Running Head: SINGLE-CASE RESEARCH IN SPORT PSYCHOLOGY

A Review of Single-Case Research in Sport Psychology 1997-2012: Research Trends and Future Directions

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Abstract

Single-case research methods are an important facet of applied sport psychology because they provide a framework for researchers and practitioners to outline intervention effects across time with individuals or groups. This paper reviews the research published since Hrycaiko and Martin's (1996) milestone overview of single-case research in sport psychology. Specifically, we examined the literature between 1997 and 2012 and located 66 studies that met our inclusion criteria of assessing interventions in sport psychology. The review summarizes the body of research, outlines trends, considers the limitations of the extant literature, and identifies areas that require further investigation for future single-case research.

Keywords: research methods, applied research, behavior analysis, social validation, intervention, single-subject

A Review of Single-Case Research in Sport Psychology 1997-2012: Research Trends and Future Directions

During the last three decades, sport psychology researchers and practitioners have repeatedly been encouraged to use single-case research methods and designs (SCDs) more widely in order to facilitate an understanding of effective interventions and to evaluate applied practice (e.g., Bryan, 1987; Hrycaiko & Martin, 1996; Smith, 1988; Wollman, 1987; Zaichkowsky, 1980). The focus of the last milestone paper on this area revealed that SCDs were underused compared to group designs in evaluating applied sport psychology interventions (Hrycaiko & Martin, 1996). For example, prior to 1994 only 12 articles using SCDs were published across the *Journal of Sport & Exercise Psychology (JSEP), The Sport Psychologist* and the *Journal of Applied Sport Psychology.* Since Hrycaiko and Martin's (1996) work there has been a steady increase in the prevalence of literature on SCDs in sport psychology including applied research studies (see Martin, Thomson, & Regehr, 2004), and a monograph on *Single-Case Research Methods in Sport and Exercise Psychology* (Barker, McCarthy, Jones, & Moran, 2011) has been published. Despite this apparent increase in awareness and publication of SCD studies, the sport psychology literature currently lacks an up-to-date review of current SCD practices and trends. Furthermore, recent developments in SCD research methodology including design and analysis techniques (e.g., Kazdin, 2011; McDougall, Hawkins, Brady, & Jenkins, 2006) can be disseminated to the sport psychology community to encourage future SCD research developments. Of course, while the questions which researchers attempt to answer are valuable to extend the extant literature, so to is understanding how the discipline of sport psychology has answered applied questions. In sum, this review focuses on the methods and tools used in SCD research. The purpose of this current review is to add to the extant literature by updating the work of Hrycaiko and Martin (1996) and providing a comprehensive review of studies using SCDs in sport psychology between 1997 and 2012.

The objectives of this review are twofold. First, we intend to outline trends and gaps in the application of SCDs to sport psychology in relation to research settings, designs, and analysis. Second, we seek to draw on current SCD developments and provide suggestions for applied researchers and practitioners regarding optimal design options and analysis procedures. The review is organized by firstly outlining the philosophy and history of SCDs, then providing an overview of landmark SCD papers, followed by a summary of relevant research between 1997 and 2012 with a critical synthesis of the emerging methodological issues, and finally suggestions for future SCD research.

Overview of Philosophy and History of Single-Case Research Designs

Traditionally, scientific development in psychology has predominantly relied on the study of groups of participants via the use of *nomothetic* (i.e., a tendency to generalize) group-orientated designs to establish broad, general, and universal laws (Clark-Carter, 2010). However, major scientific advances have also been made through the careful evaluation of *idiographic* (i.e., a tendency to specify) approaches including one or a few individuals (e.g., Allport, 1962). Psychoanalysis, for example, both as a theory of personality and a treatment technique developed from a relatively small number of cases seen by Freud in outpatient psychotherapy. He developed his theory of psychoanalysis from this intense study of individual cases. Further, well-known cases throughout the history of clinical work have stimulated major developments in theory and practice. Studying the individual case aided many disciplines of psychology. For instance, theoretical understanding of the brain and its functions has been significantly enhanced by intensive studies of individuals such as Phineas Gage (see Macmillan, 2000). Further, Burrhus Frederic Skinner and his colleagues refined the single-case method in their study of animal behavior to develop a sophisticated method allowing researchers and practitioners to study individual cases intensively (Skinner, 1938). The publication of Sidman's (1960) *Tactics of Scientific Research* marked the definitive

method of single-case research in explaining the assumptions and conditions of a true experimental analysis of behavior. Skinner and his colleagues established the *Journal of Experimental Analysis of Behavior* (JEAB) in 1958 to overcome the reluctance of editors of major psychological journals to publish their work using data from single-cases (Kazdin, 2011). The experimental study of the single-case in basic and applied research was marked with a journal in 1968 (*Journal of Applied Behavior Analysis; JABA*). The experimental study of the single-case has subsequently appeared in major psychological and psychiatric journals, with basic research methodology termed experimental analysis of behavior and applied problems termed *behavior modification* or *behavior therapy* (Barlow, Nock & Hersen, 2009).

The unique feature of SCDs is the capacity to conduct experimental investigations with one or a few cases. Central to the method is the ability to rigorously evaluate the effects of interventions. SCDs have therefore been applied to many research contexts including psychology, medicine, education, rehabilitation, social work, counselling, and sport psychology (Kazdin, 2011). Sport psychologists have been encouraged to use SCDs to provide evidence-based interventions for applied work with sport performers. Not surprisingly, therefore, many sport psychologists also use SCDs to justify the strength of their applied work with sport performers (Barker et al., 2011; Hemmings & Holder, 2009; Smith, 1988). Indeed, to advance applied sport psychology practice, research, and theory, sport psychologists need experimental, quasi-experimental, and non-experimental research methods. We do not propose that SCDs should replace controlled group designs. There are many questions (e.g., which of two different interventions works best for a group of athletes?) that are best answered using group designs. So, SCDs and group designs can be complementary. Choosing a single-case approach is valuable, particularly when embarking on new research areas (e.g., hypnosis; Barker & Jones, 2006) or when working with unique populations (e.g., elite athletes; Kinugasa, Cerin, & Hooper, 2004) because SCDs allow the

detection of positive effects for individuals who would otherwise have their success masked in a non-significant group design. Furthermore, SCDs allow programs to be tailored for individuals engaged in real-life sport. Finally, single-case research has the potential in demonstrating to consumers of sport and exercise services that improvements in athletic performance are due to interventions (Barker et al., 2011).

Milestones for Single-Case Research in Sport Psychology: 1972-1996

Between 1972 and 1996, various landmark and influential papers have been published to increase awareness and encourage SCDs in sport psychology. For example, Rushall and Siedentop (1972) first described behavioral applications of SCDs to sport settings in their book *The Development and Control of Behavior in Sport and Physical Education.* This book drew heavily from Skinner's writings and outlined practical strategies to shape new sport skills and generalize practice skills to competitive settings (Martin et al., 2004). Zaichowsky (1980) detailed the problems of using group designs for intervention research in sport psychology and proposed the use of alternative methods (e.g., SCDs) to detail important intervention effects. Wollman (1986) further revealed how future imagery and motor performance research would benefit from the application of SCDs to allow for the detection of successful effects for individuals who otherwise would have had their success masked in a group design. A paper by Bryan (1987) was the first to document systematically the benefits of SCDs in evaluating psychological interventions for sport skill acquisition and performance enhancement, along with outlining the A-B-A-B and multiple-baseline design options to the sport psychology community. Smith (1988) further championed the benefits of single-case methods to sport psychology whilst noting that such methods are appropriate for observing changes on a wide range of dependent variables including measures of performance and psychological constructs (e.g., anxiety, mental toughness, and concentration). Indeed, this later suggestion was an important development for the application of SCDs in sport as they

had traditionally been presented as a mechanism with which to monitor changes in observable behavioral outcomes rather than psychological constructs as measured by psychometric questionnaires (Kazdin, 1982). Finally, the work of Hrycaiko and Martin (1996) remains the last landmark paper regarding the application of SCDs to sport psychology. Within their paper, the authors outlined some fundamental characteristics of SCDs (e.g., procedural reliability, social validation), and debunked some misunderstandings which may have accounted for the paucity of SCD research in sport psychology (note that there were only 12 published articles in sport psychology journals up to 1994). First, they outlined that SCDs are a more robust alternative to the case study given that they can demonstrate internal validity and also external validity via the replication of intervention effects across settings, participants, and outcomes. Second, visual inspection of data in SCDs is an appropriate analysis procedure as long as criteria for change are closely followed. SCDs (i.e., the alternating-treatment design option) can be used to compare alternative intervention strategies with a single-participant(s). Finally, statistical analysis of SCD data can assist in the study of small effects. Hrycaiko and Martin (1996) further commented that the scant use of SCDs may also have been a consequence of research funding agencies appearing to favour group designs over SCDs perhaps because of the traditional dominance of the nomothetic approach and the medical model in psychology research. As a result, students and supervisors may not completely understand SCDs as these methods are rarely, if ever, taught in university programmes.

In summary, these landmark papers have revealed some important issues regarding the evolution of applying SCDs to sport psychology. Across all of the papers, we observed researchers repeatedly justifying SCDs as a viable research method amidst continual misconceptions and skepticism. In these papers, researchers have detailed the theoretical underpinning (including the internal and external validity of SCDs) and value of idiographic

approaches, along with clarifying the distinction between SCDs, case studies, and more traditional nomothetic approaches. Traditionally, researchers have used this theoretical detail as a springboard to make calls for a greater prevalence of applied studies adopting SCDs. Following these repeated calls we observe guidance being offered on SCD options for sport psychologists. Indeed, this guidance has typically focussed on using withdrawal (e.g., A-B-A), multiple-baseline, and alternating treatment design(s) whilst ignoring more elaborate varations such as the changing-criterion design (Kazdin, 2011).

Inclusion Criteria for the Current Review

To achieve systematic coverage of relevant studies, we used the following criteria in this review. First, our search included studies that were performance related to fit with the aims of the review. We searched for studies where dependent variables were in the context of sport performance. We also included studies that used psychological skills and behavior modification strategies commonly used in sport psychology. Although much literature exists regarding the use of SCDs in relation to Physical Education (PE) and PE pedagogy (see Vidoni & Ward, 2006, 2009), we did not include such studies in our review as the variables, contexts, and interventions are beyond that typical of sport psychology. Second, we selected studies that used athletes who competed regularly together with those selected for convenience (e.g., student samples). Third, studies that used contrived performance settings (e.g., dart throwing tasks) and those that used actual sport performance-related markers were included along with those with dependent variable(s) that were either behavioral or construct related (Kazdin, 2011). Fourth, we included studies that used subjective ratings of performance on the basis that measures of this nature might offer greater utility than those using actual performance–particularly when determining effective performance in team sports. Finally, we also included A-B designs in our review because we felt that these are an important aspect of SCD methods and also reflected the applied essence of doing research in

the real world where interventions are used to bring about an increase or decrease in target variable(s) without the opportunity for withdrawal (Barker et al., 2011).

We began our literature search after 1996 and examined behavioural journals (e.g., *Behavior Therapy, Behavior Modification, and JABA*) and sport psychology journals (e.g., *Journal of Applied Sport Psychology, Journal of Sport Behavior, Journal of Sport and Exercise Psychology, The Sport Psychologist, Journal of Clinical Sport Psychology, Sport and Exercise Psychology Review, Sport Psychology in Action, Psychology of Sport and Exercise, Research Quarterly for Sport and Exercise*) for articles that met the above criteria.

Summary of Research

The literature search yielded 66 studies that met the inclusion criteria. Each study is summarized in Table 1.

Publication Trends

Between 1997 and 2012, 66 SCDs were published in sport psychology and behavioural journals. Nineteen studies were published between 1997-2001, 24 between 2002-2007, and currently 23 between 2008 and 2012. The spread of SCDs publications indicated that 54 were published in sport psychology-based journals, 10 were published in behavior-related journals and 2 were in other journals (e.g., *Imagination, Cognition, and Personality*).

Participant Characteristics

Three hundred and nine individuals (216 males and 93 females) participated in the 66 studies covered by the present review. These participants comprised 106 college athletes, 56 elite adult athletes, 44 elite youth athletes, 41 recreational athletes, 36 youth athletes, 12 novice athletes, 8 national athletes, 5 professional athletes, and 1 international athlete. The sample also comprised three teams of college, youth, and disabled athletes respectively.

Type of Sport

Ten studies focussed on soccer; six on tennis; seven on basketball (including one on wheel-chair basketball); five on athletics; five on golf; three each on American Football, cricket and swimming; two each on ice-hockey, softball, rugby union, cycling; and one each on speed-skating, roller-hockey and gymnastics, tennis and field-hockey, gymnastics, flat horse-racing, rowing, badminton, roller-speed skating, field-hockey, judo, volleyball, weight-lifting, ten-pin bowling, boxing, water-polo, and dart-throwing.

Type of Research Designs

The multiple-baseline design was the most widely used design appearing in 47 of the 66 studies. The across-participants variation appeared 41 times (e.g., Callow, Hardy, Hall, 2001; Marlow, Bull, Heath, & Shambrook, 1998; O'Brien, Mellalieu, & Hanton, 2009; Thelwell, Greenlees, & Weston, 2006). Galvan and Ward (1998), for example, assessed the effectiveness of a public posting intervention in reducing inappropriate on-court behaviors among five tennis players. The study involved observing players concurrently throughout a season during weekly challenge matches. A staggered baseline was used with two participants receiving the intervention after six baseline measures, another two participants after ten baseline measures and one participant after fourteen baseline measures. Data indicated the intervention was effective in immediately reducing inappropriate on-court behaviors for all players.

The across-behaviors variation appeared three times (e.g., Brobst & Ward, 2002; Jones, Lavallee, & Tod, 2011; Ward & Carnes, 2002). For example, Ward and Carnes (2002) explored the effects of goal setting and public posting on 5 male collegiate linebackers across a series of dependent variables (i.e., reads, drops, and tackles). Data indicated immediate increases in performance on the dependent variables following the presentation of the intervention package.

The across-groups variation appeared twice (e.g., Munroe-Chandler & Hall, 2004; Shearer, Mellalieu, Thomson, & Shearer, 2009). For example, Shearer et al. (2009) studied the effects of a Motivational General-Mastery (MG-M) imagery intervention on the collective-efficacy of three regional wheel-chair basketball training groups. The intervention was delivered to group one at week 5, group two at week 9 and to group three at week 13. Data indicated mixed results for each of the training groups with increases in collective-efficacy for group one, and no substantial changes in groups two and three.

Only one across-settings design was located in the searched studies. Allen (1998) used an enhanced simplified habit-reversal (SHR) procedure with a 14-year old elite youth tennis player who had reported a long history of disruptive, angry outbursts during matches. The player and his parents collected baseline data on outbursts during four non-tournament and six tournament matches. Using an across-settings design the SHR procedures were delivered across non-tournament and tournament settings where data revealed elimination of disruptive outbursts in both settings.

There were eight appearances of the A-B design in the selected studies with a typical application to athletes in real-world applied settings (e.g., Annesi, 1998; Mellalieu, Hanton, & O'Brien, 2006; Thelwell & Maynard, 2003; Scott, Scott, & Howe, 1998). Furthermore, the A-B design was also applied to reflect consultancy work with individual athletes (e.g., Barker & Jones, 2005, 2006, 2008) and a sports team (Pain & Harwood, 2009).

The reversal design was used in six studies with the A-B-A-B variation appearing four times (e.g., Anderson & Kirkpatrick, 2002; Messagno, Marchant, & Morris, 2008, 2009; Ward, Smith, & Sharp, 1997), and the A-B-A variation appearing twice (e.g., Pates, Maynard, & Westbury, 2001; Polaha, Allen, & Studley, 2004). Interestingly, the reversal designs were typically applied to training or laboratory-based situations rather than to actual performance outcomes. In addition, Messagno and colleagues (2008, 2009) used the A-B-A-

B design to manipulate pressure with the A-phases as low pressure and the B-phases as high pressure situations respectively.

The multi-element design appeared in three of the reported studies (i.e., Galloway, 2011; Loukus, Bordieri, Dixon, & Bordieri, this issue; Pain, Harwood, & Anderson, 2011). More specifically, Pain et al. explored the effects of imagery and music using a multiple-treatment design on flow and soccer performance in 5 male collegiate soccer players. The participants received the intervention in the following elements: music, music and imagery, and imagery. Data indicated that the combined elements of music and imagery had a facilitative effect on flow and perceived soccer performance.

The alternating-treatment design appeared in one study with Lambert, Moore, and Dixon (1999) investigating the effects between different types of goal-setting strategies (self-set and coach-set) on the on-task gymnastic beam behavior across 4 female elite youth gymnasts. Participants were exposed to both goal-setting conditions. When clear and stable differences in data occurred under the two treatment conditions became apparent, a second phase was implemented where participants received the intervention that had been shown to be most effective.

Finally, one study used the changing-criterion design (Scott, Scott, & Goldwater, 1997). Scott et al. observed the effects of an electronic feedback intervention on the technical skill and performance of an international-level pole-vaulter using the changing-criterion design. The participant was required to break a photoelectric beam with his hands at the moment of take-off. The height of the beam was gradually increased until he reached maximum arm extension at take-off. Data revealed an increase in arm extension and in bar height clearance as a result of the intervention.

Intervention Characteristics

Analysis of the type of intervention adopted revealed that 46 studies used individual mental skills whilst 20 studies employed combined intervention packages.

Individual mental skills. In general, the individual mental skills targeted in these studies can be divided into five categories: imagery, hypnosis, goal setting, feedback, and self-talk. Specifically, 12 studies involved imagery (e.g., Bell, Skinner, & Fisher, 2009; Mellalieu, Hanton, & Thomas, 2009; Post, Punchie, & Simpson, in press; Wakefield & Smith, 2011), six studies used hypnosis-based interventions (e.g., Barker & Jones, 2005, 2008; Pates, Maynard et al. 2001), four studies used goal-setting (Lambert et al., 1999; Mellalieu et al., 2006; O'Brien, Mellalieu, & Hanton, , 2009; McCarthy, Jones, Harwood, & Davenport, 2010), three studies used feedback (Anderson & Kirkpatrick, 2002; Scott et al., 1997; Kladopoulous & McComas, 2001), and three studies used self-talk (Hamilton, Scott, & MacDougall, 2007; Johnson, Hrycaiko, Johnson, & Halas, 2004; Landin & Hebert, 1999). Additionally, 17 studies examined various interventions including public-posting (Gavin & Ward, 1998), bio-feedback (Galloway, 2011), self-monitoring (Polaha et al., 2004), behavioural coaching (Stokes, Luiselli, Reed, & Fleming, 2010), perceptual training (Oudejans, Koedijker, Bleijendaal, & Bakker, 2005; Scott et al., 1998), coping effectiveness (Reeves, Nicholls, & McKenna, 2011), self-modeling (Ram & McCullagh, 2003), pre-performance routines (Marlow et al., 1998; Messagno et al., 2008), social-support (Freeman, Rees, & Hardy, 2009), music (Messagno et al., 2009), mutual-sharing (Pain & Harwood, 2009), rational-emotive behavior therapy (REBT; Turner & Barker, this issue), cognitive self-dialogue (Neil, Hanton, & Mellalieu, this issue), and financial contingiences (Loukus et al., this issue).

Combined packages. Studies using combined packages can be divided into three categories: psychological skills training (PST) programs, mental-training packages, and

multi-modal intervention packages. Ten studies used traditional PST programs including goal setting, relaxation, imagery, and self-talk (Hanton & Jones, 1999; Patrick & Hrycaiko, 1998; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2001, 2003; Thelwell & Maynard, 2003; Thelwell et al., 2006; Thelwell, Weston, & Greenlees 2010; Thomas, Maynard, & Hanton, 2007; Wanlin, Hrycaiko, Martin, & Mahon, , 1997). Five studies used mental training packages including anxiety regulation (Annesi, 1998), emotional self-regulation (Robazza, Pellizzari, & Hanin, 2004), behavior modification (Lauer & Paiement, 2009), life-skill development (Jones et al., 2011), and an association and dissociation audio and visual package (Scott, Scott, Bedic, & Dowd, 1999). Finally, five studies used multi-modal interventions combining both mental skills and behavior modification techniques. These studies included goal setting and public posting (Ward, Smith & Sharp, 1997; Ward & Carnes, 2002), goal setting, public posting and oral feedback (Brobst & Ward, 2002), imagery and music (Pain, Harwood, & Anderson, 2011), and hypnosis, technique refinement, and self-modeling (Barker & Jones, 2006).

Dependent Variable Characteristics

Increased effort and performance-related behavior. Nine studies examined interventions to improve participant effort or performance-related behavior(s). Studies that focussed on increasing effort included rowing distance (Scott et al., 1999), gym triathlon performance (Thelwell & Greenlees, 2001, 2003), swimming stroke-count (Polaha et al., 2004), amount of work during a 20-minute cycling task (Hamilton et al., 2007), and 1 rep-max bicep curl performance (Wakefield & Smith, 2011). Studies targeted improvement in such performance-related behavior(s) as blocking and running routes in wide-receivers (Ward et al., 1997), offensive line-pass blocking (Stokes et al., 2010), and communication and organization skills (Jones et al., 2011).

Decreasing problem behaviors. Four studies focussed on decreasing problem behaviors including the successful reduction of inappropriate, angry, and aggressive outbursts in tennis (Allen, 1998; Galvan & Ward, 1998) and ice-hockey (Laurer & Paiemet, 2009), and a substantial reduction in occurrences of the 'yips' in golf (Bell et al., 2009).

Skilled performance development. Twenty-one studies focussed exclusively on improving skilled performance across participants in various sports (e.g., Brobst & Ward, 2002; Haddad & Tremayne, 2009; Loukus et al., this issue; Patrick & Hrycaiko, 1998; Thelwell et al., 2006; Thelwell et al., 2010). For example, Galloway (2011) successfully facilitated participants' tennis serve accuracy through a five-step biofeedback approach, whilst Wanlin et al. (1997) successfully improved speed-skaters' 500m race times through the use of PST program. Out of these 21 studies 20 were actual sport skills performed in real-world settings and one used a contrived performance skill task (McKenzie & Howe, 1997).

Psychological constructs. Ten studies focussed specifically on exploring the effects of interventions on psychological constructs including self-confidence (Callow et al., 2001), self-efficacy (Barker & Jones, 2005), collective-efficacy (Munroe-Chandler & Hall, 2004; Shearer et al., 2009), attention (Calmels, Berthoumieux, & d'Arripe-Longueville, 2004), imagery ability (Calmels, Holmes, Berthoumieux, & Singer, 2004), emotions (Robazza et al., 2004), affect (McCarthy et al., 2010), and anxiety (Mellalieu et al., 2009; Turner & Barker, this issue).

Psychological constructs and subjective performance. Six studies explored intervention effectiveness on psychological constructs and ratings of subjective performance. Specifically, studies focussed on anxiety and perceived tennis performance (Annesi, 1998), flow states and perceived basketball (Pates, Cummings, & Maynard, 2002) and soccer performance (Pain et al., 2011), self-efficacy and perceived soccer performance (Barker & Jones, 2008; Reeves et al., 2011), and team functioning and perceived soccer performance

(Pain & Harwood, 2009). Further, one study explored the effects of a hypnosis-based intervention on subjective ratings of basketball free throw and jump shot performance (Pates, Maynard, et al., 2001).

Psychological constructs and actual performance. Fifteen studies sought to ascertain the effects of various interventions on both psychological constructs and actual performance outcomes. Included here were studies exploring flow states and golf putting (Pates, Oliver, & Maynard, 2001) and cycling performance (Lindsay, Maynard, & Thomas, 2005), anxiety and- swimming times (Hanton & Jones, 1999), hockey performance (Thomas et al., 2007), 10-pin bowling (Messagno et al., 2008), free-throw basketball shooting (Messagno et al., 2009), and boxing performance (O'Brien et al., 2009), self-confidence and cricket bowling (Barker & Jones, 2006), volleyball serve (Ram & McCullagh, 2003), dart throwing (McKenzie & Howe, 1997), and horse racing (Callow & Waters, 2005), perceptual skill and soccer performance (Jordet, 2005), social support and golf score (Freeman et al., 2009), emotions and golf score (Neil et al., this issue), and finally imagery ability and swim times (Post et al., in press).

Procedural Reliability or Treatment Integrity

A procedural reliability assessment ensures that an intervention is applied as intended. Typically, in a formal procedural reliability assessment, two or more observers independently evaluate whether specific components of an intervention are applied as described by the researchers or practitioners. A procedural reliability score may also be computed (Martin et al., 2004). Treatment-integrity refers to the researcher's or practitioner's responsibility to describe the intervention and procedures within a study to allow for future consistency in delivery and replication of procedures. A treatment-integrity check does not include a formal reliability assessment of the application of the specific components of an intervention. Instead, a check may be achieved by presenting materials used during the intervention (e.g.,

imagery scripts) or by requesting participants to keep intervention diaries about self-practice and adherence (Barker et al., 2011). From the searched studies, 42 included either a procedural reliability assessment or a treatment integrity check. The remaining 24 did not present any evidence of either procedure.

Analysis Procedures

Traditional analysis of single-case data has included visual inspection or analysis of descriptive statistics along with the inspection of trends and patterns of data through graphical analysis (Bloom, Fischer, & Orme, 2009; Kazdin, 2011). Graphical analysis may include the calculation of celeration lines or the split-middle method (White, 1971) to further explain and describe changes and trends in dependent variables. Alongside both visual and graphical analysis evaluating change in single-case data can also be achieved through tests of statistical significance including traditional parametric and non-parametric statistics (e.g., chi-square, *t*-tests, *F*-tests, Mann-Whitney U) and time-series analysis (Huitema, 2004; Kazdin, 2011; Parker & Brossart, 2003) including interrupted time-series analysis procedures (ITSACORR; Crosbie, 1993). From the literature search, all 66 studies employed both visual analysis and graphical procedures. Nine studies used the split-middle technique to assess trends and patterns in data (Callow et al., 2001; Callow & Waters, 2005; Marlow et al., 1998; Messagno et al., 2008, 2009; Munroe-Chandler & Hall, 2004; Oudejans et al., 2005; Post et al., in press; Wakefield & Smith, 2011). Sixteen studies used statistical analysis to assess data including *t*-tests (Annesi, 1998; Barker & Jones, 2008; Calmels, Berthoumieux et al., 2004; Robazza et al., 2004; Scott et al., 1998; Turner & Barker, this issue), Mann-Whitney U (Calmels, Holmes et al., 2004; McCarthy et al., 2010), *F*-tests (Barker & Jones, 2006, Landin & Hebert, 1999; Loukus et al., this issue), ITSACORR (Callow & Waters, 2005; Freeman et al., 2009), binomial tests (Marlow et al., 1998; Wakefield & Smith, 2011), and standard mean difference (Jones et al., 2011).

Social Validation

The notion of social validity is an integral part of SCDs and is designed to ensure that interventions consider views from the consumers of interventions (e.g., teammates, parents, coaches; Kazdin, 2011; Schwartz & Baer, 1991). Social validity typically encompasses three questions about interventions (Martin et al., 2004): (a) What do participants (and significant others) think about the goals of the intervention? (b) What do they think about the intervention procedures? and (c) What do they think about the results produced by the intervention procedures? For the review, 34 studies used a social validation questionnaire based around the three questions listed previously (e.g., Freeman et al., 2009; Mellalieu et al., 2009; Thomas et al., 2007). Six studies adopted a social validation questionnaire for both participants and coaches (e.g., Brobst & Ward, 2002; Galloway, 2011; Johnson et al., 2004; Mellalieu et al., 2006; Messagno et al., 2009; Rogerson & Hrycaiko, 2002), one study used a questionnaire for participants and parents (Allen, 1998), and another developed a questionnaire for participants, coaches, and parents (Turner & Barker, this issue). Regarding the adoption of social validation interviews, 16 studies used an interview for participants post-intervention (e.g., Jones et al., 2011; Reeves et al., 2011; Wakefield & Smith, 2011), two studies interviewed coaches (Patrick & Hrycaiko, 1998; Scott et al., 1999), and one interviewed participants and coaches (Johnson et al., 2004). In addition, one study used a social validation focus group for participants following delivery of an intervention with a soccer team (Pain & Harwood, 2009). Fourteen studies did not include any evidence of social validation procedures (e.g., Annesi, 1998; Loukus et al., this issue; McKenzie & Howe, 1997; Post et al., in press).

Discussion

The primary purpose of the current paper was to provide a comprehensive review of SCD studies in sport psychology between 1997 and 2012. The following sections contextualise the

issues emanating from the summary of research along with suggestions for the future application of SCDs in applied sport psychology research.

In relation to participant characteristics, the literature indicates a clear reliance on collegiate, competitive, and recreational participants with only a few studies using professional and international athletes. The lack of high-level athletes used in SCD studies remains a limitation of this body of research literature. This limitation has not been addressed adequately despite repeated calls from researchers to undertake and publish work with elite participants (e.g., see Martin et al., 2004; Moran, 2012). The finding is also surprising on two levels. First, accreditation bodies (e.g., Association for Applied Sport Psychology; AASP and British Psychological Society; BPS) require individuals to deliver and evaluate intervention work, which typically may be with elite athletes. Second, SCDs would appear particularly suitable for work with high-level athletes given large group studies with high-level athletes rarely happen because of the difficulties of getting large numbers of participants (Barker et al., 2011). The review also revealed limited application of SCDs to sports teams (e.g., Pain & Harwood, 2009) and disabled athletes (Shearer et al., 2009), whilst no study included coaches, sport science support staff or medical personnel. In sum, to provide a more comprehensive understanding of the issues and effectiveness of interventions in sport psychology, future SCD researchers should draw upon participants including elite able and disabled athletes, sports teams, coaches, and sport science support staff (Harwood & Steptoe, this issue; Kinugasa, this issue).

Analysis of the types of designs used across the studies revealed the multiple-baseline across-participants variation to be the most prevalent. A key attraction to this design is that it does not require a reversal phase to determine intervention effectiveness and thus is participant friendly (Kazdin, 2011). Further, the design has also been advocated to be particularly pertinent for applied sport psychology given that researchers and practitioners are

often required to work with individuals from the same team or with individuals sharing similar performance-related issues (Bryan, 1987; Hrycaiko & Martin, 1996). In contrast, there were few examples of the across-behaviors design variation, which is surprising because practitioners and researchers may be interested in assessing interventions across more than one dependent variable (e.g., performance and self-confidence). The across-settings and across-group designs also appeared occasionally even though these designs are appropriate to determine intervention effectiveness for an individual or group across different situations (e.g., home and away performance), or evaluating the effects of interventions between different sport groups (e.g., age specific development squads; Barker et al., 2011). Future researchers may look to move beyond the across-participants design where appropriate by embracing other multiple-baseline variations. Publications using other design options will help to increase an understanding and awareness of their potential application. Furthermore, future researchers might consider the multiple-probe design (Horner & Baer, 1978), which is a variation of the multiple-baseline design and includes brief 'probes' taken at baseline and during the intervention (Kazdin, 2011). The design has been suggested to be useful in situations in which the collection of prolonged baselines and repeated measures does not fit with the needs of the participant or situation (e.g., crisis interventions). Currently no studies in sport psychology have adopted this design.

Various studies in the current review used the A-B design despite it being reported to be arguably the weakest SCD because of difficulties in determining true intervention effects from natural development (Morgan & Morgan, 2009). The A-B design remains an important tool, particularly for practitioners looking to quantify intervention effectiveness in their professional practice where removing an intervention or having multiple participants is neither appropriate nor feasible (Barker et al., 2011). We posit that the A-B design remains a common feature for professional practice researchers (despite its limitations) particularly if

the design provides an approach to present work with elite or professional athletes (e.g., Barker & Jones, 2008). The use of social validation data can partially address the limitation of A-B designs in determining what has brought about any change.

The reversal design is advocated to be the most robust single-case design in determining causal inferences regarding intervention effectiveness (Kazdin, 2011); however, removing interventions and reversal of behaviors can be unethical and logistically challenging in applied practice and research (Hrycaiko & Martin, 1996). Practitioners will continue to face the ethical dilemma of using the reversal design in professional practice (e.g., Heyman, 1987), whilst researchers may feel more comfortable using the design in laboratory-based experiments where removing an intervention before a contrived performance task will not have the same consequences as if removed for a professional athlete before an important competition (e.g., Pates, Maynard, et al., 2001).

The present review identified only one example of the alternating-treatment design, which is surprising because this design systematically provides a framework to alternate two or more interventions across time and compare relative responses of the dependent variables to each intervention. Comparing changes in dependent variables may be important when exploring potentially effective or redundant interventions for the same participant(s) (Kazdin, 2011). Our review also provided illustrations of the multi-element design. The multi-element design is particularly important to determine how a participant performs under different intervention conditions. The design has been reported to be experimentally strong because data typically reveal clear differences on dependent variables(s) when different elements of an intervention are presented individually or collectively (Kazdin). Both of these designs are viable options for researchers who are concerned about comparing intervention effects or when deciding which intervention(s) work best for a participant or group when several options may be appropriate (see Loukus et al., this issue; Pain et al., 2011). Finally, these

designs also represent an obvious strategy with which to reduce the shortcomings of multi-modal interventions where it can often be difficult to determine which elements had the most beneficial effect on the dependent variables (Collins, Morriss, & Trower, 1999).

Finally, only one example of the changing-criterion design appeared in the literature. The limited application of this design is hardly surprising as it is usually restricted to enhancing, reducing, or shaping habitual behavior and is less appropriate where the dependent variables include psychological constructs (Kazdin, 2011). Therefore, the design may be appropriate in situations where gradual changes (using goal-setting interventions) are required to manipulate important sport behaviors such as skill development (Kinugasa et al., 2004). However, future research in exercise psychology and physical activity may consider adopting this design to modify exercise adherence and physical activity pattern related behavior (see Gorczynski, this issue). In addition, researchers may also be interested in the range-bound criterion (McDougall, 2005) and the distributed-criterion design options (McDougall, 2006). Both of these designs could help researchers evaluate the efficacy of goal setting and behavioral self-management on sport and exercise behavior (see McDougall, this issue).

Another key aspect of SCDs and intervention research per se has been to assess intervention and maintenance effects improvements over time (Gardner & Moore, 2006; Martin et al., 2004). Our analysis of the 66 studies revealed that only 12 involved a follow-up phase or maintenance check (Allen, 1998; Barker & Jones, 2005, 2006; Bell et al., 2009; Brobst & Ward 2002; Galloway, 2011; Hanton & Jones, 1999; McKenzie & Howe, 1997; Neil et al., this issue; O'Brien et al., 2009; Reeves et al., 2011). To allow stronger conclusions to be drawn about long-term intervention effectiveness, future researchers should consider the inclusion of follow-up or maintenance check procedures, where appropriate.

Evaluation of the intervention characteristics across the studies indicated that various traditional and novel techniques have been used in individual and combined packages to bring about change in behavior, constructs, and performance. The range of interventions used is comparable with that in previous research (Martin et al., 2004) and highlights the substantial body of research exploring intervention effectiveness in sport psychology. Specifically, across the 46 studies involving individual mental skills, imagery, hypnosis, goal setting, and feedback where the most common techniques represented. Whilst in the 20 studies using combined packages, PST's, mental-training packages, and multi-modal interventions were the most prevalent.

The present review indicated that whilst SCD studies typically relied on traditional and well established psychological skills (e.g., imagery and goal setting) researchers have recently used techniques from the domains of counselling, psychotherapy, and behavior modification and explored their efficacy in sport psychology (e.g., hypnosis, REBT, bio-feedback, social support, mutual-sharing, public posting, self-monitoring). Indeed, exploring 'new' techniques in the context of sport psychology has not only encouraged innovative thinking and impetus for continued intervention research, but has further increased the tools available to applied sport psychologists. Future research is needed to explore the salience of these 'new' techniques in comparison to more traditional and widely used interventions (Mellalieu & Shearer, 2012).

Studies in our review also assessed the effects of combined intervention packages, including the predominant use of PST programs (e.g., Thelwell & Greenlees, 2001), mental training packages (e.g., Annesi, 1998), and multi-modal interventions (e.g., Hanton & Jones, 1999). The prevalence of these combined packages reflects the real world of doing sport psychology where psychological skills are often packaged together and presented simultaneously to participants (Thelwell et al., 2010) or based on an individual's needs

analysis (e.g., Barker & Jones, 2006). Whilst combined interventions are practically appropriate, they make it difficult to draw causal inferences about which elements were most effective in bringing about changes in dependent variables. Consequently, future researchers may consider including a component analysis to identify the most active and effective elements of a treatment package (Miltenberger, Fuqua, & McKinley, 1985).

In applied behavior analysis SCDs have been used as a framework to assess the effectiveness of various interventions in reducing, increasing, or shaping overt behavior (Kazdin, 1982). In contrast, the current review revealed SCDs have been applied to various outcomes. To illustrate, studies have focussed on outcomes such as effort (e.g., rowing distance; Scott et al., 1999), performance-related behavior (e.g., offensive line-pass blocking; Stokes et al., 2010), skilled performance (e.g., tennis serve accuracy; Galloway, 2011), psychological constructs (e.g., anxiety; Mellalieu et al., 2009), subjective performance (e.g., ratings of basketball performance; Pates, Maynard et al., 2001), actual performance (e.g., horse-racing; Callow & Waters, 2005), and to decrease problem behaviors (e.g., inappropriate on-court outbursts; Galvan & Ward, 1998). In sum, given the fact that many SCD studies have used psychological constructs as outcome variables (e.g., anxiety; Hanton & Jones, 1999), future researchers should consider triangulating multiple-measures (e.g., self-report, observation, and social-comparison) to allow stronger intervention effectiveness conclusions (Kazdin, 2011). Overall, SCDs have typically been used to either increase or decrease outcomes including overt behaviors and psychological constructs. The range of outcomes used in this review further demonstrates the versatility of SCDs in applied research (Barker et al., 2011).

Regarding the assessment of performance, some studies used subjective measures of performance in situations where it was difficult to collate objective markers (e.g., Barker & Jones, 2008; Pain & Harwood, 2009). Whilst such measures often reflect the real-world of

professional practice, they are potentially open to response bias and social desirability. In contrast, some studies assessed intervention effectiveness on actual sport-related performance (e.g., O'Brien et al., 2009). Such studies are important because they demonstrate the true value of sport psychology interventions to athletes, coaches, and fellow practitioners. Therefore, where appropriate, we encourage researchers and practitioners to collect objective markers of performance (e.g., match analysis statistics) to overcome potential restrictions with subjective measures and to enable more accurate evaluations of practice and intervention effectiveness.

In relation to visual- and graphical analysis, many researchers have argued that there are several characteristics of the data that should be examined including: changes in means, levels, and trends, and speed of changes (see Gage & Lewis, this issue; Kazdin, 2011; Ottenbacher, 1986). To this end, our review revealed that all of the studies used both visual- and graphical analysis techniques to determine intervention effectiveness. Moreover, a few studies moved beyond conventional graphical analysis techniques and undertook trend or pattern analysis using the split-middle technique (e.g., Callow & Waters, 2005). Future SCD research in sport psychology should therefore seek to draw on trend and pattern analyses to further delineate treatment effects (Barker et al., 2011). In addition to visual- and graphical analysis some studies also adopted one of a range of statistical analysis procedures (e.g., Jones et al., 2011; McCarthy et al., 2010; Wakefield & Smith, 2011). Recently, there has been an increased interest and willingness to use statistical analysis in SCDs. Statistical analyses are seen as a complementary method to visual- and graphical procedures for evaluating the results of single-case studies, but also a method that can permit the accumulation of knowledge from different investigations (Kazdin, 2011). The typical beginning point for using statistical analysis in SCDs is to determine *serial dependence*. Serial dependence refers to the relationship of the data points to each other in the series of

continuous observations. The dependence reflects the fact that the residuals (error) in the data points are correlated from one occasion to the next. It is measured by evaluating whether the data are correlated over time (i.e., autocorrelation; Ottenbacher, 1986). Serial dependence must be calculated in SCDs where appropriate as its presence violates a number of assumptions to many statistical tests. Serial dependence has not always consistently been applied to SCDs in sport psychology, therefore future researchers should consider undertaking this procedure before drawing on statistical analyses procedures.

Various statistical techniques are currently available to SCD researchers in sport psychology. These techniques include *t*-tests, hierarchical linear modeling, and time-series analysis (for a review see Gage & Lewis, this issue). The prevalence of time-series analysis in the review was somewhat scant with only two examples (Callow & Waters, 2005; Freeman et al., 2009) using ITSACORR procedures (Crosbie, 1993). Time-series analysis is used to compare data over time for separate phases for an individual or group of participants. The analysis examines whether there is statistically significant change in level and trend from one phase to the next (Kinugasa et al., 2004). Whilst not wanting to present quantitative analysis (including time-series analysis) as a panacea for all SCD data analysis procedures, future researchers should consider embracing statistical procedures to further assist visual- and graphical analysis in determining treatment effects (cf. Gage & Lewis, this issue).

Finally, the review indicated that most studies included some form of social validation procedures. Examples included open-ended questionnaires, interviews, and focus groups with data collection commonly involving participants, coaches, and parents (for a review see Page & Thelwell, this issue). According to Kazdin (2011) social validation not only involves gaining feedback about the delivery and consumption of interventions but also includes social-comparison (i.e., comparing the participant or group with a peer group on the same dependent variable(s) and subjective evaluation (i.e., gathering the opinions of others who

have familiarity with the participant or group). Therefore, the studies in this review typically gained feedback on the interventions with very few demonstrations of subjective-evaluation (e.g., Allen, 1998; Turner & Barker, this issue), whilst none explored social-comparison. Future researchers therefore should consider providing a more holistic evaluation of social-validation in SCD studies (Page & Thelwell, this issue).

Summary and Conclusions

This review focussed on exploring the research methods used in SCD research from 1997-2012. Overall, literature indicated an increase in use of SCDs in sport psychology as a method to identify small but significant changes in athletes' performance over time. The review also outlined that SCDs can be used to evaluate interventions and thereby, to establish cost-effective, evidence-based practice in applied sport psychology. In this review, we have outlined trends, and limitations of SCD research between 1997 and 2012 along with outlining areas for future investigation.

One limitation of this review is that we have focused on methods rather than outlining how the methods can be used to help explain the cognitive and behavioral mechanisms underpinning sport performance. Whilst this is a limitation of this current review it is also a general limitation that can be applied to any facet of sport psychology research. Indeed, using SCDs to determine mechanisms in applied sport psychology research may help our understanding. For example, SCDs provide a framework with which to explore cause and effect relationships in unique and small populations (e.g., elite athletes; Kinugasa et al., 2004). SCDs have also driven research in the development and application of unique interventions because they allow for repeated measurement over time, investigation of individual differences and responses, individual feedback about tailored interventions, and reveal individual treatment effects. To illustrate, two areas where SCDs have recently driven sport psychology intervention research is in relation to hypnosis (e.g., Barker & Jones, 2006,

2008; Pates, Maynard et al. 2001) and imagery (e.g., Bell et al. 2009; Mellalieu et al. 2009). Despite these examples it is beyond the scope of this review to determine the kind of contribution made by SCDs in enhancing our practices and understanding in sport psychology, but undoubtedly is an important question worthy of future exploration.

Researchers should consider using SCDs as a platform to guide their research questions and determine mechanisms rather than as just another method to employ. Ultimately, SCDs are an important aspect of research methodology, however they should be viewed as contributing to the literature as an adjunct to group-based research. Accordingly, researchers using SCDs in the future should consider: the use of elite or unique participants; differing design options; follow-up or maintenance effects assessment; component analysis; triangulation of outcomes; innovations in statistical analysis; an holistic assessment of social validation; along with integrating SCDs into the areas of coaching- and exercise psychology. Moreover, together with developing the extant literature we also encourage individuals currently undertaking sport psychology accreditation programs to embrace SCDs as a framework with which to determine their professional practice effectiveness when compiling evidence-based portfolios.

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Table 1 Research Publications in Sport Psychology using Single-Case Methods: 1997-2012

Study	Sport/Task/Activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
McKenzie & Howe (1997)	Dart-throwing	3 male and 3 female collegiate students	MB across participants	Imagery	Self-efficacy; dart throwing performance	No	VA GA
Scott, Scott, & Goldwater, (1997)	Pole-vault	1 male international athlete	Changing-criterion	Prompting and shaping with electronic feedback	Arm extension at take off; performance	No	VA GA
Wanlin, Hrycaiko, Martin, & Mahon (1997)	Speed skating	4 female youth skaters	MB across participants	Goal-setting, self-monitoring, self-talk, imagery package	Number of laps and drills completed; 500 meter race times	Yes	VA GA SVQ participants
Ward, Smith, & Sharp (1997)	American football	5 male college wide receivers	ABAB	Goal-setting and public posting	Blocking; running routes	No	VA GA SVQ for participants and coaches
Allen (1998)	Tennis	1 male elite youth player	MB across settings	Simplified habit reversal (SHR)	Angry on-court outbursts during matches	Yes	VA GA SVQ for particiapant and parents
Annesi (1998)	Tennis	2 male and 1 female elite youth players	AB	Anxiety regulation package	Competitive state anxiety (CSAI-2); subjective ratings of performance	No	VA GA SA (*t*-tests and effect size)
Galvan & Ward (1998)	Tennis	4 male and 1 female college players	MB across participants	Public posting	Inappropriate on-court behaviors	Yes	VA GA SVQ for participants
Marlow, Bull, Heath, & Shambrook (1998)	Water-Polo	3 male elite water-polo players	MB across participants	Pre-performance routine	Penalty shooting performance	No	VA GA (split-middle technique) SA (binomial tests) SVI for participants
Patrick & Hrycaiko (1998)	Track and triathlon	1 male adult elite runner and 3 male adult triathletes	MB across participants	Goal-setting, relaxation, imagery, and self-talk package	1,600 meter running times	Yes	VA GA SVQ for participants SVI for coaches
Scott, Scott, & Howe (1998)	Tennis	3 male and 3 female recreational tennis players	AB	Tennis-serve anticipation enhancing videos	On-court serve-return performance	No	VA GA SA (t-tests)

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Hanton & Jones (1999)	Swimming	4 male elite adult swimmers	MB across participants	Goal-setting, Imagery, and self-talk package	Competitive state anxiety (CSAI-2D); swimming times and splits	No	VA GA SVQ for participants
Lambert, Moore, & Dixon (1999)	Gymnastics	4 female elite youth gymnasts	Alternating-Treatment Design (ATD)	Self-set and coach-set goal-setting procedures	On-task behavior directed related to the beam activity	Yes	VA GA
Landin & Hebert (1999)	Tennis	5 female college players	MB across participants	A two-word self-talk strategy	Volleying skill	Yes	VA GA SA (ANOVA) SVQ and SVI for participants
Scott, Scott, Bedic, & Dowd (1999)	Rowing	5 female and 4 male adult novice rowers	MB across participants	An association audio tape, a music dissociation tape, or a dissociation video tape of rowing	Distance rowed indoors during a 40min ergometer session	Yes	VA GA SVI for coaches
Callow, Hardy, & Hall (2001)	Badminton	3 male and 1 female high-level youth players	MB across participants	Motivational General-Mastery (MG-M) imagery	State sport confidence (SSCI)	Yes	VA GA (split-middle trend- and slope analysis); SVI for participants
Kladopoulos & McComas (2001)	Basketball	3 female college players	MB across participants	Instruction for proper form and praise for correct form	Free-throw percentage; proper shooting form	No	VA GA
Pates, Maynard, & Westbury (2001)	Basketball	3 male college players	ABA	Hypnosis plus a “trigger” word	Rating of free-throws and jump shots	Yes	VA GA SVQ and SVI for participants
Pates, Oliver, & Maynard (2001)	Golf	5 male adult “casual” golfers	MB across participants	Hypnosis and a “trigger” behavior	Flow states (FSS); Distance from the hole in putting	Yes	VA GA SVQ for partcipants
Thelwell & Greenlees (2001)	Track and triathlon	5 male adult recreational athletes	MB across participants	Goal-setting, relaxation, imagery, and self-talk package	Gym triathlon performance (rowing, cycling, running); mental skills useage	Yes	VA GA SVQ for participants
Anderson & Kirkpatrick (2002)	Roller Speed-Skating	1 female and 3 male youth competitive skaters	ABAB across participants	Verbal praise, performance feedback, and coaching instruction	Number of successful relay tags	Yes	VA GA

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Brobst & Ward (2002)	Soccer	3 female youth players	MB across-behaviors	Goal-setting, public posting, and oral feedback	Movement with ball, movement during re-starts, and movement after passing	Yes	VA GA SVQ for participants and coaches
Pates, Cummings, & Maynard (2002)	Basketball	5 male college players	MB across participants	Hypnosis plus a "trigger" word	Flow states (FSS); Rating of three-point shots	Yes	VA GA SVQ for participants
Rogerson & Hrycaiko (2002)	Ice hockey	4 male youth goal tenders	MB across participants	Relaxation and self-talk	Save percentage	Yes	VA GA SVQ for participants and coaches
Ward & Carnes (2002)	American football	5 male college line-backers	MB across behaviors	Goal-setting and public posting	Correct reads, drops, and tackles	No	VA GA
Ram & McCullagh (2003)	Volleyball	3 female and 2 male collegiate players	MB across participants	Self-modeling video	Volleyball serve performance, self-efficacy	No	VA GA SVI for participants
Thelwell & Greenlees (2003)	Track and triathlon	4 male adult recreational athletes	MB across participants	Goal-setting, relaxation, imagery, and self-talk package	Gym triathlon performance (rowing, cycling, running); mental skills useage	Yes	VA GA SVQ for participants
Thelwell & Maynard (2003)	Cricket	4 male semi-professional players	AB	Goal-setting, activation regulation, self-talk, imagery, and concentration package	Subjective cricket performance; actual cricket performance	No	VA GA SVQ for participants
Calmels, Berthoumieux, d'Arripe-Longueville (2004)	Softball	4 female national players	MB across participants	Imagery	Attentional style (B-TAIS)	No	VA GA SA (*t*-tests) SVQ for participants
Calmels, Holmes, Berthoumieux, & Singer (2004)	Softball	4 female national standard netballers	MB across participants	Imagery	Movement imagery vividness (VMIQ)	No	VA GA SA (Mann-Whitney U) SVQ for participants
Johnson, Hrycaiko, Johnson, & Halas (2004)	Soccer	4 female elite youth players	MB across participants	Self-talk	Soccer shooting performance	Yes	VA GA SVQ and SVI for participants and coaches

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Munroe-Chandler & Hall (2004)	Soccer	14 female competitive youth players	MB across groups	MG-M imagery	Collective-efficacy	Yes	VA GA(Split-middle technique) SVQ for participants
Polaha, Allen, & Studley (2004)	Swimming	8 fitness swimmers (5 female and 3 male) and 3 femal collegiate level swimmers	ABA	Self-monitoring	Stroke-count	Yes	VA GA
Robazza, Pellizzari, & Hanin (2004)	Roller-skating and Gymnastics	4 male high-level roller-hockey players 4 male and gymnasts	MB across participants	Emotional self-regulation package	Emotions and bodily symptoms	No	VA GA SA (paired-samples *t*-tests) SVQ for participants
Barker & Jones (2005)	Judo	1 female elite judoka	AB	Hypnotic intervention comprising ego-strengthening and self-hypnosis	Self-efficacy	No	VA GA SVQ and SVI for participant
Callow & Waters (2005)	Horse racing	3 male professional flat-race jockeys	MB across participants	Kinaesthetic imagery	State sport confidence (SSCI); racing performance	No	VA GA (split-middle technique) SA (ITSACORR) SVQ for participants
Jordet (2005)	Soccer	3 male elite soccer players	MB across participants	Imagery	Perception (visual exploratory activity and prospective control of future actions); soccer performance	Yes	VA GA SVQ and SVI for participants
Lindsay, Maynard, & Thomas (2005)	Cycling	2 male and 1 female elite cyclists	MB across participants	Hypnosis plus ‘trigger’	Cycling performance; flow states (FSS)	Yes	VA GA SVQ for participants
Oudejans, Koedijker, Bleijendaal, & Bakker (2005)	Basketball	5 male competitive level basketball players	MB across participants	Perceptual training intervention	Basketball jump shooting	No	VA GA (split-middle technique SA
Barker & Jones (2006)	Cricket	1 male semi-professional	AB	Hypnosis (including self-hypnosis), self-modeling, and technique refinement	Self-efficacy; bowling performance	Yes	VA GA SA(ANOVA) SVI for participant

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Mellalieu, Hanton, & O'Brien (2006)	Rugby union	5 male collegiate rugby union players	AB	Goal-setting	Performance related behaviours including number of ball carries, tackles, successful kicks and turnovers	Yes	VA GA SVQ for partcipants and coaches
Thelwell, Greenlees, & Weston (2006)	Soccer	5 male collegiate players	MB across participants	Relaxation, imagery and self-talk package	Soccer performance including successful first touch percentage, pass percentage, and tackle percentage	Yes	VA GA SVQ for participants
Hamilton, Scott, & MacDougall (2007)	Cycling	3 female and 6 male collegiate cyclists	MB across participants	Self-talk	Total amount of work over a 20mins cycling task (Kpm/20 minutes)	Yes	VA GA
Thomas, Maynard, & Hanton (2007)	Field hockey	3 female elite players	MB across participants	Psychological skills program	Competitive state anxiety (CSAI-2D); hockey performance	Yes	VA GA SVQ for participants
Barker & Jones (2008)	Soccer	1 male professional soccer player	AB	Hypnosis including ego-strengthening	Self-efficacy, positive and negative affect (PANAS), subjective ratings of soccer performance	No	VA GA SA (*t*-tests) SVI for participant
Messagno, Marchant, & Morris (2008)	Ten-pin bowling	3 male skilled ten-pin bowlers	ABAB	Pre-performance routine development	Anxiety (i.e., CSAI-2, SAS); coping style; self-consciousness; bowling performance; routine	Yes	VA GA (split-middle technique) SVI for participants
Bell, Skinner, & Fisher (2009)	Golf	3 experienced male golfers	MB across participants	Solution-focussed guided imagery	Occurrence of 'yips' during rounds of golf	Yes	VA GA
Freeman, Rees, & Hardy (2009)	Golf	3 male high-level golfers	MB across participants	Social-support intervention	Received social-support; golf performance	No	VA GA SA (ITSACORR); SVQ for participants
Haddad & Tremayne (2009)	Basketball	2 female and 3 make junior representative players	MB across participants	Centering	Free-throw shooting performance	No	VA GA SVQ for participants
Lauer & Paiement (2009)	Ice-hockey	3 male youth players	MB across participants	Behavior modification program	Frequency of aggressive acts; emotional toughness	Yes	VA GA SVQ and SVI for participants

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Mellalieu, Hanton, & Thomas (2009)	Rugby union	5 male collegiate rugby players	MB across participants	Imagery	Competitive state anxiety (CSAI-2D); affect	Yes	VA GA SVQ for participants
Messagno, Marchant, & Morris (2009)	Basketball	3 experienced female basketball players	ABAB	Music	Anxiety (i.e., CSAI-2, SAS); coping style; self-conciousness; free-throw shooting performance	No	VA GA (split-middle technique) SVQ and SVI for participants
O'Brien, Mellalieu, & Hanton (2009)	Boxing	3 elite male and 3 non-elite boxers	MB across participants	Goal-setting	Boxing performance behaviors (e.g., number of punches landed); CSAI-2D)	Yes	VA GA SVQ for participants
Pain & Harwood (2009)	Soccer	Collegiate male soccer team (n=18)	AB	Mutual-sharing based intervention	Team functioning variables; subjective soccer performance	No	VA GA SVFG for participants
Shearer, Mellalieu, Thomson, & Shearer (2009)	Wheel-chair basketball	10 elite males	MB across groups	MG-M imagery	Collective-efficacy (CEI)	NO	VA GA SVQ for participants
McCarthy, Jones, Harwood, & Davenport (2010)	Multi-eventing	3 female junior athletes	MB across participants	Goal-setting	Positive and negative affect (PANAS)	Yes	VA GA SA (Mann Whitney-U); SVQ for participants
Stokes, Luiselli, Reed, & Fleming (2010)	American Football	5 male high school players	MB across participants	Behavioral coaching intervention	Offensive line pass-blocking	Yes	VA GA SVQ for participants
Thelwell, Weston, & Greenlees (2010)	Soccer	3 male amateur soccer players	MB across participants	Relaxation, self-talk, and imagery package	Pass, tackle, and first touch percentage	Yes	VA GA SVQ for participants
Galloway (2011)	Tennis	6 elite male junior tennis players	Multi-element	5-step bio-feedback intervention	Tennis-serve accuracy	Yes	VA GA SVQ for participants and coaches

Study	Sport/task/activity	Participants	Design	Intervention	Dependent variable(s)	Procedural reliability or treatment integrity	Analysis procedures
Jones, Lavallee, & Tod (2011)	Tennis and Field Hockey	Collegiate 3 male tennis players; 2 female hockey players	MB across behaviors	ELITE life skill intervention program	Communication and organization	Yes	VA GA SA (Standard Mean Difference) SVI for participants
Pain, Harwood, & Anderson (2011)	Soccer	5 male collegiate soccer players	Multi-element	Imagery and music	Flow states (FSS); perceived performance	Yes	VA GA SVQ for participants
Reeves, Nicholls, & McKenna (2011)	Soccer	5 male elite junior soccer players	MB across participants	Coping effectiveness training	Coping self-efficacy; coping effectiveness; subjective soccer performance	Yes	VA GA SVI for participants
Wakefield & Smith (2011)	Weight-lifting	4 male collegiate students	MB across participants	PETTLEP Imagery	1 rep-max bicep curl performance	No	VA GA (Split-middle technique) SA (binomial tests; effect size) SVI for participants
Loukus, Bordieri, Dixon, & Bordieri (special issue)	Golf	1 male professional golfer and 3 male recreational golfers	Multi-element	Financial contingencies	Golf putting and chipping performance-distance from the hole	Yes	VA GA SA (ANOVA and *t*-tests)
Neil, Hanton, & Mellalieu (special issue)	Golf	4 male adult recreational golfers	MB across participants	Cognitive-self-dialogue technique	Emotions; golf performance;	Yes	VA GA SVQ and SVI for participants
Post, Punchie, & Simpson (in press)	Swimming	1 male and 3 female elite youth swimmers	MB across participants	Imagery	Imagery ability; 1000-yard swim times	Yes	VA GA (Split-middle technique)
Turner & Barker (special issue)	Cricket	4 male elite youth cricketers	MB across participants	Rational-Emotive Behavior Therapy (REBT)	Irrational beliefs (SGABS); Anxiety (SAS-2)	Yes	VA GA SA (*t*-tests) SVQ for participants, coaches, and parents

Abbreviations:

VA-visual analysis; GA-graphical analysis; SA-statistical analysis; SVQ-social validation questionnaire; SVI-social validation interview; SVFG-social validation focus group