performance.

Implications for Applied Practice in Sport Psychology

One of the main implications of this study for sport psychology consultants is the need to individualize PST and biofeedback training programs to meet the needs and progress of athletes throughout such programs. Although many athletes experience similar challenges and needs, it is important to seek out what they feel they need to work on and design a program to fit those potentially different needs. As athletes progress, their needs may change and require that the program be modified. Previous research has demonstrated that both PST programs (Evans et al., 2004; Gucciardi et al., 2009b; Holliday et al., 2008; Lidor et al., 2007) and biofeedback training (e.g., Blumenstein et al., 1997; Blumenstein et al., 2005; Edmonds et al., 2008) need to take athletes' individual differences, preferences, sport demands, and training phases into consideration.

For the present study, specific psychological skills were targeted based on previous research and the consultant's previous experience (i.e., focus, arousal control, and debriefing); furthermore, all five biofeedback modalities were used for all athletes. However, other psychological skills were introduced because of the athletes' needs and progress throughout the program (e.g., visualization). Regarding the individualization of the biofeedback training, several studies have used full or adapted versions of the Wingate 5-Step Approach to mental training with biofeedback (Blumenstein et al., 1997), while accounting for individual differences and

needs within that protocol (e.g., Bar-Eli et al., 2002; Blumenstein et al., 1997; Edmonds et al., 2008). The Wingate 5-Step Approach suggests that athletes be introduced to all five biofeedback modalities before selecting the most responsive modality for further training. Although the biofeedback protocol was quite similar for all five athletes in this study, the consultant did decide to modify one athlete's biofeedback training to address his pressing need, compared to the other athletes, for recovery. Even though visualization was not one of the skills that were targeted in the basic PST protocol of this study, three athletes used the skill to solidify their focus plans.

Another key implication of this study for practitioners is the ongoing need for awareness and management of athletes' and coaches' perceptions of PST. By the end of their PST-Biofeedback training, all five athletes had a positive perception of the program, and they found the majority of its components helpful, interesting, and relevant to their training and performance contexts. However, three of the five athletes began the program with a mild to strong degree skepticism of its potential usefulness. Although disconcerting for the researcher and consultant, these skeptical and/or negative impressions of PST are not uncommon among athletes and coaches. Negative or false perceptions about PST must be acknowledged and managed to help ensure more athletes and coaches are willing to engage in PST and biofeedback training. To that end, education is essential; consultants must anticipate and rectify misconceptions prior to initiating, and during the implementation of, PST or biofeedback programs. It is important that athletes and coaches understand that PST and biofeedback training programs can be helpful for all athletes, not just for those with so-called "problems". Such programs are about performance enhancement, not just problem-solving; therefore, consultants should be mindful of the terminology they use when introducing the idea of PST to athletes and coaches. Specifically, the word "intervention" may not be ideal for use by practitioners. As mentioned, Chris indicated at

the end of his PST-Biofeedback program that his initial impression had been negative because the consultant had used the word “intervention” during the initial group meeting. Given Chris’ reaction to the word “intervention”, perhaps “training program” might be more a more appropriate phrase since the athletes already use those words to describe their physical training.

Coaches’ perceptions of PST can also influence their athletes’ views; therefore, it is helpful if coaches cooperate and believe in the importance of the PST-Biofeedback program. If coaches are committed to the program, the consultant can work with and through them to supplement the direct contact they have with the athletes. Although it is not surprising that coaches of elite athletes would be primarily concerned with performance rather than the theory or structure of PST programs, it is important to keep this in mind so that consultants remember to frame their PST programs as performance enhancement tools. Such an emphasis would help garner the interest and support of coaches and athletes alike, while simultaneously reducing the possibility of them labelling psychological skills “interventions” as measures reserved for athletes with “problems”.

Finally, those athletes in the present study who started out with negative or false views of PST indicated that their perceptions changed as a result of speaking with the consultant and experiencing the program itself. One of the athletes moved from skepticism to openness and willingness to continue with the consultant and another said “[the consultant] really showed that there’s a science to [mental training] and how that can help with your recovery and focus”. The importance of athletes being open to PST programs was supported by Blumenstein and colleagues (2002), who made a similar observation regarding biofeedback training programs:

> There are several sources of ‘noise’ in research into the use of mental techniques that incorporate biofeedback devices. The first one is the participant. The degree to which the

> person is motivated to practise the mental techniques and biofeedback until he/she experiences some control over the mental state is important. However, the most crucial aspect is the extent to which the participant is willing to adopt the technique. Lack of motivation may jeopardize any attempt to learn the technique and control the mind, emotions, and mental state of the learner. As far as we know, personal variables have not been taken into consideration in biofeedback research, and therefore we lack empirical evidence as to the personal characteristics required to increase openness towards developing an optimal mental state. (p. 115)

Clearly the views of the athletes in the present study can help to provide answers to the lack of evidence identified by Blumenstein and colleagues (2002) regarding athletes' willingness to engage with and adopt psychological and physiological regulation techniques.

Limitations and Future Directions

Although this study's results provide further support for the benefit of PST and biofeedback training programs for psychological, physiological, and emotional self-regulation in athletes, it has a number of limitations. First, the small sample size limits the generalizability of the results beyond the athlete participants of the study. However, this is not a true limitation because the purpose of this study was to understand the *individual* experiences of the athletes with regard to the PST-Biofeedback program and not to generalize their experiences to the athletic population at large. As mentioned, case study research is designed to "understand the particular in depth, not to find out what is generally true of the many" (Merriam, 2009, p. 224). Nevertheless, future research designs should continue to use case studies of combined PST-Biofeedback programs to extend this study's results to other sports and populations. Given that three of the five athletes in the present study ended up using visualization as part of their PST-

Biofeedback programs, future research on such programs could add visualization as one of the core psychological skills.

A second limitation of this study was the time period between PST-Biofeedback sessions. Due to the scheduling challenges inherent in coordinating the athletes, consultant, and researcher, there were sometimes weeks or even months between certain athletes' lab sessions, which disrupted the continuity of the face-to-face meetings to a certain extent. To help address this shortcoming, email, phone calls, and Skype were used to increase the consultant's contact with the participants. Similarly, Chris and Dennis' final interviews took place several months after their respective last sessions with the consultant. The reason for this time delay was that the researcher and consultant had hoped to conduct a few more sessions with these two athletes before ending their programs; however, due again to the athletes' individual travel and competition schedules, it was not feasible for the athletes to have any more sessions before the data collection period needed to be terminated.

A final limitation of this study was the relative lack of involvement the coaches had with the program. As Cotterill (2011) stated, it is important for the coaches to take some responsibility for the implementation and maintenance of PST programs. Therefore, future research should continue to examine ways to ensure coaches are an integral part of such programs.

Conclusion

The purpose of this study was to explore the experiences of five track athletes during a season-long PST-Biofeedback training program designed to help them learn how to self-regulate physiologically, psychologically, and emotionally. Specific psychological skills were targeted during an individualized PST-Biofeedback training program, and these skills included focusing, debriefing, and arousal control through biofeedback.

The results indicated that the athletes found the majority of the PST-Biofeedback program components to be helpful, interesting, and/or relevant to their training and competitive contexts, and they all indicated a willingness to continue working with the consultant and to recommend such a program to other athletes (even the two athletes who began the program with a strong degree of skepticism of the relevance or benefit of PST). Furthermore, all of the athletes felt they improved their ability to focus (via specific cues within focus plans for their races), debrief, and control their arousal levels in the lab (via biofeedback training). Finally, the athletes transferred, to varying degrees, the skills they had begun to learn into their training and competitive contexts (e.g., using respiration to calm down before a race or between runs in practice).

Implications for sport psychology consultants are that PST-Biofeedback programs need to be individualized to meet the needs and progress of athletes throughout the program. Also, consultants need to be aware of how they present their programs to athletes and coaches so that the terminology they use does not trigger preconceived (and often false) notions about what PST is. Future directions for research in this area include continuing research on combined PST-Biofeedback programs and the exploration of ways to improve athletes' and coaches' perceptions of PST and the field of sport psychology.

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Table 1

Athlete Demographics and General Information

Participant	Sex/Age	# of years in athletics	Event(s)	Best times	Highest level of competition
Scott	M/22	5	200m 400m	21.12s 46.60s	2008 IAAF World Junior Championships in Athletics 2011 FISU World University Games
Amanda	F/18	5	100mH	13.86s	2010 IAAF World Junior Championships in Athletics 2011 Junior Pan American Games
Chris	M/26	9	100m 200m 4x100m	10.25s 20.95s 38.52s	2004, 2008 (alternate) Olympics
Leah	F/24	5	100m 200m 4x100m	10.23s 20.83s 38.39s	2009, 2011 (alternate) IAAF World Championships in Athletics 2010 Commonwealth Games
Dennis	M/33	4	400m 1500m	64.2s 5:16min	2009 Parapan American Games 2011 IPC World Championships in Athletics

Table 2

Study Phases of a Season-Long PST-Biofeedback Training Program

Phase 1	Phase 2	Phase 3
Group meeting (May 2011)	Initial interviews	Final interviews
With head coach, athletes, athletes' coaches, consultant, and researcher	PST-Biofeedback program	
Introduction to the study	Amanda	
	May-November 2011	November 2011
	Scott	
	June-December 2011	January 2012
	Chris	
	June 2011-March 2012	June 2012
	Leah	
	July-September 2011	December 2011
	Dennis	
	July 2011-April 2012	July 2012

Table 3

Coding Example for the Theme of Arousal Control

Theme: Arousal Control		
Subthemes	Codes	Extracts
General observations of BFB	Facilitated arousal control and calm	[The biofeedback] really helped me to control my arousal level and keep me calm in situations that I used to get too excited. (Scott)
	Facilitated an optimal performance state	I could use the breathing and skin conductivity to get myself into a state where I could race fast and not worry about what's going on around me. (Amanda)
Respiration	Breathing to control arousal in training	In between sets in practice I can go into the corner and [breathe], and I can get to a [high] stress level and bring myself down. (Chris)
	Breathing to control arousal in competition	At [Pan Am Juniors] I went off and did some breathing because I needed to be calm and forget [the race delay and track closure]. (Amanda)
	Breathing to facilitate recovery and sleep	I did the breathing through the week to help me recover [before the race]. (Scott)
		Before I go to training I take a nap, and I use the breathing, which sends me to sleep.

		(Leah)
sEMG	Increased awareness of muscle tension	I'm more aware of when my shoulders are tensing up, and I'll take the time to shake my arms out during the run. (Dennis)
	Reinforced understanding of the importance of relaxation	We're always tight, and it's not a good trait to have as a sprinter. You have to be relaxed because with relaxation comes speed. (Chris)
Other modalities	Other modalities are linked to breathing	I would put temperature hand-in-hand with breathing. If I could get my breathing right, temperature increased. (Leah)
	Some modalities difficult to transfer to training	I haven't been able to work on the jaw [sEMG] and my skin conductance out of the testing environment. (Leah)
	Better control over HR	The main thing was learning the breathing and slowing my heart rate. I found that helpful on competition day. (Dennis)
	Control over EDA did not change	I feel I have little or no control over my EDA. I found it tough even in the lab. (Dennis)
	Temperature not used in	I've never put temperature to

	training and competition	use I don't think. (Dennis)

Note: BFB = biofeedback, HRV = heart rate variability, sEMG = surface electromyography, EDA = electrodermal activity

Appendix A

Initial Interview Guide

1) Obtain athlete demographics (e.g., age, gender, education)
2) Tell me about your background as an athlete.
    a. In which events do you compete?
    b. How long have you been competing?
    c. What are your best times or performances to date?
3) Tell me about how you presently prepare for competition, particularly from a psychological standpoint.
    a. Do you have a plan for competing/racing? If, yes, please tell me about it.
    b. Do you use a pre-competition routine? If yes, please tell me about that routine.
    c. Do you do anything else to prepare?
4) Tell me about your coach. How long has he/she been coaching you? Do you meet/debrief with your coach after competition?
5) Tell me about your best performance last season.
    a. What did it feel like? What were you thinking? What were you focusing on? What worked?
6) Tell me about a time when you performed below your expectations last season.
    a. What did it feel like? What were you thinking? What were you focusing on?
7) What things do you think you need to work on to compete well this year?
    a. What are your goals for this year?
8) Is there anything else we should talk about that would help you perform better this year?

Appendix B

Final Interview Guide

1) Tell me about your overall experience with the PST-Biofeedback program.
    a. How did you find the psychological skills training? Helpful? Not helpful? Please explain.
    b. How did you find the biofeedback training? Helpful? Not helpful? Please explain.
2) With this program complete, (a) how is your ability to focus (refocus), (b) manage your arousal levels in training and competition, and (c) debrief (i.e., reflect on and learn from your previous performances)?
3) Tell me about your results/performances this season. Have you improved (i.e., times)? Do you feel that the program played a role in your performances?
4) If you found the program helpful, what specific aspects were most useful to you?
    a. Creating and executing race focus plans? Debriefing your races? Learning how to manage your physiology through biofeedback? (Ask about each modality)
5) What do you think you need to continue to work on?
    a. All of these things? One in particular?
6) Is there anything else you would like to add?

Appendix C

Debriefing Form for Creating an Effective Race Focus

The race (i.e., What race was it? Where? When?):

1) How did the race go from your perspective?
2) What were you thinking and feeling *prior* to the race? What did you focus on?
3) What were you thinking and feeling *during* the race?? What did you focus on?
4) So what have you learned? What will you plan to focus/work on for next race?
5) Is there anything else we should talk about? Any other concerns?

Appendix D

The PST-Biofeedback Session Schedule and Content

Athlete	Date	Skills/issues addressed
Amanda	May 31st, 2011	Interview #1, created a 100mH (hurdles) focus plan, introduced debriefing form, discussed coaching situation and illness before competition
	June 18th, 2011	Debriefed recent races, modified focus plan for Senior Nationals, discussed coaching situation, BFB
	June 29th, 2011	Debriefed Nationals, discussed coaching/training situation, still feeling sick, made a focus plan for Junior Nationals, BFB (respiration only)
	July 2nd, 2011*	Debriefed 100mH heat, reviewed focus plan for 100mH final, reminded her to lower shoulders and relax to improve her focus
	July 2nd, 2011*	Debriefed 100mH final, talked about upcoming Junior Nationals, reminded her to go to bed earlier and practise breathing
	July 8-10th, 2011*	Advised how to maximize coach-athlete relationship at Junior Nationals – goal is to have a good race despite frustration in training
	July 16th, 2011*	Debriefed 100mH final, made a focus plan for Junior Pan American Games, talked about move to new city/training group, gave breathing homework
	July 22-24th, 2011*	Helped her refocus despite distractions at Junior Pan American Games, reviewed her focus plan, reminded her to use breathing to relax
	Aug 4th, 2011	Debriefed Junior Pan American Games, talked about her plan before the move to train with new

		coach, BFB
	Nov 17th, 2011*	Talked about school, training, and how the transition to a new city, coach, and training group was going so far
Scott	June 2nd, 2011	Interview #1, created 200m and 400m focus plans, discussed upcoming race schedule
	June 16th, 2011	Debriefed two recent races, completed debriefing form, created focus plan for upcoming Senior Nationals based on debrief, BFB
	July 7th, 2011	Debriefed Senior Nationals, created focus plans for two upcoming races, BFB
	July 18th, 2011	Debriefed Ontario Championships, discussed training for upcoming FISU Games, reminded him to practise breathing, BFB
	Aug 4th, 2011	Discussed how training has been going, reviewed focus plan for FISU Games, gave breathing and focus plan visualization homework, BFB
	Oct 7th, 2011	Debriefed FISU Games, talked about technique issues and plans for after graduation, talked about upcoming Pan American Games, BFB
	Oct 17th, 2011	Briefly discussed how training and school have been going, reviewed focus plan and coaching situation for Pan American Games, BFB
	Oct 18th, 2011	Discussed how training has been going and what his training will be like at Pan American Games before he races, BFB
	Nov 22nd, 2011	Talked about training, school, and time standards for the 2012 Olympics, BFB
	Dec 5th, 2011	BFB, discussion of how he is looser/more relaxed now in general and in track, specifically
Chris	June 18th, 2011	Interview#1; BFB; created focus plan for Senior

		Nationals; gave visualization, breathing, and debriefing homework
	July 8th, 2011	Debriefed Nationals, discussed nature of focus, created a focus plan for upcoming race, gave focus plan visualization and breathing homework, BFB
	Aug 1st, 2011	Debriefed three recent races, discussed and created a focus plan for upcoming Worlds relay training camp, discussed training issues, BFB
	Aug 6th, 2011	Debriefed races at Worlds relay camp, discussed Worlds selection process and focus plan for remainder of pre-Worlds training camp, BFB
	Oct 21st, 2011	Debriefed Worlds (not selected to the team), discussed his plan/goals for upcoming season and Olympics, discussed his talk with his coach, gave breathing and visualization homework, BFB
	Feb 15th, 2012	Discussed how training and racing have been going, talked about recent minor injury and treatment, debriefed recent indoor races, BFB
	March 6th, 2012	Discussed how training has been going, reviewed competition schedule, went over 100m focus plan, gave breathing and focus plan visualization homework, BFB
Leah	July 3rd, 2011	Interview #1, created a focus plan for Ontario Senior Championships, discussed nature of focus and importance of mental training, BFB
	July 7th, 2011	Discussed her expectations of the program, discussed how she over-analyzes her runs, made a focus plan for training, BFB
	July 12th, 2011	Discussed recent practices, created a focus plan for next two races, talked about focus (factors in

		and out of one's control), BFB (viewed video of recent race during EDA modality)
	July 18th, 2011	Debriefed Ontario Senior Championships, made a focus plan for upcoming race, BFB
	July 25th, 2011	Debriefed recent race, discussed and made focus plan for upcoming Worlds relay training camp, created new focus plan/protocol for training, BFB
	Aug 7th, 2011	Debriefed Worlds relay camp races, created a plan for training during final Worlds selection, talked about influence of results and physical training on confidence, BFB
	Aug 13-20th, 2011*	Discussed pre-Worlds training, addressed her anxiety about the pending Team selection and helped her regain composure/focus on the task
	Sept 8th, 2011	Debriefed Worlds (she was not selected), discussed plans for next season and her decision to move to a new city for new coaching
	Sept 19th, 2011	Discussed pending move and current coach's reaction, talked about need to improve flexibility to avoid injury, gave breathing and yoga homework, BFB
	Sept 23rd, 2011	BFB, gave breathing and yoga/flexibility homework, decided what to discuss at her next (last) session
	Sept 26th, 2011	Discussed what she needs to work on in the new city, talked about implications of carding status for access to support services, BFB
Dennis	July 7th, 2011	Interview #1, discussed goals for current season, created focus plan for upcoming race, BFB
	July 19th, 2011	Debriefed Ontario Senior Championships, reviewed focus plan for next race, discussed

	factors in and out of his control, talked about rest/recovery/illness/injury issues, BFB
Oct 5th, 2011	Discussed winter racing schedule and implications of a former injury for upcoming ParaPan American Games, talked of need to reduce stress in school/life, BFB (respiration/HR)
Nov 1st, 2011	BFB - respiration only (to target recovery/stress reduction)
Nov 2nd, 2011	BFB - respiration only
Nov 7th, 2011	BFB - respiration only
Nov 10th, 2011	BFB - respiration only
Nov 18th, 2011	BFB - respiration only
Nov 23rd, 2011	Discussed training, coaching situation, school, his new condo, BFB (introduced hand-held EDA device due to his vision loss – auditory feedback)
Nov 29th, 2011	BFB - respiration only
Dec 2nd, 2011	BFB - respiration only
Feb 15th, 2012	Debriefed his latest 1500m race and 800m time trial and his coach's reaction to both, created focus plan for next 1500m race, BFB
April 6th, 2012	Discussed his relationship with coach and guide, out-of-sport stressors, and how he feels about track in general, created focus plans for next races; discussed training camp/races in US; BFB

Note: PST = psychological skills training, BFB = biofeedback (sessions comprised all five modalities unless otherwise stated), * = session occurred on-site at a competition or via Skype/email/phone call