

A Replication of a Systematic Review of Behavioral Interventions in Sports.

by

Sofia Macias Mendoza

Submitted in Partial Fulfillment of the Requirements

for the Degree of

Master of Science

in

Applied Behavior Analysis

YOUNGSTOWN STATE UNIVERSITY

May 2024

## A Replication of a Systematic Review of Behavioral Interventions in Sports

Sofia Macias Mendoza

I hereby release this thesis to the public. I understand that this thesis will be made available from the OhioLINK ETD Center and the Maag Library Circulation Desk for public access. I also authorize the University or other individuals to make copies of this thesis as needed for scholarly research.

Signature:

---

*Sofia Macias Mendoza*, Student Date

Approvals:

---

*Dr. Kristopher Brown*, Psy.D, BCBA-D, Thesis Advisor Date

---

*Dr. Alicia Prieto-Langarica*, Committee Member Date

---

*Joseph Corpa*, MS, BCBA, Committee Member Date

---

Salvatore A. Sanders, PhD, Dean, College of Graduate Studies Date

**ABSTRACT**

Behavioral Sports Psychology (BSP) research has experienced significant growth over recent decades, with various interventions implemented across different sports, athletes, and coaching contexts. This study builds upon previous systematic reviews by examining research from 2018 to 2024, focusing on behavioral interventions to enhance sports performance. Using inclusion criteria aligned with prior studies, 15 articles were identified from academic journals, covering nine sports and employing ten distinct behavioral interventions. Findings indicate consistent performance improvements across studies, with no negative outcomes reported. However, gaps persist in research, including the need for more studies on specific interventions, sports, and skill levels, as well as a scarcity of research involving professional athletes. The study analyzes the effectiveness of behavioral interventions in sports performance enhancement while highlighting avenues for future research to address limitations and broaden the applicability of findings across diverse sporting contexts.

*Keywords:* ABA, applied behavior analysis, behavioral sports psychology, behaviorism, sport psychology

Table of Contents

Introduction..... 1

Method.....5

Results.....9

Discussion.....16

References.....20

## **Introduction**

According to the Behavior Analyst Certification Board (n.d.), applied behavior analysis (ABA) is the science of behavior. The guiding philosophy of this concept is based on behaviorism, which aims to improve the human condition through behavior change. According to Cooper et al., (2007), ABA is a scientific approach that utilizes behavior-based techniques such as reinforcement, extinction, shaping, and chaining to enhance socially significant behavior. ABA also is data based and uses experimentation to identify the variables responsible for improvements in the behavior of individuals. ABA is characterized by data collection and review of the behavior of individuals as opposed to groups (which is the norm in much of social science). Because of its emphasis on individual behavior and empirical nature, ABA has been used as a treatment for many psychological conditions. Most recently, ABA has been associated with autism treatment with several decades of studies have shown that ABA is effective in helping individuals with autism. Even though ABA is mostly known for its success in treating individuals with autism, ABA has been applied successfully in other areas. These areas include clinical, health and fitness, substance use disorders, brain injury rehabilitation, education, organizational, and behavioral sports psychology (BACB, n.d.). However, there is still more to explore in these areas to show their full potential.

## **History of Behavioral Sport Psychology**

Behavioral sports psychology (BSP) involves the use of behavior analysis principles and techniques to enhance the performance and satisfaction of athletes and others associated with sports (Martin & Tkachuk, 2000). Martin and Thomson (2011), in

their work *Overview of Behavioral Sport Psychology*, explained the impressive evolution of the field of sports psychology. This field gained recognition in the 1960s, establishing major organizations like the International Society of Sports Psychology, the North American Society for the Psychology of Sports and Physical Activity, and the Canadian Society for Psychomotor Learning and Sport Psychology. One of the leading figures in this area was Brent Rushall, who became known for his behaviorally oriented approach (see Rushall, 1972, 1975). During the late 1970s and early 1980s, there was an increase in published works investigating behavioral strategies designed to enhance athletic performance. These studies focused on a variety of sports and age groups, and included evaluations of individual athletes, analysis of factors that impacted sports participation, coaching methods for young athletes, as well as research on cognitive-behavioral approaches for adult athletes. By the mid-1980s, behavioral sport psychology had not only established a strong foundation but also a promising future (Martin & Thomson, 2011).

### ***Research in BSP***

Research in BSP has grown over the past few decades. Many different behavioral interventions have been implemented across different sports, athletes, and coaches. Recent systematic reviews have documented the increase in the publication of BSP over the years, its growth across different sports, the variety of behavioral interventions implemented, and the different trends, limitations, and directions for future research (Luiselli & Reed, 2015; Schenk & Miltenberger, 2019; Martin et al., 2004). The publication of BSP articles in sports journals increased from one article per year from 1974-1983 to 17 per year from 1994-2003, while the number of these articles published

in behavioral journals remained between five and seven per year during that same time frame (Martin et al., 2004). Their study summarizes 30 years of research in BSP utilizing single-subject designs, it included 40 studies across 16 different sports and nine different interventions. Their review included sections of assessment of generality of behavior change and procedural reliability or treatment integrity (Martin et al., 2004).

The most recent systematic review on behavioral interventions to enhance sports performance was published in 2019 by Schenk and Miltenberger. They included studies from the early 1960s to 2018, including 101 studies, across 21 different sports utilizing 23 different sports. Categorizing the different procedures into consequence procedures, antecedent procedures, feedback procedures, skill training procedures, and other procedures. Instruction and verbal feedback procedures were implemented the most across all the studies. The results of this review indicated that various behavioral procedures can be used across numerous sports to facilitate performance enhancement effectively. Behavior analysis has much to offer athletes in many sports (Schenk & Miltenberger, 2019).

### **Social and Personal Benefits of Sports**

Investigations into the best ways to modify sports performance are important. Sports have many benefits for both individuals and society. They promote fitness, reduce the risk of chronic diseases such as obesity, cardiovascular diseases, diabetes, and improve overall health outcomes (Bailey et al., 2013). Some other benefits of sports are improved mental well-being (Penedo & Dahn, 2005), building social connections, and enhancing social cohesion within communities, which leads to greater social integration and a sense of belonging (Eime et al., 2013). Lastly, sports (especially professional)

contribute to economic growth through various channels, including job creation, tourism revenue, infrastructure development, and increased consumer spending on sports-related goods and services (Rosentraub, 2018). According to Seniuk and colleagues (2020) it is important to consider the role that behavior analysis could play in the sports industry based on the significant influence of sports in society. Conversely, publication of research in the field could also be hindered based on *how* effective it is. Martin and Miltenberger (2019), for example, speculated that publishing research with a specific population might be detrimental to the profits of the professional teams if they reveal interventions that enhance the performance of their athletes and thus facilitate the loss of competitive edge.

Based on previous research in BSP, there are many different possibilities for future research especially as the field grows. The number of studies published every year has increased. However, there are relatively few studies on behavioral sports psychology to strongly demonstrate the effectiveness of a certain behavioral intervention in certain sports or to generalize a behavioral intervention across different skill levels, sports, or settings (practice/competition). In their paper, Schenk and Miltenberger (2019) suggested that future research could assess the utility of different interventions across different sports and age ranges. Schenk and Miltenberger (2019) and Martin and colleagues (2004) both identified the paucity of research that focuses on the performance enhancement of professional athletes as an issue for the field. The purpose of this study was to systematically replicate and extend the findings of Schenk and Miltenberger (2019) by analyzing the findings of the newest research on behavioral interventions to enhance sports performance from 2018 to 2024. The second purpose of this study was to analyze the gaps in the current research and suggest new directions for future research.



## **Method**

### **Search Criteria**

A search was done via EBSCOhost through Youngstown State University Maag Library. The author searched the terms “Sports” and “Behavior Analysis” and “Feedback” together. These terms were searched in databases APA PsycINFO and Psychology and Behavioral Sciences Collection. Only academic journals were included. Search was limited to academic journals published between 2018 and 2024. Books, magazines, thesis, and dissertations were excluded.

### **Inclusion and Exclusion Criteria**

The inclusion and exclusion criteria used to identify studies for review were replicated from the (Schenk & Miltenberger, 2019). These criteria were chosen to ensure consistency and comparability with the original study. There were two inclusion criteria: first, the articles had to use a behavioral intervention that altered observable behavior. Second, the target behavior had to be sport performance consisting of the measurement of an athlete’s observable behavior. Studies that focused solely on physical activity or that were therapeutic in nature were excluded, as well as studies not on the performance of a skill related to an organized sport or not written in English. Any sport could be included.

### **Behavioral Interventions**

Categories of all behavioral interventions were coded by the authors and were based on those from Schenk and Miltenberger (2019). However, some required slight modification. One intervention was not in their study (Positive Interventions to Enhance

the Performance of Dancers, POINTE) so the authors defined it. Categories and their definitions follow.

### **Consequence Interventions**

Procedures were categorized as consequence interventions when some stimulus was introduced contingent on performance and was clearly described to function as reinforcement or punishment (Schenk & Miltenberger, 2019). Examples of the categories are provided below.

***Auditory Feedback.*** Auditory feedback is a method of providing feedback through an auditory device to reinforce correct steps in the task analysis of targeted athletic skills, this method is sometimes referred to as TAGteach (teaching with acoustical guidance; Quinn et al., 2015).

***Chaining.*** Chaining is a series of responses in which each step serves both as a reinforcer for the previous step and as a discriminative stimulus for the next step (Cooper et al., 2007). This method is used to teach complex behavior. There are two different types of chaining: starting with the last step (backward chaining) or with the first step (forward chaining) and proceeding sequentially until the entire sequence of behaviors occurs together.

### **Antecedent Interventions**

Interventions were categorized as antecedent interventions when the stimulus was introduced at the beginning of each session or trial or before the behavior occurred to evoke the behavior (Schenk & Miltenberger, 2019).

***Goal Setting.*** It involves setting a specific, challenging, measurable, and relevant goal for performance within a specified amount of time.

***Video Modeling and Expert Modeling.*** Video modeling or instruction includes any time a visual electronic device (e.g., TV or computer screen) was used to provide verbal and/or visual instruction, including words, diagrams, and images of people engaging in the target behavior (Schenk & Miltenberger, 2019). This intervention was sometimes implemented along with expert modeling, where a video of an expert was shown before the participant's performance or side-by-side with the participant's video performing the specific skill. According to (Walker et al., 2020), expert modeling consists of an individual who is fluent in a skill, deemed the "expert," exhibiting the skill accurately in the presence of the participant.

### **Feedback Interventions**

Interventions were categorized as feedback when information about the athletic performance just exhibited was introduced following an instance of behavior (Schenk & Miltenberger, 2019).

***Verbal Feedback.*** Includes any time the individual implementing the intervention (coach, researcher, or peer) provided statements about performance in response to a subject engaging in the target behavior, verbal feedback was not categorized if it was used as a component of video feedback (Schenk & Miltenberger, 2019). Peer-implemented feedback was implemented in two of the studies (Cochrane et al., 2022; Quinn et al., 2022) that met the inclusion criteria.

***Video Feedback.*** Consists of the participants viewing their performance either before or after a skill attempt. When video feedback was used, verbal comments (verbal

feedback) were provided on the behavior in the video (Schenk & Miltenberger, 2019).

Another variation of video

***Self-Monitoring.*** Anytime the study participants recorded their engagement in the target behavior that can occur during or after training (Schenk & Miltenberger, 2019). For the particular study that implemented self-monitoring, a self-monitoring checklist was completed after the end of a period of time to monitor whether the participant had completed a list of expected behaviors (Ayvazo & Naveh, 2024).

***Public Posting.*** Involves publicly posting an athlete's performance data to influence their athletic performance.

#### **Other Interventions.**

Interventions were categorized as other procedures when they included multiple components and types of procedures that were used concurrently (Schenk & Miltenberger, 2019).

***Behavioral Skills Training.*** BST is an empirically supported training protocol consisting of instruction, modeling, rehearsal, and feedback. The instruction component involves describing the desired target behavior; the modeling component demonstrates to the participant how to perform the target behavior; and the rehearsal and feedback consist of the participant practicing the target behavior while getting feedback on the performance (Miltenberger, 2003).

***Positive Interventions to Enhance the Performance of Dancers.*** POINTE is a manualized behavioral coaching program developed by Quinn et al. (2015). It is a compilation of various behavioral coaching procedures based on ABA, this manual is specifically tailored to enhance dance performance.

## Results

A total of 134 journal articles were initially located using the parameters above. After a secondary review, 15 met all inclusion criteria. Search criteria were replicated from Schenk and Miltenberger (2019) with a slight modification of adding the word “Feedback” to the search criteria. Nine different sports and ten different behavioral procedures were implemented across those sports. 39 different target behaviors were evaluated, and most studies evaluated multiple behaviors simultaneously. All studies included in the current study are categorized by sport, target behavior, and behavioral intervention in Table 1. Two of the 15 articles occurred outside of the United States, one in Germany (Vorbeck & Bördlein, 2020) and one in Israel (Ayvazo & Naveh, 2024). Most of the studies evaluated the performance of athletes, but only one evaluated the coaches' performance by presenting them a behavioral manual with different interventions and their respective definitions and training (Quinn et al., 2022). All the studies included some target behaviors of improving the athlete's performance on a specific skill in their respective sport, 100% of the studies implemented a task analysis (TA) to evaluate the performance of the participants when performing the skill by breaking it down in small steps to be able to teach it to the participants or objectively evaluate the number of correct steps completed by the participants. Most of the studies designed their own TA and consulted with experts on the sport or skill being evaluated to ensure it was correct and adjust if needed. TA was also utilized during interobserver agreement (IOA) so the additional observers would score with the same criteria as the individual implementing the intervention (researcher or coach).

### **Participant Characteristics**

There were 56 participants in total. A total of 32 were female, 13 were male, and 11 were not specified. Participants in the studies ranged from 6 to 58 years old. A total of 34 were adults, 13 were children, and 9 were adolescents. The skill levels of the participants were not specified in all the studies; some only specified years of experience. For example, Quinn et al., (2022), only presented the demographics of the participants and specified years of dance lessons and competition dance lessons of each participant without specifying their skill level. Other categories used in different studies to classify the skill level of the participants were novice (no previous experience in the sport), beginner, intermediate, recreational, and competitive. Within the competitive category, some studies included varsity college athletes. For example, Mize-Climer et al., (2023) selected three female volleyball players at a collegiate level to evaluate three interventions across practice and in-game settings. Table 2 summarizes all the participants across all the studies, categorizing them by number of participants, age range, gender, and skill level.

### **Behavioral Intervention Characteristics**

Ten different behavioral interventions were implemented across all 15 studies. Auditory feedback and chaining were categorized under consequence interventions. Auditory feedback was implemented in three studies (Vorbeck & Bördlein, 2020; Krukauskas et al., 2019; Ennett et al., 2019), one more study implemented auditory feedback but was not the main intervention being evaluated. Quinn et al. (2022) main intervention being evaluated was POINTE, which is a behavioral manual specialized in dance instruction; four dance instructors and four dance students participated in the study. Three of the four dance instructors chose auditory feedback to improve their students'

dance performance. Vorbeck and Bördlein, (2020) evaluated the effectiveness of auditory feedback in improving handstand performance with three participants. Significant improvement was shown across all participants when auditory feedback intervention was implemented. Krukauskas et al. (2019) used auditory feedback to improve an MMA skill (right cross) with four participants, demonstrating the effectiveness of auditory feedback across all participants and maintenance after the intervention was completed. Ennett et al. (2019) used TAGteach to improve the performance of four novice athletes performing yoga. This study implemented two interventions: a standard TAGteach and a TAGteach with reduced practice. Both methods demonstrated effectiveness without a clear difference in whether one method was more effective than the other in teaching yoga poses.

Only one study evaluated the effectiveness of chaining in enhancing sports performance. This study compared forward and backward chaining to improve the technique of Olympic weightlifting. Moore and Quintero (2019) evaluated backward and forward chaining with four participants. The results showed that forward chaining was more effective in improving technique for Olympic weightlifting (clean and snatch). All participants reached mastery for both skills using forward chaining compared to backward chaining, where mastery was not reached.

Goal setting, video modeling, and expert modeling were categorized under antecedent interventions. Goal setting was implemented only in one of the studies. Mize-Climmer et al. (2023), they evaluated three different interventions to improve the performance of correct blocks with three volleyball players. Only two of the three interventions implemented included goal setting and neither of those two interventions evaluated goal setting alone. One evaluated goal setting and verbal feedback; the other

intervention evaluated goal setting, public posting, and verbal feedback. All interventions improved performance for all participants. Video modeling was used in four different studies. Two of the studies evaluated video modeling alone and then evaluated video modeling with video feedback; both studies got similar results indicating that video modeling alone showed moderate improvement in the participant's performance, but video modeling and video feedback showed more significant improvements. One study evaluated soccer (Capalbo et al., 2022), and one dance (Quinn et al., 2020). Mulqueen et al. (2021), combined video modeling with verbal feedback to improve the technique of clean and jerk and snatch, two Olympic weightlifting skills. Results demonstrated effectiveness in improving skills in Olympic weightlifting across participants. Walter et al. (2020) implemented expert modeling and video feedback to enhance performance of competitive dancers, they also evaluated video expert alone. All participants improved their skill and dance performance with both interventions, but more significant improvement was shown when video expert with video feedback intervention was implemented.

The following interventions were categorized as feedback interventions: verbal feedback, video feedback, self-monitoring, and public posting. Verbal feedback was implemented in two studies (Mize-Climmer et al., 2023; Deshmukh et al., 2022). The second study compared verbal feedback and video feedback to improve dance skills performance with three participants. The researchers could not determine which intervention was more effective because all participants' results differed: verbal feedback was more effective for one participant, video feedback was more effective for another participant, and both interventions were equivalent for the third participant (Deshmukh et al., 2022). Video feedback was implemented in seven studies. All seven studies have been mentioned



previously except Cochrane et al. (2022), which evaluated peer-implemented video feedback, a variation of video feedback that was implemented by a participant to a participant to improve weight training form when performing a deadlift. The first part of the study utilized BST to teach the participants who were playing the role of trainers how to implement video feedback to their peers. Results demonstrated the effectiveness of both interventions, BST and peer-implemented video feedback, to increase the correct performance of deadlifts and properly teach their peers the correct form of deadlifts. Self-monitoring was used only in one study, where it was implemented with public posting to increase performance in three young cyclists by measuring their intensity precision, performance volume, and performance duration in their designated practice regimen (Ayvazo & Naveh, 2024). Public posting was implemented in two studies previously described (Mize-Climer et al., 2023; Ayvazo & Naveh, 2024).

Lastly, BST and POINTE were under the category of other interventions. Both interventions include a variety of behavioral interventions. BST was implemented in three studies. For example, O'Neill and Miltenberger (2020) evaluated the effectiveness of BST in field hockey with three adolescents to increase their correct form of three types of shots; the results demonstrated significant improvement across all participants and shots. POINTE was implemented in only one study. Quinn et al. (2022) evaluated POINTE eight participants, where four were dance instructors and the other four were their respective students. Each dance instructor read the POINTE manual and selected a behavioral intervention based on the needs of their student, got some training on the specific intervention, and then implemented it with the student. Results showed that the instructors successfully implemented the behavioral intervention they selected, and all student

participants showed significant improvement in their dance skills when the intervention was implemented. Figure 1 summarizes the number of times each intervention was implemented across all 15 studies.

### **Study Design Characteristics**

Eight different variations of experimental designs were found across all 15 studies. The most common design was a multiple baseline across behaviors, which was implemented in five studies. The second most common design was a non-concurrent multiple baseline across participants, which was implemented in three studies. Multiple baseline across participants was implemented in two studies. The following experimental designs were implemented in only one study: reversal design (Ayvazo & Naveh, 2024), alternating treatments (Mize-Climmer et al., 2023), multiple-baseline across behaviors and participants (Mulqueen et al., 2021), adapted alternating-treatments (Ennett et al., 2019), and non-concurrent multiple-baseline across participants with embedded alternating treatments (Deshmukh et al., 2022).

IOA was calculated in 100% of the studies. Social validity was measured in all the studies except in one (e.g., Moore & Quintero, 2019). All studies that measured social validity included a questionnaire at the end of the study. The questionnaire contained different questions to assess the acceptability, relevance, and effectiveness of the intervention. For example, Walker et al. (2020) asked “How appropriate were the procedures used to increase climbing performance?”. Five studies included a second way to assess social validity, which consisted of sending pre and post-intervention videos of each participant to an expert coach or coaches who were blinded to the study. The expert coach was not told which video was from which phase. Coaches were asked to rate the

participants' performance based on a TA or scale depending on what each study was measuring. For example, O'Neill and Miltenberger (2020) sent the expert coaches videos of each participant along with a 10-point scale (completely incorrect to completely correct). Then, the researcher reviewed the rates from the expert coaches to see if they noticed an improvement from pre- to postintervention.

Treatment integrity was measured in 11 of the 15 studies to ensure correct intervention implementation. Some of the studies utilized video recording to assess treatment integrity. For example, Vorbeck and Bördlein (2020) evaluated treatment integrity by observing video recordings of the trainer implementing the intervention and using a checklist to evaluate if the intervention was executed correctly. They evaluated 37 videos where the trainer correctly executed 95% of the intervention.

Maintenance was evaluated in eight of the studies (53%) by including a follow-up phase after the intervention sessions were completed. Most of the studies implemented a follow-up phase at least one week after the last intervention session. For example, Mulqueen et al., (2021) conducted maintenance sessions one week and four weeks after the last intervention session, demonstrating maintenance across all participants. Generalization was measured in only three studies (20%). Krukauskas et al., (2019) evaluated generalization by simulated matches with the coach between regular assessment trials. The other two studies evaluated the generalization of a volleyball skill (blocking) to game settings, and a soccer skill (zig-zag drill) to practice with direct and indirect distractors (Mize-Climer et al., 2023; Harris et al., 2020). Table 3 summarizes all the study design characteristics.

### **Discussion**

The purpose of this study was to replicate and extend the findings of (Schenk & Miltenberger, 2019), analyze the findings of the newest research and their gaps, and suggest new directions for future research. All studies demonstrated improvement in sports performance when implementing a behavioral intervention. However, multiple points about the research need to be discussed.

Across all the studies there were no negative results with all the behavioral interventions implemented. Publishing studies with negative results could help expand the research by guiding future research building on what was evaluated and did not demonstrate positive results. Some of the studies had mixed results (Deshmukh et al., 2022) where one participant improved with one intervention, the other participant improved with a different intervention, and the third one improved with both interventions; Not demonstrating a clear effective intervention. This example could lead to future research where they evaluate the interventions with more participants to clearly identify which intervention is more effective.

Almost all studies mentioned that there were relatively few studies on the specific intervention they were about to implement, or there was research on the intervention but not on the specific sport or skill being evaluated. For example, O'Neill and Miltenberger (2020) mentioned that no behavioral research to date has investigated procedures for improving field hockey shots. This demonstrates that there are still many possibilities for new research. However, at the same time, there is a long way to strongly demonstrate the effectiveness of certain behavioral interventions and effectively generalize the findings across different sports, skill levels, and ages. Another example, Capalbo et al., (2022)

mentioned that there were very few studies on soccer skills and no studies on the skills of a goalkeeper. There is a big area for future research among different sports (baseball, basketball, American football) into their specific player position's skills (e.g., soccer players: defender, midfielder, forward). Each position requires specific skills to enhance the performance of the athlete.

One of the points made by Schenk and Miltenberger (2029) was about package interventions and not being able to identify what individual components of the package were more effective in enhancing performance. In the current study, only four studies evaluated only one intervention. All other studies evaluated two or more interventions. This suggests that package interventions are very popular in this field and continue to demonstrate effectiveness across different sports and participants. A new package intervention that was POINTE. Quinn et al. (2022) this intervention evaluated the coach's and athletes' behavior. It was the only study evaluating the coaches. This particular intervention allowed the coaches to learn about different behavioral interventions and pick the one that would best fit their student's needs and get some training on it. POINTE was designed for dance instructors but future research could develop similar interventions that can be implemented for different sports.

A study took a different approach: improving technique by reducing the risk of injuries. Harris et al. (2020) implemented BST to improve skill acquisition of movement in soccer, which may help reduce the risk of ACL injury. Behavioral interventions were implemented to improve technique, which led to sports performance enhancement and injury prevention. Future research could explore injury prevention and sports performance.

Some limitations were the lack of generalization measures across the studies. Only three studies implemented generalization measures and only one of those three was in a real competition setting. Behavioral interventions should be generalized to more real-life settings like competitions, as it is a crucial setting for athletes. Most athlete's end goal is to win a competition. Another limitation was the scarcity of international research, with only two studies involving international athletes. Limiting the generalizability of findings to broader global contexts may overlook valuable insights and perspectives from diverse cultural and geographical settings.

One limitation of the current study was the lack of IOA to ensure the consistent implementation of inclusion and exclusion criteria, which may have introduced potential biases or oversights in the selection of studies. Additionally, the absence of cross-reference checking may have resulted in the omission of relevant research studies that could have met the inclusion criteria and potentially impacted the comprehensiveness of the review.

As Schenk and Miltenberger (2019) and Martin and colleagues (2004), we did not find any studies evaluating the performance of professional athletes. None of the studies we found had high-performance athletes as participants, or at least it was not specified. Ayvazo and Naveh, (2024) participants practiced 12-14 hours per week, which was the study with the highest training regimen according to the number of hours of training per week.

As an athlete becomes more skilled and proficient in their sport, the need for attention to detail becomes increasingly important to improve their performance. This is particularly true for athletes with a high level of fluency in their skillset, as the margin for

error becomes smaller and smaller. To continue improving, athletes must employ a high level of precision and accuracy in their training and execution of skills. As an athlete progresses to higher levels of competition, the complexity of the skills required to excel also increases. Therefore, if there is not enough behavioral intervention research focusing on enhancing more complex sports skills, it is possible that it might not be attractive for professional athletes or coaches of professional athletes to implement interventions that have no previous evidence with complex skills.

In conclusion, this study analyzes the newest research on behavioral interventions in sports performance in the past six years, supporting the evidence that behavioral interventions are effective in improving sports performance across various sports, participants, and settings. This study contributes to the growing body of research in behavioral sports psychology and provides valuable insights into the effectiveness of these interventions.

### References

- Ayvazo, S., & Naveh, M. (2024). Self-monitoring and public posting improve competitive youth cyclists' training performance. *Journal of Applied Behavior Analysis, 57*, 394-407. <https://doi.org/10.1002/jaba.1058>
- Capalbo, A., Miltenberger, R. G., & Cook, J. L. (2022). Training soccer goalkeeping skills: is the video modeling enough? *Journal of Behavior Analysis, 55*(3), 958-970. <https://doi.org/10.1002/jaba.937>
- Cochrane, E., Miltenberger, R., & Concepcion, A. (2022). Evaluating peer-implemented video feedback to improve weight training form. *Journal of Applied Behavior Analysis, 55*(4), 1144-1156. <https://doi.org/10.1002/jaba.949>
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson.
- Deshmukh, S. S., Miltenberger, R. G., & Quinn, M. (2022). A comparison of verbal feedback and video feedback to improve dance skills. *Behavior Analysis: Research and Practice, 22*(1), 66-80. <https://doi.org/10.1037/BAR0000234>
- Ennett, T. M., Zonneveld, K. L. M., Thomson, K. M., Vause, T., & Ditor, D. (2019). Comparison of two TAGteach error-correction procedures to teach beginner yoga poses to adults. *Journal of Applied Behavior Analysis, 53*(1), 222-236. <https://doi.org/10.1002/jaba.550>
- Harris, M., Casey, L. B., Meindl, J. N., Powell, D., Hunter, W. C., & Delgado, D. (2020). Using behavioral skills training with video feedback to prevent risk injury in youth female soccer athletes. *Behavior Analysis in Practice, 13*, 811-819. <https://doi.org/10.1007/s40617-020-00473-4>



- Krukauskas, F., Miltenberger, R., & Gavoni, P. (2019). Using auditory feedback to improve striking for mixed martial artists. *Behavioral Interventions*, 34(3), 419-428. <https://doi.org/10.1002/bin.1665>
- Miltenberger, R. G. (2003). *Behavior modification: Principles and procedures*. Belmont, CA: Wadsworth.
- Mize-Climer, C. K., Lukkes, C.K., & Sweeney, W. J. (2023). Behavioral interventions to improve the performance of collegiate volleyball. *Journal of Behavioral Education*, 32(2), 169-188. <https://doi.org/10.1007/s10864-021-09433-6>
- Moore, J. W., & Quintero, L. M. (2019). Comparing forward and backward chaining in teaching Olympic weightlifting. *Journal of Applied Behavior Analysis*, 52(1), 50-59. <https://doi.org/10.1002/jaba.517>
- Mulqueen, D., Crosland, K. A., & Novotny, M. A. (2021). Using video modeling and video feedback to improve Olympic weightlifting technique. *Behavior Analysis: Research and Practice*, 21(3), 282-292. <https://doi.org/10.1037/bar0000211>
- O'Neill, K., Miltenberger, R., (2020). The effect of behavioral skills training on shot performance in field hockey. *Behavioral Interventions*, 35, 392-401. <https://doi.org/10.1002/bin.1717>
- Quinn, M. J., Blair, K. C., & Miltenberger, R. G. (2015a). *A dance instructor's guide to applying applied behavior analysis principles in the coaching of competitive dancers: The POINTE Program Manual*. University of South Florida.
- Quinn, M., Blair, K. C., Novotny, M., & Deshmukh, S. (2022). Pilot study of a manualized behavioral coaching program to improve dance performance. *Journal of Applied Behavioral Analysis*, 55(1), 180-194. <https://doi.org/10.1002/jaba.874>

Quinn, M., Narozanick, T., Miltenberger, R., Greenberg, L., & Schenk, M. (2020).

Evaluating video modeling and video modeling with video feedback to enhance the performance of competitive dancers. *Behavioral Interventions*, 35(1), 76–83.

<https://doi.org/10.1002/bin.169>

Rushall, B. S. (1972). Operant conditioning as a realistic method for physical education.

*CAHPER Journal*, 28, 31-33.

Rushall, B. S. (1975). Applied behavior analysis for sports and physical education.

*International Journal of Sport Psychology*, 6, 75-88.

Schenk, M., & Miltenberger, R. (2019). A review of behavioral interventions to enhance sports performance. *Behavioral Interventions*, 34(2), 248–279.

<https://doi.org/10.1002/bin.1659>

Vorbeck, B., & Bördlein, C. (2020). Using auditory feedback in body weight training.

*Journal of Behavior Analysis*, 53(4), 2349-2359. <https://doi.org/10.1002/jaba.723>

Walker, S. G., Mattson, S. L., & Sellers, T. P. (2020). Increasing accuracy of rock-climbing techniques in novice athletes using expert modeling and video feedback.

*Journal of Applied Behavior Analysis*, 53(4), 2260-2270.

<https://doi.org/10.1002/jaba.694>

**Table 1***Studies Included in Current Review*

<b>Sport</b>	<b>Target Behavior</b>	<b>Procedures</b>	<b>Citation</b>
Dance	Improving specific dance skills (straddle leap, arabesque, single pirouette, needle, and double pirouette)	Verbal Feedback and Video Feedback	(Deshmukh et al., 2022)
	Improving specific dance skill (brise)	Video Modeling and Video Feedback	(Quinn et al., 2020)
	To test instructor fidelity to POINTE and improvement of specific dance skills.	Manualized behavioral coaching program (Positive Interventions to Enhance the Performance of Dancers POINTE )	(Quinn et al., 2022)
Cycling	Improve specific performance skills for cycling training (volume, intensity, and duration)	Self-monitoring and public posting	(Ayvazo & Naveh, 2024)
Field Hockey	Improving performance on a specific hockey skill (drive, slap shot and sweep)	Behavioral Skills Training (BST)	(O'Neill & Miltenberger, 2020)
Mixed Martial Arts	Improving a specific skill of MMA (right cross)	Auditory Feedback	(Krukauskas et al., 2019)
Soccer	Improving performance of specific goalkeeper skills (high jump, forward smother, and side dive)	Video Modeling and Video Feedback	(Capalbo et al., 2022)
	Improving performance of specific soccer skills (zigzag drill)	Behavioral Skills Training (BST) with Video Feedback	(Harris et al., 2020)
Volleyball	Improving specific volleyball skill (Blocking the ball)	Goal setting, verbal feedback, and public posting	(Mize-Climer et al., 2023)

**Table 1 (continued)**

<b>Sport</b>	<b>Target Behavior</b>	<b>Procedures</b>	<b>Citation</b>
Weightlifting	Study 1: correct implementation of Video feedback by peer trainers. Study 2: Improving deadlift performance	BST and Peer-implemented video feedback	(Cochrane et al., 2022)
	Improving a specific skill of bodyweight training (handstand)	Auditory Feedback	(Vorbeck & Bördlein, 2020)
	Improving specific skills of Olympic weightlifting (clean & jerk, and snatch)	Video Modeling and Video Feedback	(Mulqueen et al., 2021)
	Improving specific skills of Olympic weightlifting (clean and snatch)	Forward and Backward chaining	(Moore & Quintero, 2019)
Yoga	Improving specific yoga skills (side angle, half peagon, chair, downward dog, and warrior III)	Auditory Feedback (TAGteach)	(Ennett et al., 2019)
Rock-climbing	Improving specific rock-climbing skills (The drop knee, heel hook, and rear flag techniques)	Video Modeling and Video Feedback	(Walker et al., 2020)

**Table 2***Participants in Studies Included in Current Review*

<b>Citation</b>	<b>No. of Participants</b>	<b>Age Range</b>	<b>Target Population</b>	<b>Skill Level</b>
(Deshmukh et al., 2022)	3 Females	6 to 9	Kids	Competitive and recreational. Beginners - intermediate
(Mize-Climer et al., 2023)	3 Females	18 to 21	Adults	Collegiate
(Cochrane et al., 2022)	5 Females 1 Male	22 to 40	Adults	Novice to Intermediate
(Quinn et al., 2020)	4 Females	9 to 13	Kids	Competitive
(Walker et al., 2020)	1 Male 2 Females	20 to 29	Adults	Not specified/ only years of experience
(O'Neill & Miltenberger, 2020)	3 Females	15	Adolescents	Novice/ 2 year of experience/ 8 years of experience
(Vorbeck & Bördlein, 2020)	1 Female 2 Males	25 to 30	Adults	Novice and Beginners
(Krukauskas et al., 2019)	2 Females 2 Males	25 to 54	Adults	Novice and Beginners
(Mulqueen et al., 2021)	3 participants	30 to 39	Adults	Beginners
(Moore & Quintero, 2019)	2 Females 2 Males	25 to 58	Adults	Beginners
(Ennett et al., 2019)	4 participants	32 to 39	Adults	Novice
(Quinn et al., 2022)	4 Dance instructors (Not specified) 4 Students (Females)	Dance instructors: 28 to 37 Students: 6 to 13	Kids and Adults	Not specified/ only years of experience

**Table 2 (continued)**

<b>Citation</b>	<b>No. of Participants</b>	<b>Age Range</b>	<b>Target Population</b>	<b>Skill Level</b>
(Ayvazo & Naveh, 2024)	3 Males	14 to 16	Adolescents	Competitive
(Capalbo et al., 2022)	2 Males	9 years old	Kids	Not specified/ only years of experience
(Harris et al., 2020)	3 Females	12 to 13	Adolescents	Competitive

**Table 3***Study Design Characteristics*

<b>Citation</b>	<b>Experimental Design</b>	<b>IOA</b>	<b>Social Validity</b>	<b>Treatment Integrity</b>	<b>Follow Up/ Maintenance</b>	<b>Generalization</b>
(Deshmukh et al., 2022)	Non-concurrent multiple baseline across participants with an embedded alternating treatments	YES	YES	YES	NO	NO
(Mize-Climer et al., 2023)	Multiple-baseline (ABACAD) design	YES	YES	YES	NO	YES/ games and practices
(Cochrane et al., 2022)	Study 1 & 2: Non-concurrent multiple baselines across participants.	YES	YES	YES	YES (only for Study 2)	NO
(Quinn et al., 2020)	Multiple baseline across participants	YES	YES	YES	NO	NO
(Walker et al., 2020)	Multiple baseline across behaviors	YES	YES	NO	YES	NO
(O'Neill & Miltenberger, 2020)	Multiple baseline across behaviors	YES	YES (2)	YES	NO	NO
(Vorbeck & Bördlein, 2020)	Multiple baseline across behaviors	YES	YES (2)	YES	YES	NO
(Krukauskas et al., 2019)	Non-concurrent multiple baseline across participants	YES	YES (2)	YES	YES	YES/simulated match with coach
(Mulqueen et al., 2021)	Multiple baseline across behaviors and participants	YES	YES (2)	NO	YES	NO

**Table 3 (continued)**

<b>Citation</b>	<b>Experimental Design</b>	<b>IOA</b>	<b>Social Validity</b>	<b>Treatment Integrity</b>	<b>Follow Up/ Maintenance</b>	<b>Generalization</b>
(Moore & Quintero, 2019)	Multiple baseline alternating treatments across participants	YES	NO	NO	YES	NO
(Ennett et al., 2019)	Adapted alternating treatments design	YES	YES (2)	YES	NO	NO
(Quinn et al., 2022)	Multiple-baseline design across behaviors	YES	YES	YES	YES	NO
(Ayvazo & Naveh, 2024)	Multiple-baseline design	YES	YES	YES	NO	NO
(Capalbo et al., 2022)	Multiple-baseline design across behaviors	YES	YES	YES	YES	NO
(Harris et al., 2020)	Multiple-baseline design across participants	YES	YES	NO	YES	YES/ practice with distractors



**Figure 1**

*Frequency of Behavioral Interventions Across Articles*

