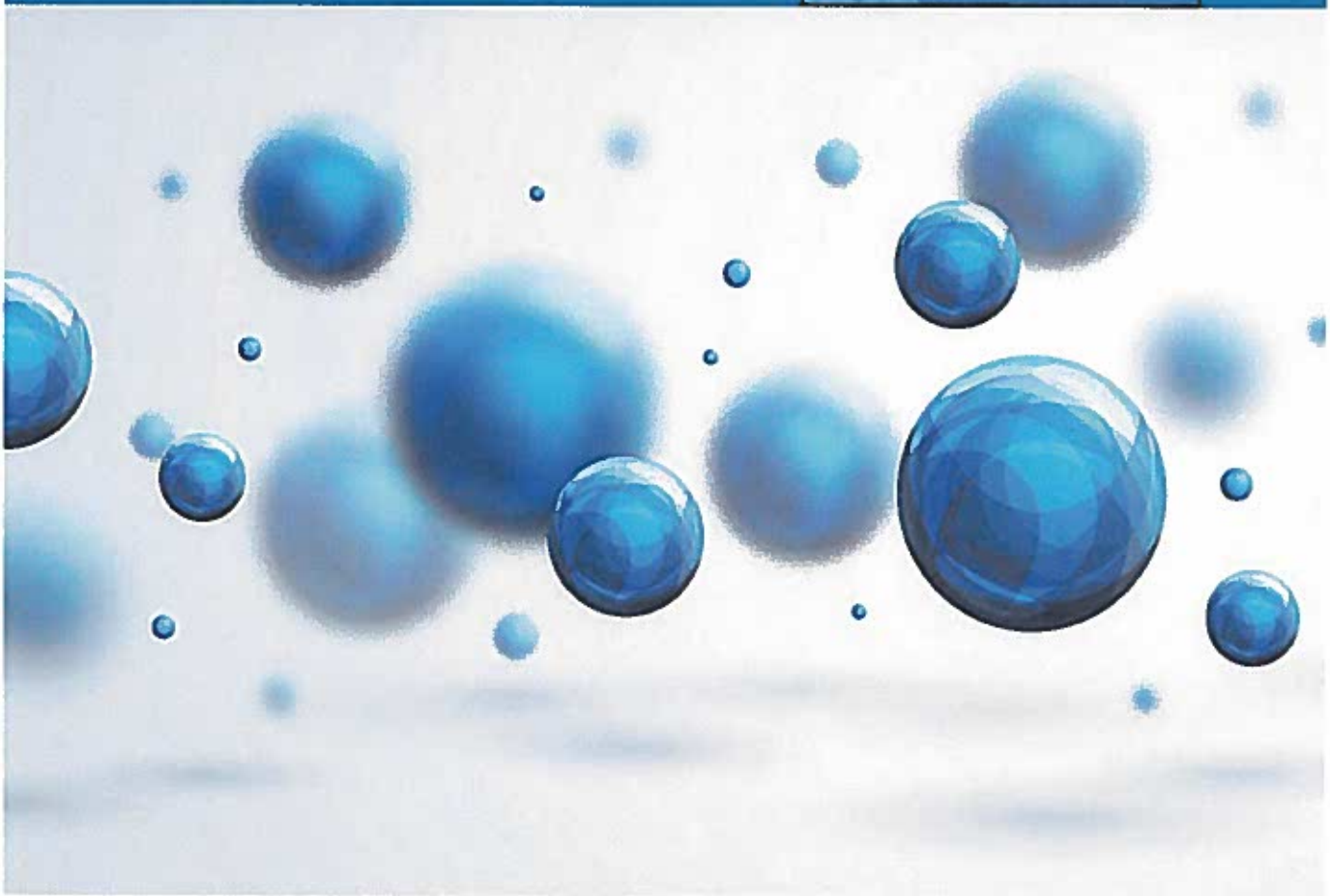
PRACTICAL RESOURCES for the Mental Health PROFESSIONAL



Clinical and Organizational Applications of Applied Behavior Analysis

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CHAPTER 21

Applied Behavior Analysis and Sports Performance

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In 1974, McKenzie and Rushall published one of the first studies using applied behavior analysis (ABA) methods to improve sports performance. About 40 years later ABA continues to play a vital role in sports with youth, collegiate, and elite athletes (Luiselli & Reed, 2011; Luiselli, Woods & Reed, 2011; Martin, 2011). Behavioral intervention and research has focused on many sports, including football, basketball, swimming, tennis, soccer, and others. ABA applications have also been used to increase exercise and physical activity in normative and at-risk populations (DeLuca & Holborn, 1992; Fitterling, Martin, Gramling, Cole, & Milan, 1988; Wack, Crosland, & Miltenberger, 2014). In this chapter, we review ABA and sports performance by describing seminal and contemporary studies, highlighting key areas that impact practice and research, and summarizing future directions.

OVERVIEW

Martin and Thomson (2011) identified several characteristics of ABA-sports performance, which they subsumed under the category of *behavioral sport psychology*. First, the specialty area of ABA and sports "involves identifying target behaviors of athletes and/or coaches to be improved, defining those behaviors in a way so that they can be reliably measured, and using changes in the behavioral measure as the best indicator of the extent to which the recipient of an intervention is being helped" (p. 5). A second characteristic is that ABA interventions with athletes rely on principles and procedures of both respondent and operant conditioning. Third, most ABA-sports research has relied on single-case experimental methods as a strategy for evaluating intervention effectiveness (Luiselli, 2011; Martin, Thompson, & Regehr, 2004). Finally, social validation assessment emphasizes how the

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recipients of ABA-sports interventions value the goals, procedures, and results of the services they received. We explore each of these characteristics in more detail later in the chapter.

Martin and Thomson (2011) also commented that many interventions with athletes "have been developed by practitioners with a cognitive-behavioral orientation" (p. 7). Although some behavior analysts dismiss the influence of cognitive processes in human learning, cognitively focused sport psychologists have demonstrated that manipulating an athlete's thoughts and attitudes can improve performance (Brown, 2011; Zinsser, Bunker, & Williams, 2006). In effect, "from an applied behavior analysis (ABA) perspective. . .it is assumed that the behavioral principles and techniques that apply to overt behaviors are also applicable to covert behaviors" (Martin & Thomson, 2011, p. 7). As revealed in our subsequent research review, goal setting, imagery training, and self-talk are cognitive-behavioral procedures sometimes included with ABA-sports interventions.

Several other characteristics of ABA-sports intervention should be highlighted. One prominent concern is the distinction between skills and performance deficits. Some children and adults, for example, receive intervention to teach them new athletic skills or skills that have yet to be mastered. In other cases, the focus of intervention is to improve and perfect performance of acquired skills. Accordingly, skills and performance objectives may involve different intervention methods. Additionally, skill acquisition is usually the purview of practice and training sessions, whereas improving performance is in the domain of competitive events.

Whether skills- or performance-focused, ABA-sports interventions must include procedures for motivating athletes during practice and competition. Motivation is influenced by several factors such as (a) positive and negative reinforcement contingencies arranged for athletic behaviors, (b) manipulation of establishing operations (Michel, 1982), and (c) proper identification of reinforcing stimuli, ideally through preference assessment (Tiger & Kliebert, 2011). Virtually all of the studies reviewed in this chapter illustrate the influence of motivational processes when intervening with athletes at every level.

Behavioral assessment is fundamental within sport psychology in general (Tkachuk, Leslie-Toogood, & Martin, 2003) and a cornerstone of ABA across multiple disciplines (Kazdin, 2013). Within sports, behavioral assessment is principally focused on evaluating effectiveness by measuring intervention-targeted responses. However, behavioral assessment has other objectives as well, namely, selecting skill and performance objectives, identifying functional influences on responding, and informing intervention

planning. Ideally, behavioral assessment should encompass multiple methods to provide the broadest possible documentation of critical measures.

ABA-SPORTS RESEARCH

This section of the chapter describes ABA intervention research in several sports. The representative studies are not inclusive of the extant literature; instead, we selected sports that have the largest research base or have been studied recently with promising results. We also reference less frequently studied sports to illustrate the full extent of ABA work in the athletic arena. For each sport, we highlight procedural methodology in light of the intervention objectives and some of the commonalities and differences among the studies.

Football

Allison and Ayllon (1980) evaluated a behavioral coaching intervention with four youth football players (11-12 years old) to teach them line blocking skills. The responses constituting a correct block were identified and described in an 8-step task analysis. The dependent measure in the study was the percentage of trials in which each player demonstrated all of the steps correctly. During a standard coaching (baseline) phase, the coach instructed players in what he wanted them to do, praised correct execution, and "loudly informed the player and, at times, commented on the player's stupidity, lack of courage, awareness, or even worse" (p. 300). With intervention, the coach was taught to (a) give explicit instructions to the players about executing the blocking responses, (b) evaluate and provide feedback to the players following trials, (c) model correct performance of a block, and (d) request the players to imitate his model. As evaluated in a multiple baseline design across players, this combination of procedures effectively increased the percentage of blocks executed correctly from near-zero levels during baseline to averages of 50-70%. This study is noteworthy in being one of the first to evaluate ABA procedures with football players.

In a study with five linebackers (19-21 years old) on a Division II football team, Ward and Carnes (2002) implemented goal setting and public posting to improve "reads" (covering a specific area of the field during a pass or run), "drops" (moving to the correct field position before each offensive snap), and "tackles" (bringing a runner to the ground). These dependent measures were recorded as percentage of correct execution during 10 trials per player at practices and games. Under baseline conditions, the coach met with the

players before practice, reviewed expectations, and gave them in-practice feedback and error correction. Intervention started with a researcher speaking to each player about his baseline performance for drops, reads, and tackles. The players were then requested to set goals that exceeded their mean performance during practices (they did not set goals for games). All of the players selected a goal of 90% correct execution for the three performance measures. The public posting component of intervention featured a chart that was displayed in the locker room on which each player's daily practice results were depicted as him achieving ("yes") or not achieving ("no") the 90% goal-setting criterion. Similar to the goal-setting procedure in practice, public posting was not implemented for performance during games.

Ward and Carnes (2002) intervened with each player according to a multiple baseline design across the three dependent measures. All of the players had relatively stable performance during baseline, ranging from 60% to 80% correct execution of reads, drops, and tackles. Average performance during intervention increased to 90-100%, again for all of the players and the three dependent measures. Notably, players uniformly improved their baseline game performance during the time that intervention was implemented in practice.

In another study with Division II college football players, Smith and Ward (2006) intervened with three wide receivers (ages not specified) to improve their percentage of correct blocks, routes run, and releases from the line of scrimmage during practice. Following a baseline phase in which the coach met with the players, reviewed performance expectations, and gave verbal feedback and error correction in practice drills, the researchers implemented three intervention phases, each phase separated by a brief return-to-baseline condition. With *public posting plus verbal feedback*, the players were informed before each practice about their previous day's performance of the three target skills. Also, their performance data were presented in a chart on the door leading to the locker room. The next intervention phase, *goal setting plus verbal feedback*, imposed a 90% performance criterion for each skill and positive verbal feedback to the players when they were successful. The third intervention phase was *public posting plus verbal feedback plus goal setting*, in effect a combination of the previously implemented procedures. Identical to baseline, the coach continued to give verbal feedback and error correction during intervention practice phases.

The results of the Smith and Ward (2006) intervention were that all three players improved their performance of blocks, routes, and releases from

50-80% correct during baseline to 80-100% during intervention with each combination of verbal feedback, goal setting, and public posting. Game performance, which was included as a generalization measure, also improved similarly over baseline levels, something that would be expected given the advanced football competence of the players. Unfortunately, the comparative effectiveness of the procedures could not be determined because the three intervention phases were introduced sequentially in the same order with each player.

Several studies have highlighted behavioral coaching methods with high school football athletes. Stokes, Luiselli, Reed, and Fleming (2010) developed a 10-step task analysis to improve offensive line blocking of five players (15-17 years old). Five offensive line coaches (not associated with the study) were surveyed to validate the steps that comprised the task analysis. Normative data were also acquired by using the task analysis to record pass blocking execution of the three highest rated starting offensive linemen from the previous season. The dependent measure throughout the study was the percentage of task analysis steps the players executed correctly during one pass blocking drill in practice and 3-4 pass blocking sequences during a single game. Under baseline conditions, the offensive line coach implemented conventional procedures that entailed instructing the players about proper positional technique and staying focused. The coach typically praised good performance ("That's the way to hit!"), responded negatively to poor execution, and sometimes modeled the desired blocking responses.

During intervention, Stokes, Luiselli, Reed, and Fleming (2010) exposed the players to the following procedures: (1) *Descriptive feedback*: The coach reviewed the task analysis steps with each player after the pass blocking drill. Correctly executed steps received praise and nonverbal approval (e.g., slapping a "high five"). The coach responded to incorrect steps by explaining how they should be executed, having the player repeat the steps correctly, and praising performance accordingly. (2) *Descriptive feedback plus video feedback*: The coach continued to deliver descriptive feedback following pass blocking drills. Each player then watched a videotape of his performance, completed task analysis ratings with the coach, and performed missed steps one time correctly. Players could also question the coach about how to further refine their pass blocking skills. (3) *Teaching with acoustical guidance* (*TAG*): During this phase, the coach selected task analysis steps that each player continued to execute inconsistently. When a player performed these steps correctly in the pass blocking drill the coach sounded a bullhorn that produced a siren lasting 1-5 s. The audible stimulus was intended to

function as immediate feedback (reinforcement; Pryor, 1999). TAG was the only procedure implemented.

Stokes, Luiselli, Reed, and Fleming (2010) found that descriptive feedback alone did not improve pass blocking. However, all five players improved with video feedback, and four of the five players that received TAG enhanced their performance further. Another finding was that, with intervention, the players pass blocked at a level of proficiency that was comparable to more experienced linemen. They also showed this improvement during games. However, for three of the five players returning for a second season, descriptive and video feedback, and in one case, TAG, had to be implemented again because their line blocking skills deteriorated in the absence of practice and behavioral coaching.

Two additional studies with high school football players targeted tackling skills. Stokes, Luiselli, and Reed (2010) intervened with two linebackers (16-17 years old) to improve their performance in practice and during games. Based on a 10-step task analysis, the coach presented the players with a colorful helmet sticker each time they matched or exceeded the percentage of correctly executed steps during preceding tackling drills. Although no contingencies were programmed for their behavior, teammates also responded positively. This relatively simple intervention was associated with improved tackling during practice and in each player's first postintervention varsity game. Harrison and Pyles (2013) reported similar results with three linebackers (16-17 years old) using verbal instructions and TAG, initially to train four-component tackling skills at walking speed. Subsequently, the intervention procedures were applied successfully with the players during progressive speed drills that advanced from walking, to jogging, and then, running. However, the skills acquired during practice were not measured in games.

Soccer

Ziegler (1994) employed a multiple baseline design across four Division I college soccer players (ages were not specified) to study the effects of "an attention-training program" on their execution of four passing and kicking skills. In baseline, player performance was measured under conventional practice conditions. The training program included an information phase, in which attention shifting skills were taught via lecture and "laboratory attention shift exercises," then an application phase that consisted of using attention shifting skills while executing soccer drills. The players also

received performance feedback during drills. With intervention, each player performed the soccer skills more accurately compared to consistently lower baseline levels. Ziegler (1994) acknowledged that these effects were difficult to interpret because the attention-training program combined simulated and *in vivo* procedures, and she did not assess intervention integrity. Also, the study did not evaluate game performance.

Brobst and Ward (2002) evaluated the effects of public posting, goal setting, and verbal feedback on three behaviors executed by three female soccer players (15–17 years old) during practices and games: movement with the ball, movement during restarts, and movement after a player passed the ball. In the baseline phase of a multiple baseline design across behaviors, the coach conducted practice drills with the team and gave performance feedback through praise and error correction. Several procedures were implemented during intervention in which (a) the players were expected to perform each behavior at a minimum of 90% accuracy, (b) practice performance data were posted on a chart each day, and (c) one of the researchers met individually with the players to review the performance data, praise goal-achievement, and encourage effort to improve sub-goal execution. The two main effects from this study were that intervention improved soccer skills during practice and the positive findings generalized to games for movement with the ball but not the other two skills.

Swimming

Koop and Martin (1983) described a behavioral coaching strategy that was implemented to decrease swimming errors of five children (7–12 years old) who were members of a competitive swim club. The researchers identified specific swim stroke errors within freestyle (9 errors), backstroke (7 errors), and breaststroke (11 errors) categories. The dependent measure was the percentage of errors each swimmer committed during 10 stroke trials per category. Following a "standard coach" baseline phase, the swimmers participated in a training phase in which a coach first referenced "large checklists containing drawings and instructions for correct behaviors on each stroke" (p. 451). Other components of the training phase featured (a) out-of-pool instructions about stroke execution, verbal prompting, modeling, and swimmer role-playing; (b) in-pool practice of correct strokes; and (c) in-pool consequences for correct (praise) and incorrect (contingent tactile cues and instructions) strokes. After the training phase, the coach introduced maintenance procedures consisting of an initial prompt during practice and performance feedback.

Koop and Martin (1983) evaluated an intervention using a multiple baseline design across swimmers for each of the three stroke categories. Their results were extensive, which they interpreted as demonstrating "that the error correction package resulted in a decrease in errors on swimming strokes to a low rate during training sessions, stimulus generalization to regular practice with three of four swimmers, and maintenance of improved performance with minimal prompting and feedback under normal practice conditions" (p. 458). Furthermore, intervention did not disrupt practice, and the swimmers and coach rated the procedures favorably.

Dragen and Austin (2008) reported another combination of behavioral procedures to improve performance of youth swimmers. The participants were three girls (15-18 years old) on a high school swimming and diving team. In this study, the dependent measure was the duration of freestyle "flip turns" during swim meets. The swimmers received standard training during baseline practices and then two intervention phases within an A (baseline)-B (intervention 1)-A (baseline)-C (intervention 2) experimental design. The first intervention phase consisted of graphic feedback in the form of a bar graph showing each swimmer's average flip turn in seconds for preceding swim meets. The coach also delivered accompanying verbal feedback. In the second intervention phase, the swimmers were instructed to use self-talk, for example, "explode" when pushing off the pool walls, and "reach" to remain in a streamlined position after pushing off. They were also taught to record their performance at swim meets on self-monitoring forms that the coach reviewed with them. Although the results were modest, each swimmer improved her flip turn speed while receiving graphic and verbal feedback, engaging in self-talk, and self-monitoring her swim performance.

Tennis

Allison and Ayllon (1980) compared a behavioral coaching intervention with standard coaching procedures for 12 students (18-35 years old) enrolled in a tennis instruction program. A detailed task analysis was created to measure forehand, backhand, and service strokes. The researchers described standard coaching as a combination of verbal instruction, modeling, feedback, and encouragement. Similar to their behavioral coaching protocol for football players described previously, Allison and Ayllon had the tennis coach deliver behavior-specific instructions about stroke position, evaluate correct and incorrect executions, and guide the students to assume proper positioning with further instruction. Multiple baseline designs across

students and tennis strokes demonstrated that behavioral coaching increased the percentage of trials in which the students executed strokes correctly. Eventually, the standard coaching procedures were able to maintain the performance improvement that had been achieved with intervention. This finding is particularly relevant where there is concern about sustaining the more intensive and time-consuming demands that characterize most behavioral coaching applications.

Ziegler (1987) studied the effects of a self-directed stimulus cueing technique on the skill acquisition of 20 beginning tennis players (19-31 years old) attending a university-based physical education service program. Each day their forehand and backhand strokes were measured during ball-machine-generated drills. Performance was quantified as the percentage of task analysis steps executed correctly. The players were assigned to three groups, each group receiving general directions from a tennis instructor as well as ball-machine supervision from two assistants. The self-directed stimulus cueing intervention occurred in a multiple baseline design across groups. Intervention taught the players to (a) track the ball and say "ball" as soon as it was fired from the ball-machine, (b) say "bounce" as the ball contacted the court surface, (c) say "hit" upon striking the ball with the racket, and (d) say "ready" to prepare physically for the next ball. Reported as group data, the average percentage of correct forehand and backhand strokes increased dramatically, from 13-33% during baseline to 43-83% during intervention. Ziegler (1987) concluded that the performance improvement effects from self-directed stimulus cueing derived from "focusing on the ball as a form of preparation for skill execution" (p. 410), but the study was not planned to test this hypothesis.

One additional tennis study, reported by Allen (1998), is of interest because the objective was to *reduce negative behavior* during matches. The participant was a 14-year-old tennis player with a history of uncomplimentary outbursts (loud vocalizing, striking racket on the court, waving arms) when competing during state and regional tennis events. Baseline data documented numerous outbursts despite parental efforts to curtail the behavior. Intervention started with awareness training that had the boy describe outbursts, identify precursor behaviors, and pinpoint the most common provoking conditions. He was also taught to perform diaphragmatic breathing whenever he recognized the precursor behaviors and in response to an audible cue from his parents in the stands. Finally, he was able to earn points (exchanged for new stereo compact discs) when he was observed engaging in the competing response. This combination of procedures reduced the number of outbursts per tennis match but they continued at an unacceptable frequency.

Thereafter, any outburst resulted in the boy having to withdraw from the current match and forfeit his next event. This response cost procedure essentially eliminated outbursts. Unfortunately, a 12-month follow-up assessment revealed that the boy was again displaying outbursts, although his parents opined that behavior *intensity* had diminished.

Basketball

Kladopoulos and McComas (2001) used instructions and feedback to refine foul-shooting form and increase accuracy of three Division II female, college basketball players (19-20 years old). Foul-shooting form was measured as percentage of task-analyzed steps executed correctly on practice trials. The percentage of those shots falling through the hoop without touching the backboard was also recorded. In baseline, the players took 10 foul shots without instructions or feedback. During intervention, they continued taking 10 practice foul shots but a researcher instructed them in proper shooting form by (a) reviewing the task-analyzed steps, (b) having the players take 10 more foul shots, and (c) praising each shot made with reference to form (e.g., "Good job keeping your feet in the same position throughout the shot."). If a player missed a shot, the researcher gave corrective feedback about form but not accuracy. A multiple baseline analysis across players demonstrated that intervention simultaneously improved the percentage of trials with correct form as well as foul-shooting accuracy. This study did not evaluate whether improved performance could be maintained without ongoing form training or whether practice effects generalized to games.

Baseball

Osborne, Rudrud, and Zezoney (1990) conducted a study to determine whether adding distinctive visual cues to baseballs would improve curveball hitting of five collegiate players (ages not specified). A pitching machine set at a standard speed delivered curveballs to each player, and it was adjusted to accommodate their personal strike zone. There were 20 pitches per practice session. Only unmarked balls were pitched in the first phase of a multielement design. In the next two phases the unmarked balls were mixed with balls that had either 1/4 in. or 1/8 in. orange highlighting strips around the seams. The researchers recorded the percentage of "well-hit" balls according to exacting criteria that encompassed distance, location, and swing. Results were that adding visual cues to the baseballs improved curveball hitting proficiency over unmarked balls, with the 1/4 in. color stimulus

slightly better than the 1/8 color stimulus. The ultimate effect of such training would obviously have to be evaluated by gradually fading the baseball cues under live pitching conditions. Nevertheless, a stimulus control intervention may be an effective strategy for quickly improving athletic skills, which subsequently can be withdrawn to support performance in competitive games.

Track and Field

A study by Scott, Scott, and Goldwater (1997) incorporated prompting and shaping with a 21-year-old collegiate pole vaulter. The intervention objective was to improve his arm extension at take-off, a critical step that could lead to increased vaulting height. To start, his percentage of vaults with correct arm extension was recorded before intervention. After calculating his mean hand height on the pole (2.25 m), procedures were introduced to gradually shape maximum positioning at 2.54 m. The researchers installed a photoelectric beam that delivered an audible tone when his hand height on the pole achieved a specified criterion, beginning at 2.30 m (5 cm above the mean baseline height), and advanced over successive vaults to a terminal hand height of 2.52 m. A coach also verbalized "reach" as the vaulter progressed down the runway and preceding his take-off. Plotted as a changing criterion design (Hartmann & Hall, 1976), the performance data revealed that his hand height improved with the gradual increase in criterion, and it corresponded with higher bar height clearance. One caveat when interpreting these findings is that the data were highly variable and the duration of intervention lasted 200 sessions over a period of 18 months.

Gymnastics

Wolko, Hrycaiko, and Martin (1993) compared standard coaching with two self-management interventions among five female gymnasts (10-13 years old). This study consisted of an alternating treatments design in which frequency of attempted and completed balance beam skills were recorded within practice sessions. The baseline (standard coaching) phase had several procedures in effect, namely coach verbal goal setting, performance feedback, technique correction, encouragement, reprimands, and spotting. These procedures continued during both self-management intervention phases. One of these phases included public coach-written goal setting combined with public self-recording and graphing with coach feedback. Additionally, the gymnasts could select from a list of "rewards" if they achieved

coach-written goals for both skill attempts and completions. The second intervention phase differed from the first in that the gymnasts engaged in private self-goal setting and self-recording plus graphing without coach feedback. The same reinforcement contingencies remained in effect.

The supplement of self-management to standard coaching in Wolko et al. (1993) improved balance beam performance of the gymnasts. This improvement was gradual, possibly because "the time span allotted for each condition to show its effect may have been too brief" (p. 220). The results also suggested that the private self-goal setting and self-monitoring combination was marginally more effective than the publically implemented procedures. This study also reported social validity assessment indicating that the gymnasts liked both self-management interventions more than standard coaching.

Another approach to gymnastics training, by Boyer, Miltenberger, Batsche, and Fogel (2009), incorporated video modeling and feedback with four girls (7-10 years old) at a local club. The dependent measures were three skills (backward giant circle to hand stand, hip cast, clean hip circle), executed on the uneven bars, which were sequenced in a 28-item checklist per skill. In a multiple baseline design across motor skills, a coach provided verbal feedback to the girls after they dismounted from the uneven bars during practice sessions. With intervention, the girls watched a computer screen showing a video clip of an expert gymnast performing one of the three targeted skills that was paired with their own practice performance. Next, (a) a technician freeze-framed each video clip at select emphasis-points for the skill, (b) the video clips were shown one time at normal speed, and (c) the girls attempted the target skill two more times. In summary, the results suggested "that adding video modeling by experts with video feedback to typical coaching and practice techniques could reduce the number of practice sessions required to improve a difficult physical skill" (Boyer et al., 2009, p. 857). Follow-up measures demonstrated generally positive maintenance of skills without further intervention. Both the gymnasts and coaches gave high approval ratings for the video modeling and feedback procedures.

Other Sports

In rounding out this description of ABA-sports research, we briefly cite other studies of interest, focusing on athletic areas that have less supportive data but nonetheless positive results. For example, Anderson and Kirkpatrick (2002) measured the percentage of correct relay tags executed by four female

youth (12–16 years old) on a competitive inline roller speed skating team. Relative to baseline conditions, each skater improved her percentage of correct tags in response to intervention that included skill clarification, descriptive praise, and performance feedback. Harding, Wacker, Berg, Rick, and Lee (2004) taught two adults (33 and 40 years old) who were beginning students in the Kenpo system of martial arts to execute punching and kicking techniques through differential reinforcement and performance feedback. In work with five male rugby players (21–25 years old), Mellalieu, Hanton, and O'Brien (2006) used a three-phase intervention of goal-determination, goal setting, and goal reviewing to improve game performance of ball carries, tackles, successful kicks, and turnovers. Finally, Fogel, Weil, and Burris (2010) implemented TAG and other behavioral procedures to train five behaviors comprising a proper golf swing by a 30-year-old novice golfer.

Summary of ABA-Sports Research

The preceding review of research reveals that ABA methodology and procedures have been implemented with many sports, for individuals and teams, and among beginning, developing, and advanced athletes. Virtually every study featured direct measurement of skill acquisition and performance, although data gathered from video recording and self-report were also used on occasion. Certain procedures such as shaping, positive reinforcement, and goal setting were common, whereas methods such as TAG have been evaluated less frequently. One largely consistent finding is that ABA-sports interventions integrate multiple procedures—it is rare that a single method accounts for success.

The studies previously emphasized usually conducted intervention evaluation during practice sessions and routines, particularly when the objective was to train new skills. In some of the research, measurement was extended to postintervention games and competitive events in order to assess response generalization. The most complete and robust research measured game and competitive performance before, during, and following intervention. Notably, some maintenance evaluations were completed with intervention procedures ongoing while other studies had removed them.

Some intervention methods were evaluated with several sports but implemented differently. For example, in the case of goal setting, participants sometimes selected their own goals or were so instructed by coaches. Goals were also determined privately and publically, occasionally with accompanying performance feedback, in group or individual formats, either

verbally, graphically, or both. From a research perspective, it is desirable to standardize procedures and keep them uniform across participants. However, the legitimate concern for experimental rigor must be tempered with the reality of practical sports coaching and training. That is, most athletes and performers demand individualized interventions that conform to their unique learning histories, skill level, performance expectations, and motivation. Therefore, the professional community should carefully consider the limitations of research-to-practice translation when applying evidence-based procedures.

RESEARCH INFORMED PRACTICE STANDARDS, IMPLICATIONS, AND FUTURE DIRECTIONS

This section of the chapter expands on several key issues that were consistent in the research literature and have practice implications, namely assessment-derived intervention, behavioral coaching, intervention integrity, social validity, and single-case evaluation designs. We also discuss emerging translational research and ABA-sports intervention with special populations.

Assessment-Derived Intervention

Beyond measuring the effects of intervention on skill acquisition and performance, behavior assessment should inform procedural decision-making. With regard to positive reinforcement, for example, current convention dictates that reinforcers be selected based on the results of preference assessment (Tiger & Kliebert, 2011). We noted previously that all ABA-sports research included some type of positive reinforcement to motivate and support critical behaviors and skills. Indeed, it is difficult to imagine any coach or trainer that does not recognize the importance of positively reinforcing athletes when they perform correctly! As such, behavioral sports practitioners should not choose social and tangible "rewards" arbitrarily. Rather, preintervention assessments should be initiated to more closely align programmed reinforcers with empirically selected, athlete-specific preferences. However, in preparing this chapter we did not locate any studies that included formal standardized preference assessment in the context of ABA-sports research.

Other foundations of ABA, functional behavioral assessment and functional analysis, have rarely been reported in ABA-sports research (Tkachuk et al., 2003). Certainly, there are antecedent and consequence influences on

skill execution and problem behaviors, including but not limited to particular coaching strategies, an athlete's physical status, practice conditions, response effort, and so on. In the only published exemplar of functional analysis in ABA-sports research, Stokes and Luiselli (2010) evaluated procedures with a 17-year-old high school football player to improve his tackling skills. The functional analysis targeted the percentage of steps in a 10-step task analysis he executed correctly during one-on-one tackling drills. There were four functional analysis conditions, implemented over 2 days at a preseason camp:

No attention: With the other defensive players present during tackling drills, the coach praised the participant ("Good job!") when he tackled the ball carrier but otherwise did not give him specific feedback.

Coach attention: Only the coach was present during tackling drills. Contingent on a successful tackle he praised the participant enthusiastically ("Great work, that's how to hit!"), clapped, and delivered a "high five" or pat on the helmet.

Peer attention: The team captains and defensive players were present during the tackling drills, they shouted excitedly when the participant tackled the ball carrier and responded with "high fives" while the coach did not react.

Escape: Without other players present, the coach started the tackling drills by vigorously instructing the participant to use proper technique and "make a good tackle." Upon tackling the ball carrier, the coach did not praise the participant but allowed him to move on to the next practice activity.

Figure 21.1 presents the results of the functional analysis. These data showed that the participant had the highest percentage of correct tackling during the escape condition ($M = 56.6\%$), followed by no attention ($M = 45.0\%$), peer attention ($M = 30.0\%$), and coach attention ($M = 25.0\%$). Hypothesizing that coach avoidance instead of public commentary was responsible for the highest percentage of correct tackling during the functional analysis, Stokes and Luiselli (2010) intervened with the participant by having the coach present him with a one-page written checklist of correctly executed steps following practice and without verbal comment. Conceived as a type of delayed written performance feedback (Balcazar, Hopkins, & Suarez, 1985), the participant increased his correct tackling from an average of 33% at baseline to an average of 72% with intervention. Correct tackling was recorded at 75% during a one-game postintervention assessment. This study, although preliminary, suggests a model of functional analysis with

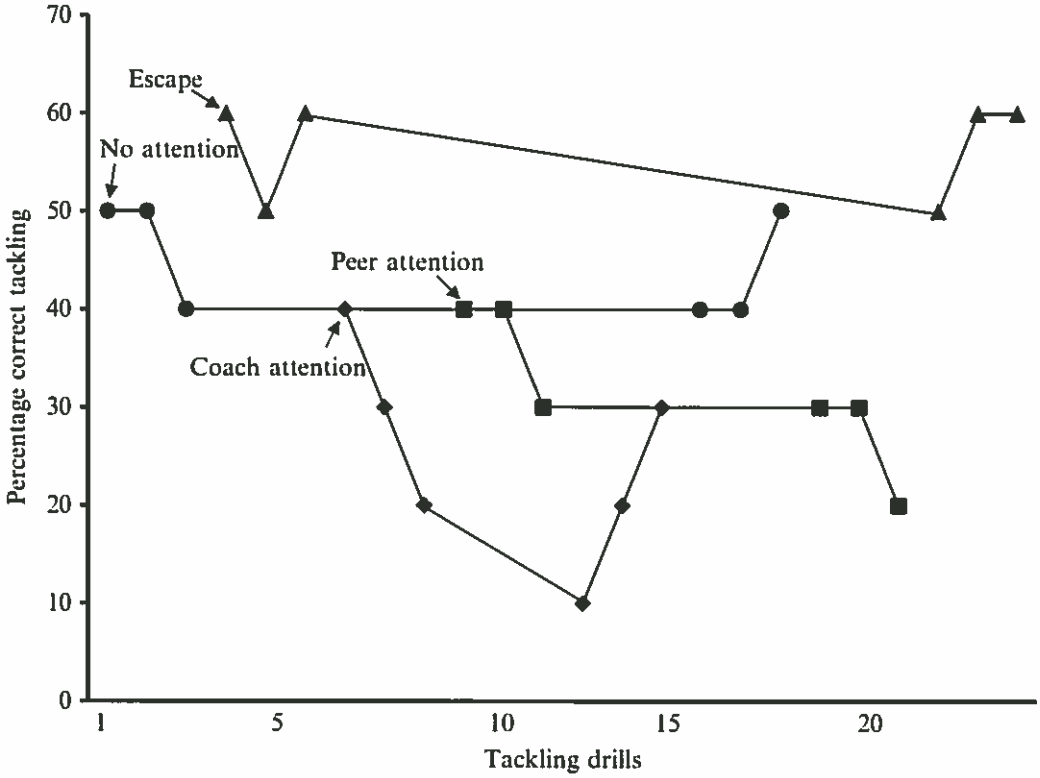

Figure 21.1 Percentage of correct tackling during a functional analysis with a high school football player.
From Stokes and Luiselli (2010).

athletes that is consistent with generally accepted ABA standards and recommendations (Cipani & Schock, 2011; Hanley, 2012).

Behavior checklists (Martin, Toogood, & Tkachuk, 1997) can also inform intervention planning and implementation in several ways. Apropos to preference assessments, athletes can complete checklists that identify pleasurable social and tangible stimuli to be incorporated into self- or coach-directed intervention plans. Similarly, sport-specific behavior checklists help highlight "identifiable psychological skills and strategies which differentiate between any athlete's best and worst performances, as well as those athletes who do and do not perform up to their potential at competitions" (Tkachuk et al., 2003, p. 108). In effect, athletes can verify skills and performance concerns that, in their judgment, should be the focus of intervention. At the same time, athletes could complete behavior checklists to inform coaches and trainers about the types of procedures that have high acceptance and satisfaction. Such data would be extremely informative because positively rated procedures by athletes are likely to be associated with intervention effectiveness (Smith & Smoll, 2011).

Behavioral Coaching

James Naismith—the inventor of basketball—is a household name in sports aficionados' circles. It may be surprising, however, to learn that Naismith vehemently opposed the notion of coaching basketball squads (Kerkhoff, 1996). Forrest "Phog" Allen challenged this premise and ultimately went on to become the father of coaching in basketball. "Phog" Allen recognized that effective coaching produces results far superior to letting athletes merely demonstrate their raw talent on the court. Many decades later, formalized coaching of sports performance has been a mainstay in nearly all popularized forms of athletics. It is not surprising that at the time of this writing, a Google search of "behavioral coaching" and "sports" yielded over 31,000 hits; a review of the various websites contained in those hits demonstrates the multiplicity of this term's interpretation.

The ABA-sports studies we reviewed in this chapter illustrated many combinations of procedures falling under the term "behavioral coaching." Behavior analysts have identified a common set of components that comprise the behavioral coaching approach (see review by Seniuk, Witts, Williams, & Ghezzi, 2013), but there are currently no standard implementation guidelines. The Seniuk et al. review revealed six components that we endorse and most behavior analysts would recognize as essential for effective coaching:

1. *Behavioral measurement*: The dependent variable should entail athletic performance that is observable, definable, and countable.
2. *Differentiation between acquisition and maintenance of athletic performance*: Coaching should approach skill acquisition differently than the maintenance of performance, using empirically supported positive reinforcement strategies for both.
3. *Within-athlete comparison*: Athletes' skills at the initiation of coaching should serve as the baseline comparison for eventual acquisition and maintenance procedures initiated by the coach.
4. *Use coaching procedures derived from rigorous experimentation*: Coaches must let data inform their practices, whether from published studies, or replications of procedures previously described and used (and that were effective) that were not necessarily published in peer-reviewed outlets.
5. *Recognize the role of the coach in athlete behavior change*: Like any other behavior analytic interventions, the behavior change agent—in this case, the coach—must change their behavior to affect change in the target client.

6. *Behavioral coaching must be socially valid*: The procedures comprising the coaching approach should be deemed acceptable by all relevant sports stakeholders, including, but not limited to, the athlete, the fans, the teammates (if relevant), and the broader athletic community.

Behavior analysts may see many parallels between behavioral coaching and behavior skills training, and for good reason; both derive from organizational behavior management. Behavioral skills training (BST) is a packaged intervention containing (a) instructions, (b) modeling and rehearsal, and (c) feedback (e.g., Sarokoff & Sturmey, 2004), three of the most popular ABA methods in sport training and consultation. Collectively, the research on BST and behavioral sport psychology suggests that BST should play an integral role in behavioral coaching.

Intervention Integrity

Intervention procedures in educational and clinical settings are most successful when practitioners implement them with high integrity (Fiske, 2008; Noell, Gresham, & Gansle, 2002; Wilder, Atwell, & Wine, 2006). The same conclusion can be drawn for ABA-sports applications but, unfortunately, intervention integrity assessment is conspicuously absent in the extant literature. A notable exception is the study by Koop and Martin (1983) in which they assessed "procedural compliance" in a program to reduce stroke errors by beginning swimmers. The assessment protocol required an observer to independently record the swim trainer's implementation of intervention procedures against an identical procedural checklist. A percentage compliance measure was calculated from these two data sets. Similarly, in their martial arts training study, Harding et al. (2004) recorded the procedural fidelity of instructor feedback to participants during sessions.

The rationale for conducting the intervention integrity assessment is ensuring proper evaluation of intervention procedures. That is, if practitioners apply procedures inaccurately it is not possible to determine whether poor intervention effects are the result of inconsistent implementation or the procedures themselves. Assessing intervention integrity is certainly a prerequisite for applied sports research but just as important in day-to-day coaching. To illustrate, Luiselli (2012) presented an intervention integrity recording form applicable to youth lacrosse coaching drills. Shown in Figure 21.2, the form designates eight coaching behaviors making up a

Intervention integrity recording form

Date of observation:
Setting: Lacrosse Practice-Smith Field
Observer:
Coach-implementer:
Target: Two-lane passing drills
Instructions: Record steps 1-7 one time (start of drill) and step 8 for the first 10 two-player passing exchanges

Coach behaviors	Integrity ratings		
	Implemented accurately	Implemented inaccurately	Not implemented
1: Divides players into 2 groups			
2: Arranges groups into 2, head-to-head vertical lines			
3: Spaces lines 15+ feet apart			
4: Calls for attention ("eyes on me")			
5. Describes purpose of drill			
6: Demonstrates expected behavior during drill			
7: Assumes monitoring position			
8: Whistles start of, and comments verbally following, each two-player passing exchange			
Player 1 >Player 2			
Player 3 >Player 4			
Player 5>Player 6			
Player 7 >Player 8			
Player 9 >Player 10			
Player 11>Player 12			
Player 13>Player 14			
Player 15>Player 16			
Player 17>Player 18			
Player 1 9>Player 20			

Implementation accuracy score (accurate ratings/total ratings scored x 100):

Figure 21.2 Intervention integrity recording form.
From Luiselli (2012).

practice passing drill. To evaluate intervention integrity, an observer, such as a behavioral consultant or assistant coach, records whether the coach displayed each behavior accurately, inaccurately, or not at all. Summing the number of accurate ratings and dividing by the total ratings scored produces an overall implementation accuracy score. Less than desirable intervention integrity would be corrected by isolating the misapplied behaviors, giving the coach respective training, and repeating intervention integrity assessment.

Social Validity

Broadly defined, social validity concerns the appropriateness and acceptability of ABA interventions as both process and outcome measures (Kazdin, 1977; Wolf, 1978). One type of social validity, expert validation, has to do with the selection of intervention objectives, skills, and procedures. Thus, as an initial step in their program to reduce swimming stroke errors, Koop and Martin (1983) developed lists of possible errors from swimming instruction books and distributed the lists to team coaches "who independently rank-ordered the errors according to their relative importance in detracting from swimming speed," refining the lists further "by deleting errors on which coaches strongly disagreed, as well as errors that were unanimously considered unimportant" (p. 449).

In the same vein, Stokes, Luiselli, and Reed (2010), Stokes, Luiselli, Reed, and Fleming (2010) and Harrison and Pyles (2013) referred to recommendations from the American Football Coaches Association (1995) and sought verification by active high school and collegiate coaches when developing task analyses for improving blocking and tackling skills. Boyer et al. (2009) provided another example of expert validation by constructing their video modeling intervention with child gymnasts from videotaped performances of USA National Team members in competition, advice from a high-ranking gymnastics judge, and consultation with coaches of elite athletes.

A second type of social validity assessment compares preintervention, intervention, and postintervention measures against a high-performing normative sample. Such assessment enables practitioners to select reasonable intervention-targeted criteria. Furthermore, the resulting data can confirm that intervention results matched or exceeded an acceptable standard. In the previously cited football study by Stokes, Luiselli, Reed, and Fleming (2010), the participants were five offensive linemen that coaches judged as having the poorest pass blocking skills on a high school varsity team. After preparing a 10-step task analysis and recording protocol for the study, the researchers documented the pass blocking performance of the three highest rated starting offensive linemen from videotaped games against opposing teams during the preceding season. The average correct pass blocking accuracy for these linemen was 80%, and the range of 70-90% was adopted as the practice and game performance criteria in the study.

A further goal of social validity assessment in ABA-sports research asks athletes and coaches to rate the acceptability of intervention procedures they received and how satisfied they were with implementation and outcomes. Smith and Ward (2006) noted that beyond acquiring measures of

acceptability and satisfaction, this type of social validity assessment may uncover unanticipated intervention effects and enable researchers to adjust procedures in future studies. On the most practical level, social validity assessment allows sports practitioners to select intervention procedures that have the greatest appeal and by extension will be implemented with good integrity.

A few research examples show the usual process of socially validating procedural acceptability and satisfaction. Following the gymnastics intervention, Boyer et al. (2009) gave a 5-point Likert-style questionnaire to the gymnasts, coach, and assistant coaches to assess "how much they liked the procedure, whether they would recommend it to others, how easy it was, how helpful it was, and how effective it was in skill development" (p. 857). Koop and Martin (1983) had a swimming coach determine the degree to which he considered intervention to be effective, useful, and easy to implement. The swimmers also documented how much they liked the procedures or found them useful. In Stokes, Luiselli, Reed, and Fleming (2010), the football players rated their satisfaction with baseline and intervention procedures on a number-coded questionnaire as poor (1), fair (2), good (3), and excellent (4). The social validity assessment with a novice golfer by Fogel, Weil, et al. (2010) required her to complete 6-point ratings (strongly disagree, disagree, slightly disagree, slightly agree, agree, strongly agree) for questions such as "My swing is better after this training," and "Learning the pivot via TAG is contributing to my long term golf goal."

The benefits of social validity assessment notwithstanding, it is possible that some respondents may not view the most effective procedures favorably. For example, young and beginning athletes might prefer procedures that are not highly strenuous or difficult independent of how quickly they learn target skills. More established performers are likely to discount procedures that do not produce rapid results and competitive success. Coaches, too, will likely judge procedures differently based on the level of play they are instructing, implementation complexity, familiarity, and so on. We suggest that these and similar variables be considered when designing and interpreting the data from social validity assessment questionnaires.

Single-Case Evaluation Designs

Single-case evaluation methodology is a mainstay of ABA research (Kazdin, 2011) and the basis of many sports related studies (Luiselli, 2011; Martin et al., 2004). The publications we reviewed in this chapter are testimony to the variety of single-case designs available to researchers. Of course, these

designs are intended to control for internal validity through time series analysis and replication of effects through experimental manipulation of independent variables. Repeated evaluation of procedures that produce similar outcomes contributes to the external validity of single-case studies.

Briefly, reversal designs have value in quickly evaluating stimulus control and antecedent interventions (Osborne et al., 1990) but may not fit well with consequence-based interventions targeting skill acquisition (i.e., learned skills may not "reverse"). Multiple baseline designs are particularly adaptable, in part because of versatility. For example, the multiple baseline design across behaviors adequately meets the common coaching objective of training more than one skill in a single athlete (Boyer et al., 2009; Brobst & Ward, 2002; Ward & Carnes, 2002). For team sports, interventions can be evaluated efficiently in a multiple baseline design across players (Harrison & Pyles, 2013; Kladopoulos & McComas, 2001). In a changing criterion design, the steps within a task analysis naturally serve as the criteria for measuring the effects of shaping procedures (Scott et al., 1997). One additional strategy, the alternating treatments design, makes it possible to compare two or more procedures (Wolko et al., 1993), thereby enhancing coaching and training efficiency.

Independent of research, single-case evaluation designs should have considerable appeal to practitioners. Whether training athletes directly or consulting with coaches, professionals working in the sports arena can employ single-case designs to evaluate learning trends and make necessary procedural revisions that improve performance. Tkachuk et al. (2003) also commented that single-case methodology can be used to demonstrate "to the consumers of sport psychology services that measurable improvements in athletic performance are due to the interventions" (p. 112). Their suggestion is consistent with Gee's (2010) assertion that applied sport psychology research plays a vital role in educating athletes and coaches about the mechanisms by which professional consultation can positively influence performance.

Translational Research

In one sense of the term, *translational* research constitutes a transfer of technologies developed in the basic operant lab to frontline interventions that address issues of societal concern (Lerman, 2003). This technology transfer interpretation suggests that most, if not all, published experiments on behavioral applications for sports (or anything else, for that matter) could be

considered translational. For the sake of this section, we will shift our focus to the middle portion of the basic-applied research continuum; that is, "bridge studies" involving novel applications of behavioral technologies informed directly from the experimental analysis of behavior (EAB).

As described earlier, sports performance constitutes a unique social behavior that is comprised of easily identifiable behavioral components, even for laypersons with no direct training in the science of behavior. Novice consumers of sport have little difficulty identifying quantifiable reinforcers that might maintain performance (e.g., points scored, shots attempted, speeds, times). More advanced consumers can identify specific sporting events that modulate reinforcers and behavioral allocation (e.g., throw a pass on third and long situations in American-rules football). As advocated elsewhere (Reed, 2011), the objective and quantifiable nature of sport performance provides scientists an excellent platform to test behavioral theories using easily accessible databases (e.g., online box scores). Using sport to test behavioral theory advances the generality of basic behavioral phenomena to everyday human events while simultaneously advancing the field's understanding of the operant principles underlying athletic performance. We will discuss two prime areas of bridge research emanating from behavior analytic perspectives on sport: behavioral momentum and matching theory.

Behavioral Momentum

Calling time outs during strategic periods in sporting events have been assumed to disrupt the momentum of the game. Whether the opponent has a "hot hand" in basketball, or a placekicker is about to attempt a crucial field goal in football, coaches rely on the notion of behavioral momentum to introduce a disruption to an unacceptable rate of reinforcement influencing an opponent's success. This concept of *behavioral momentum*—or resistance to extinction—derives from EAB studies on how rates of response persist in the presence of a disruption related to shifts in reinforcement contingencies or discriminable alternations in stimulus control (see Nevin & Grace, 2000). Like most behavioral phenomena, the origin of behavioral momentum theory (BMT) originated from infrahuman research. In perhaps the most defining paper on BMT, Nevin, Mandell, and Atak (1983) likened the maintenance of operant responding to an object in motion under Newton's second law of motion; behavior, like a rolling object, has velocity and mass (response rate and a history of reinforcement that produces resistance to change). Analogous to a rolling object under Newton's second law,

behavioral response rates are impacted by an imposing disruptive force. In an excellent translation to the everyday world, Mace and Lalli (1992) demonstrated that NCAA men's basketball teams' ability to maintain performance in the face of adversities (turnovers, fouls, missed shots) was proportional to the rate of reinforcement (shots made) prior to the adversity, in line with BMT. Interestingly, the researchers found that time-outs served as effective disruptors to opposing teams' momentum, lending additional support to BMT while simultaneously offering an operant perspective on the widely appreciated perspective that coaches should call timeouts when the other team "gets hot." These findings have been replicated with NCAA women's basketball (Roane, Kelley, Trosclair, & Hauer, 2004) as well (for an extended discussion on this topic, see Roane, 2011).

Matching Theory

Perhaps the most widely studied concept in EAB is the quantitative model of choice known as *matching theory*, derived from Herrnstein's (1961) classic study demonstrating that relative rates of reinforcement for pigeons' key pecks predicted pigeons' relative allocation of pecking between keys. Over the past several decades, matching theory has been formalized into numerous quantitative models that can be used to describe molar accounts of behavior (for a review, see McDowell, 2013). Translational researchers soon discovered the utility in testing the explanatory flexibility (Stilling & Critchfield, 2010) of matching theory through the use of sports data. In this approach, sports researchers compare the relative ratio of play calls—such as passes or rushes in American-rules football (analogous to different colored illuminated keys in an operant chamber)—to the relative ratio of reinforcement—yards gained in those plays—for those plays (analogous to a pigeons' access to grain for key pecks). Toward this end, some of the most recent advances in the applied utility of the matching law have emanated from bridge studies on matching theory using basketball (Alferink, Critchfield, Hitt, & Higgins, 2009; Romanowich, Bourret, & Vollmer, 2007; Vollmer & Bourret, 2000) and American-rules football (Reed, Critchfield, & Martens, 2006; Reed, Skoch, Kaplan, & Brozyna, 2011; Stilling & Critchfield, 2010), given the easily identifiable concurrent behavior-reinforcement alternatives of 2-pt versus 3-pt shots and pass plays versus rush plays, respectively. These bridge studies have greatly advanced the applied utility of the matching theory, while also providing a unique perspective on the variables affecting play calling in elite sport competition.

Given the proliferation of, and public interest in, sports analytics (e.g., Winston, 2009), operant contributions to the understanding of sports performance via BMT or matching theory may serve as a catalyst to promoting behavior analytic influences to sport psychology. Unfortunately, the status quo in sports analytics is a strong reliance on multivariate statistical modeling that focuses more on fitting equations to data than parsimonious accounts of performance. Operant approaches to sports analytics, however, are firmly rooted in basic science and present a theoretically driven account of performance based on decades of operant studies. We believe that further research into the translational contributions of behavior analysis to sports performance will aid in the science of sports strategy while concurrently advancing behavioral theory. For a primer on how to begin analyzing sports from a translational behavior analytic lens, see Reed (2011).

Special Populations

Children and adults who have intellectual and developmental disabilities (IDD) can benefit greatly from sports as well as planned exercise and increased physical activity (Luiselli, 2014) for promoting health (Fleming, 2011; Yilmaz, Yanardag, Birkan, & Bumin, 2004) and enhancing quality of life (Elliot, Dobbin, Rose, & Soper, 1994; Gabler-Halle, Halle, & Chung, 1993; Rosenthal-Malek & Mitchell, 1997). Parents and caregivers of people with IDD also acknowledge the desirable effects of athletic and exercise activities on learning and socialization (Glidden, Bamberger, Draheim, & Kersh, 2011; Luiselli, Woods, Keary, & Parenteau, 2013). Systematic reviews have revealed that running, jogging, and swimming were the most frequently targeted activities in the extant literature (Lang et al., 2010; Sowa & Meulenbroek, 2012). However, this research is not extensive, and there are very few ABA-specific studies concerning sports. Additional research would contribute greatly to the lives of children and adults who have IDD, their families, and practitioners responsible for delivering high quality habilitation services.

Most of the ABA research with people who have IDD has addressed jogging and running (Allison, Basile, & MacDonald, 1991; Elliot et al., 1994; Rosenthal-Malek & Mitchell, 1997). However, these studies were not concerned with athletic performance *per se* but rather the effects of jogging and running as antecedent exercise to reduce problem behaviors. And yet, running in the context of track and field events has been an intervention objective. One example was reported by Cameron and Cappello (1993) who

implemented an 11-step instructional program with a 21-year-old man preparing to run hurdles in a Special Olympics event. The program combined stimulus shaping that gradually raised the hurdle bar off the floor to a maximum height of 12 in. More recently, Luiselli, Duncan et al. (2013) improved the 100 m sprint times of two Special Olympics athletes (20 and 21 years old) through different combinations of goal setting, positive reinforcement, performance feedback, and video modeling.

Two other sports have shown the modest results from behavioral intervention. Luyben, Funk, Morgan, Clark, and Delulio (1986) taught three adults with IDD (24-52 years old) to execute a side-of-the-foot soccer pass using a most-to-least prompting hierarchy combined with forward chaining, a supportive device, and visual cueing. For instructing foundational swimming skills to three children with autism (10-12 years old), Rogers, Hemmeter, and Wolery (2010) employed a constant time-delay prompting procedure within a multiple probe design for flutter kicking, front-crawl arm stroking, and side-to-side head turning. In total, ABA-sports research in IDD is encouraging but needs to be expanded further so that more children and adults can experience the advantages of physical training and planned exercise. One avenue of innovative research is *exergaming* in which "video games or various auditory or visual stimuli are paired with different types of exercise equipment and activities, and the individual must engage in physical activity to play the game or produce the auditory or visual stimulation" (Fogel, Miltenberger, Graves, & Koehler, 2010, p. 592). This virtual sports format can be applied in a controlled setting, with individuals or peer groupings, and individualized to fit the activity interests of each player.

REFERENCES

Alferink, L. A., Critchfield, T. S., Hitt, J. L., & Higgins, W. J. (2009). Generality of the matching law as a descriptor of shot selection in basketball. *Journal of Applied Behavior Analysis, 42*, 595–608. http://dx.doi.org/10.1901/jaba.2009.42-595.

Allen, K. D. (1998). The use of an enhanced simplified habit-reversal procedure to reduce disruptive outbursts during athletic performance. *Journal of Applied Behavior Analysis, 31*, 489–492.

Allison, M. G., & Ayllon, T. (1980). Behavioral coaching in the development of skills in football, gymnastics, and tennis. *Journal of Applied Behavior Analysis, 13*, 297–314.

Allison, D. B., Basile, V. C., & MacDonald, R. B. (1991). Brief report: Comparative effects of antecedent exercise and lorazepam on the aggressive behavior of an autistic man. *Journal of Autism and Developmental Disorders, 21*, 89–94.

American Football Coaches Association. (1995). *Football coaching strategies*. Champaign, IL: Human Kinetics.

Anderson, G., & Kirkpatrick, M. A. (2002). Variable effects of a behavioral treatment package on the performance of inline roller speed skaters. *Journal of Applied Behavior Analysis, 35*, 195–198.

Balcazar, F. E., Hopkins, B., & Suarez, Y. (1985). A critical objective review of performance feedback. *Journal of Organizational Behavior Management, 7*, 65–89.

Boyer, E., Miltenberger, R. G., Batsche, C., & Fogel, V. (2009). Video modeling by experts with video feedback to enhance gymnastics skills. *Journal of Applied Behavior Analysis, 42*, 855–860.

Brobst, B., & Ward, P. (2002). Effects of public posting, goal setting, and oral feedback on the skills of female soccer players. *Journal of Applied Behavior Analysis, 35*, 247–257.

Brown, J. L. (2011). Cognitive-behavioral strategies. In J. K. Luiselli & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 113–126). New York: Springer.

Cameron, M. J., & Cappello, M. J. (1993). "We'll cross that hurdle when we get to it": Teaching athletic performance within adaptive physical education. *Behavior Modification, 17*, 136–147.

Cipani, E., & Schock, K. M. (2011). *Functional behavioral assessment, diagnosis, and treatment: A complete system for education and mental health settings*. New York: Oxford University Press.

DeLuca, R. V., & Holborn, S. W. (1992). Effects of a variable-ratio reinforcement schedule with changing criteria on exercise in obese and non-obese boys. *Journal of Applied Behavior Analysis, 25*, 671–679.

Dragen, J., & Austin, J. (2008). Using graphic and verbal feedback with self-talk and self-monitoring to improve high school swim performance. *Journal of Behavior Analysis in Health, Sports, Fitness, and Medicine, 1*, 96–102.

Elliot, R. O., Dobbin, A. R., Rose, G. D., & Soper, H. V. (1994). Vigorous, aerobic exercise versus general motor training activities: Effects of maladaptive and stereotypic behaviors of adults with both autism and mental retardation. *Journal of Autism and Developmental Disorders, 24*, 565–576.

Fiske, K. E. (2008). Treatment integrity of school-based behavior analytic interventions: A review of the research. *Behavior Analysis in Practice, 1*, 19–25.

Fitterling, J. M., Martin, J. E., Gramling, S., Cole, P., & Milan, M. A. (1988). Behavioral management of exercise training in vascular headache patients: An investigation of exercise adherence and headache activity. *Journal of Applied Behavior Analysis, 21*, 9–19.

Fleming, R. K. (2011). Obesity and weight regulation. In J. K. Luiselli (Ed.), *The handbook of high-risk challenging behaviors in people with intellectual and developmental disabilities* (pp. 195–205). Baltimore, MD: Brookes.

Fogel, V. A., Miltenberger, R. G., Graves, R., & Koehler, S. (2010). The effects of exergaming on physical activity among inactive children in a physical education classroom. *Journal of Applied Behavior Analysis, 43*, 591–600.

Fogel, V. A., Weil, T. M., & Burris, H. (2010). Evaluating the efficacy of TagTeach as a training strategy for teaching a golf swing. *Journal of Behavioral Health and Medicine, 1*, 25–41.

Gabler-Halle, D., Halle, J. W., & Chung, Y. B. (1993). The effects of aerobic exercise on psychological and behavioral variables of individuals with developmental disabilities: A critical review. *Research in Developmental Disabilities, 14*, 359–386.

Gee, C. J. (2010). How does sport psychology actually improve athletic performance? A framework to facilitate athletes' and coaches' understanding. *Behavior Modification, 34*, 386–402.

Glidden, L. M., Bamberger, K. T., Draheim, A. R., & Kersh, J. (2011). Parent and athlete perceptions of Special Olympics participation: Utility and danger of proxy responding. *Intellectual and Developmental Disabilities, 49*, 37–45.

Hanley, G. P. (2012). Functional assessment of problem behavior: Dispelling myths, overcoming implementation obstacles, and developing new lore. *Behavior Analysis in Practice, 5*, 54–67.

Harding, J. W., Wacker, D. P., Berg, W. K., Rick, G., & Lee, J. F. (2004). Promoting response variability and stimulus generalization in martial arts training. *Journal of Applied Behavior Analysis, 37*, 185–195.

Harrison, A. M., & Pyles, D. A. (2013). The effects of verbal instruction and shaping to improve tackling by high school football players. *Journal of Applied Behavior Analysis, 46*, 518–522.

Hartmann, D. P., & Hall, R. V. (1976). The changing criterion design. *Journal of Applied Behavior Analysis, 9*, 527–532.

Herrnstein, R. J. (1961). Relative and absolute strength of response as a function of frequency of reinforcement. *Journal of the Experimental Analysis of Behavior, 4*, 267–272. http://dx.doi.org/10.1901/jeab.1961.4-267.

Kazdin, A. E. (1977). Assessing the clinical or applied importance of behavior change through social validation. *Behavior Modification, 1*, 427–452.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings* (2nd). New York: Oxford University Press.

Kazdin, A. E. (2013). *Behavior modification in applied setting* (7th). Long Grove, IL: Waveland Press, Inc.

Kerkhoff, B. (1996). *Phog Allen: The father of basketball coaching*. Indianapolis, IN: Masters Press.

Kladopoulos, C. N., & McComas, J. J. (2001). The effects of form training on foul-shooting performance in members of a women's college basketball team. *Journal of Applied Behavior Analysis, 34*, 329–332.

Koop, S., & Martin, G. L. (1983). Evaluation of a coaching strategy to reduce swimming stroke errors with beginning age-group swimmers. *Journal of Applied Behavior Analysis, 16*, 447–460.

Lang, R., Koegel, L. K., Ashbaugh, K., Regester, A., Ence, W., & Smith, W. (2010). Physical exercise and individuals with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 4*, 565–576.

Lerman, D. C. (2003). From the laboratory to community application: Translational research in behavior analysis. *Journal of Applied Behavior Analysis, 36*, 415–419. http://dx.doi.org/10.1901/jaba.2003.36-415.

Luiselli, J. K. (2011). Single-case evaluation of behavioral coaching interventions. In J. K. Luiselli, & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 61–78). New York: Springer.

Luiselli, J. K. (2012). Behavioral sport psychology consulting: A review of some practice concerns and recommendations. *Journal of Sport Psychology in Action, 3*, 41–51.

Luiselli, J. K. (2014). Exercise, physical activity, and sports. In J. K. Luiselli (Ed.), *Children and youth with autism spectrum disorder (ASD): Recent advances and innovations in assessment, education, and intervention* (pp. 193–204). New York: Oxford University Press.

Luiselli, J. K., Duncan, N. G., Keary, P., Nelson, E. G., Parenteau, R. E., & Woods, K. E. (2013). Behavioral coaching of track athletes with developmental disabilities: Evaluation of sprint performance during training and Special Olympics competition. *Journal of Clinical Sport Psychology, 7*, 264–274.

Luiselli, J. K., & Reed, D. D. (2011). *Behavioral sport psychology: Evidence-based approaches to performance enhancement*. New York: Springer.

Luiselli, J. K., Woods, K. E., Keary, P., & Parenteau, R. E. (2013). Practitioner attitudes and beliefs about exercise, athletic, and recreational activities for children and youth with intellectual and developmental disabilities. *Journal of Developmental and Physical Disabilities, 25*, 485–492.

Luiselli, J. K., Woods, K. E., & Reed, D. D. (2011). Review of sports performance research with youth, collegiate, and elite athletes. *Journal of Applied Behavior Analysis, 44*, 999–1002.

Luyben, P. D., Funk, D. M., Morgan, J. K., Clark, K. A., & Delulio, D. W. (1986). Team sports for the severely retarded: Training a side-of-the-foot soccer pass using a maximum-to-minimum prompt reduction strategy. *Journal of Applied Behavior Analysis, 19*, 431–436.

Mace, F. C., & Lalli, J. S. (1992). Behavioral momentum in college basketball. *Journal of Applied Behavior Analysis, 25*, 657–663.

Martin, G. L. (2011). *Applied sport psychology: Practical guidelines for applied behavior analysts* (4th). Winnipeg, Canada: Sport Science Press.

Martin, G. L., Thompson, K., & Regehr, K. (2004). Studies using single-subject designs in sport psychology: 30 years of research. *The Behavior Analyst, 27*, 123–140.

Martin, G. L., & Thomson, K. (2011). Overview of behavioral sport psychology. In J. K. Luiselli, & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 3–21). New York: Springer.

Martin, G. L., Toogood, A., & Tkachuk, G. A. (1997). *Behavioral assessment forms for sport psychology consulting*. Winnipeg, Canada: Sport Science Press.

McDowell, J. J. (2013). On the theoretical and empirical status of the matching law and matching theory. *Psychological Bulletin, 139*, 1000–1028. http://dx.doi.org/10.1037/a0029924.

McKenize, T. L., & Rushall, B. S. (1974). Effects of self-recording on attendance and performance in a competitive swimming training environment. *Journal of Applied Behavior Analysis, 7*, 199–206.

Mellalieu, S. D., Hanton, S., & O'Brien, M. (2006). The effects of goal setting on rugby performance. *Journal of Applied Behavior Analysis, 39*, 257–261.

Michel, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37*, 149–155.

Nevin, J. A., & Grace, R. C. (2000). Behavioral momentum and the law of effect. *Behavioral and Brain Sciences, 23*, 73–90, discussion 90–130.

Nevin, J. A., Mandell, C., & Atak, J. R. (1983). The analysis of behavioral momentum. *Journal of the Experimental Analysis of Behavior, 39*, 49–59.

Noell, G. H., Gresham, F. M., & Gansle, K. A. (2002). Does treatment integrity matter? A preliminary investigation of instructional implementation and mathematics performance. *Journal of Behavioral Education, 11*, 51–67.

Osborne, K., Rudrud, E., & Zezoney, F. (1990). Improved curveball hitting through the enhancement of visual cues. *Journal of Applied Behavior Analysis, 23*, 371–377.

Pryor, K. (1999). *Don't shoot the dog: The new art of teaching and training*. New York: Bantam.

Reed, D. D. (2011). Quantitative analysis of sports. In J. K. Luiselli, & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 43–59). New York: Springer.

Reed, D. D., Critchfield, T. S., & Martens, B. K. (2006). The generalized matching law in elite sport competition: Football play calling as operant choice. *Journal of Applied Behavior Analysis, 39*, 281–297. http://dx.doi.org/10.1901/jaba.2006.146-05.

Reed, D. D., Skoch, J. J., Kaplan, B. A., & Brozyna, G. A. (2011). Defensive performance as a modulator of biased play calling in collegiate American-rules football. *Revista Mexicana de Análisis de la Conducta, 37*, 51–57.

Roane, H. S. (2011). Behavioral momentum in sports. In J. K. Luiselli, & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 143–155). New York: Springer.

Roane, H. S., Kelley, M. E., Trosclair, N. M., & Hauer, L. S. (2004). Behavioral momentum in sports: A partial replication with women's basketball. *Journal of Applied Behavior Analysis, 37*, 385–390. http://dx.doi.org/10.1901/jaba.2004.37-385.

Rogers, L., Hemmeter, M. L., & Wolery, M. (2010). Using a constant time delay procedure to teach foundational swimming skills to children with autism. *Topics in Early Childhood Special Education, 30*, 102–111.

Romanowich, P., Bourret, J., & Vollmer, T. R. (2007). Further analysis of the matching law to describe two- and three-point shot allocation by professional basketball players. *Journal of Applied Behavior Analysis, 40*, 311–315. http://dx.doi.org/10.1901/jaba.2007.119-05.

Rosenthal-Malek, A., & Mitchell, S. (1997). Brief report: The effects of exercise on the self-stimulatory behaviors and positive responding of adolescents with autism. *Journal of Autism and Developmental Disorders, 27*, 193–202.

Sarokoff, R. A., & Sturmey, P. (2004). The effects of behavioral skills training on staff implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 37*, 535–538. http://dx.doi.org/10.1901/jaba.2004.37-535.

Scott, D., Scott, L. M., & Goldwater, B. (1997). A performance improvement program for an international-level track and field athlete. *Journal of Applied Behavior Analysis, 30*, 573–575.

Seniuk, H. A., Witts, B. N., Williams, W. L., & Ghezzi, P. M. (2013). On terms: Behavioral coaching. *The Behavior Analyst, 36*, 167–172.

Smith, R. E., & Smoll, F. L. (2011). Cognitive-behavioral coach training: A translational approach to theory, research, and intervention. In J. K. Luiselli, & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 227–248). New York: Springer.

Smith, S. L., & Ward, P. (2006). Behavioral interventions to improve performance in collegiate football. *Journal of Applied Behavior Analysis, 39*, 385–391.

Sowa, M., & Meulenbroek, R. (2012). Effects of physical exercise on autism spectrum disorders: A meta-analysis. *Research in Autism Spectrum Disorders, 6*, 46–57.

Stilling, S. T., & Critchfield, T. S. (2010). The matching relation and situation-specific bias modulation in professional football play selection. *Journal of the Experimental Analysis of Behavior, 93*, 435–454. http://dx.doi.org/10.1901/jeab.2010.93-435.

Stokes, J. V., & Luiselli, J. K. (2010). Functional analysis and behavioral coaching intervention to improve tackling skills of a high school football athlete. *Journal of Clinical Sport Psychology, 4*, 150–157.

Stokes, J. V., Luiselli, J. K., & Reed, D. D. (2010). A behavioral intervention for teaching tackling skills to high school football athletes. *Journal of Applied Behavior Analysis, 43*, 509–512.

Stokes, J. V., Luiselli, J. K., Reed, D. D., & Fleming, R. K. (2010). Behavioral coaching to improve offensive line pass blocking skills of high school football athletes. *Journal of Applied Behavior Analysis, 43*, 463–472.

Tiger, J. H., & Kliebert, M. L. (2011). Stimulus preference assessment. In J. K. Luiselli (Ed.), *Teaching and behavior support for children and adults with autism spectrum disorder: A practitioner's guide* (pp. 31–37). New York: Oxford University Press.

Tkachuk, G., Leslie-Toogood, A., & Martin, G. L. (2003). Behavioral assessment in sport psychology. *The Sport Psychologist, 17*, 104–117.

Vollmer, T. R., & Bourret, J. (2000). An application of the matching law to evaluate the allocation of two- and three-point shots by college basketball players. *Journal of Applied Behavior Analysis, 33*, 137–150. http://dx.doi.org/10.1901/jaba.2000.33-137.

Wack, S. R., Crosland, K. A., & Miltenberger, R. G. (2014). Using a goal-setting and feedback procedure to increase running distance. *Journal of Applied Behavior Analysis, 47*, 181–185.

Ward, P. (2011). Goal setting and performance feedback. In J. K. Luiselli & D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement* (pp. 99–112). New York: Springer.

Ward, P., & Carnes, M. (2002). Effects of posting self-set goals on collegiate football players' skill execution during practice and games. *Journal of Applied Behavior Analysis, 35*, 1–12.

Wilder, D. A., Atwell, J., & Wine, B. (2006). The effects of varying levels of treatment integrity on child compliance during a three-step prompting procedure. *Journal of Applied Behavior Analysis, 39*, 369–373.

Winston, W. L. (2009). *Mathletics: How gamblers, managers, and sports enthusiasts use mathematics in baseball, basketball, and football.* Princeton, NJ: Princeton University Press.

Wolf, M. M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11*, 203–214.

Wolko, K. L., Hrycaiko, D. W., & Martin, G. L. (1993). A comparison of two self-management packages to standard coaching for improving practice performance of gymnasts. *Behavior Modification, 17*, 209–223.

Yilmaz, I., Yanardag, M., Birkan, B. A., & Bumin, G. (2004). Effects of swimming training on physical fitness and water orientation in autism. *Pediatrics International, 46*, 624–626.

Ziegler, S. G. (1987). Effects of stimulus cueing on the acquisition of ground strokes by beginning tennis players. *Journal of Applied Behavior Analysis, 20*, 405–411.

Ziegler, S. G. (1994). The effects of attentional shift training on the execution of soccer skills: A preliminary investigation. *Journal of Applied Behavior Analysis, 27*, 545–552.

Zinsser, N., Bunker, L., & Williams, J. M. (2006). Cognitive techniques for building confidence and enhancing performance. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th, pp. 349–381). New York: McGraw-Hill.