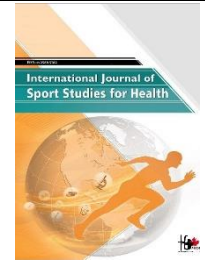


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Implicit Learning and Football Performance under Psychological Pressure: A Narrative Review



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ABSTRACT

Objective: This review aims to explore the potential of implicit learning to enhance football performance under psychological pressure. The focus is on examining how implicit learning might mitigate the negative effects of pressure and improve the consistency and effectiveness of football skills during high-stakes situations.

Materials and Methods: A systematic search strategy was employed to gather relevant research from databases such as SPORTDiscus, PsycINFO, PubMed, Google Scholar, and Web of Science. Keywords included "implicit learning," "motor skills," "football," "pressure performance," and "choking under pressure." The review considered peer-reviewed articles published in English, focusing on studies that investigated the relationship between implicit learning and football performance under pressure.

Results: Implicit learning, characterized by the unconscious acquisition of skills through repeated practice, shows promise in enhancing football performance under pressure by promoting automaticity and reducing cognitive load. Studies have demonstrated that implicit learning can lead to more automatic and smoother motor skills, potentially making them less susceptible to disruption by pressure. Evidence from research on penalty kicks and other football-related tasks supports the effectiveness of implicit learning in high-pressure situations.

Conclusion: The review highlights the potential of implicit learning to buffer the effects of psychological pressure in football, promoting resilience and adaptability in high-stakes scenarios. Further research is needed to optimize training methods for implicit learning and explore its application across different football skills and pressure conditions. Integrating implicit learning strategies into football training programs could equip athletes with the mental tools to perform at their peak under pressure.

Keywords: Implicit learning, motor skills, football, psychological pressure, choking under pressure, automaticity, skill acquisition.

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1. Introduction

In the high-stakes world of elite football, the ability to perform skilled movements consistently and effectively is paramount. However, athletes often encounter situations that induce psychological pressure, leading to a phenomenon known as "choking under pressure" (1). This phenomenon manifests as a decline in performance relative to an athlete's typical skill level, particularly in crucial moments like penalty kicks or game-winning plays. The detrimental effects of choking under pressure have been extensively documented in sports psychology research (2). Athletes facing pressure may experience heightened anxiety, leading to a breakdown in attention and focus, ultimately hindering their ability to execute well-rehearsed skills (3). Fortunately, there is growing interest in exploring methods to mitigate the negative effects of pressure on performance. One promising avenue lies in the concept of implicit learning (4). Implicit learning refers to the unconscious acquisition of skills through repeated practice, without explicit instructions or conscious awareness of the learning process (5, 6). This type of learning is thought to lead to a more automated and effortless execution of skills, potentially making them less susceptible to disruption by pressure (7). Implicit learning holds significant promise for enhancing football performance under pressure. Research suggests that implicit learning can lead to smoother, more automatic motor skills (5). This automaticity may free up cognitive resources that could become overwhelmed under pressure, allowing athletes to focus on strategic decision-making during critical moments (8). Studies investigating the impact of implicit learning on football-related tasks, such as penalty kicking, have yielded positive results (9). These findings suggest that incorporating implicit learning strategies into training regimens could equip footballers with the ability to perform at their peak even under intense pressure.

However, it is important to acknowledge that research on implicit learning in football is still developing (10). Further studies are needed to explore the optimal training methods for maximizing the benefits of implicit learning in a football context (11).

This narrative review aims to delve deeper into the potential of implicit learning to improve football performance under pressure. We will explore the theoretical advantages of implicit learning for motor skills, examine existing research on its impact in football, and discuss potential mechanisms underlying the observed effects. Finally, we will highlight the need for further research and

emphasize the potential for incorporating implicit learning strategies into football training programs.

2. Methods and Materials

2.1 Search Method and Scope

This narrative review employed a systematic search strategy to gather relevant research on the impact of implicit learning on football performance under pressure. We aimed to identify studies investigating the theoretical and practical aspects of implicit learning in this context.

2.2 Databases and Search Terms

We primarily searched through the following academic databases known for indexing high-quality, peer-reviewed research in sports science, psychology, and related fields:

- SPORTDiscus with Full Text
- PsycINFO
- PubMed
- Google Scholar
- Web of Science

These databases provided comprehensive coverage of relevant research areas like sports psychology, motor learning, and exercise science.

2.3 Search Strategy

A combination of primary and secondary keywords, along with Boolean operators, was used to ensure a focused and efficient search.

Primary Keywords

- implicit learning
- motor skills
- football (or soccer)
- pressure performance
- choking under pressure

Secondary Keywords

- automaticity
- skill acquisition
- training methods
- penalty kicks
- decision-making

We strategically combined these keywords using AND and OR operators to narrow down results and retrieve the most relevant articles. Here's an example:

- "implicit learning" AND "football" AND "pressure" - This search retrieved articles that

specifically discussed all three concepts in relation to football performance under pressure.

- "implicit learning" OR "motor learning" - This broader search included articles on both implicit and explicit motor learning in the context of football skills.

2.4 Inclusion and Exclusion Criteria

The search results were then filtered based on pre-defined inclusion and exclusion criteria to ensure the retrieved articles aligned with the review's scope.

Inclusion Criteria:

- Peer-reviewed research articles published in English.
- Articles investigating the relationship between implicit learning and football (or soccer) performance.
- Studies focusing on motor skills relevant to football, such as kicking, passing, or goalkeeping.
- Research exploring the impact of pressure on football performance in relation to implicit learning.
- Articles examining potential mechanisms through which implicit learning might influence performance under pressure.

Exclusion Criteria:

- Non-peer-reviewed articles (e.g., editorials, book reviews, commentaries).
- Articles not published in English.
- Studies investigating implicit learning in sports other than football.
- Research solely focused on the cognitive aspects of implicit learning without a clear connection to football skills.
- Articles not directly addressing the influence of pressure on performance in relation to implicit learning.

2.5 Snowballing Technique

In addition to the main search strategy, we employed a "citation snowballing" technique. This involved reviewing the reference lists of relevant articles to identify other potentially valuable publications that might not have been captured through the initial search. This helped to ensure a more comprehensive understanding of the existing research

on implicit learning and football performance under pressure.

2.6 Timeline and Scope

The search was conducted in [Month, Year] to ensure the review captured the most recent and relevant research. The scope of the review focused on research published in the last 10-15 years, considering the rapid advancements in the field of implicit learning and its applications in sports science.

By following a systematic search strategy with well-defined keywords, databases, and inclusion/exclusion criteria, this review aimed to present a comprehensive overview of the current research on how implicit learning may enhance football performance under pressure.

3. Implicit Learning Mechanisms: Potential Pathways to Peak Performance under Pressure

While the potential benefits of implicit learning for football performance under pressure are emerging (9), the underlying mechanisms that enable these benefits remain an area of ongoing research. In this context, we explore some of the theorized pathways through which implicit learning might enhance performance in high-pressure situations.

One potential pathway is the reduced cognitive load associated with implicit learning. Unlike explicit learning, which relies on conscious instruction and attention to detail, implicit learning automates motor skills, freeing up valuable cognitive resources (7). This allows athletes to focus on strategic decision-making during crucial game moments, rather than devoting mental energy to the mechanics of skill execution (8). Studies by Kal et al. (5) suggest that implicit learning may lead to greater automaticity compared to explicit learning, potentially supporting this theory.

Another proposed mechanism is the reduced interference from pressure that implicit learning may provide. Pressure can disrupt conscious control over movements, leading to performance decrements (1). Implicit learning, by bypassing conscious processing, may be less susceptible to such interference. The unconscious nature of implicit learning allows athletes to perform skilled movements even when under intense pressure, potentially mitigating the phenomenon of "choking under pressure" (4).

Additionally, the automated nature of implicitly learned skills may enhance adaptability. Football is a dynamic sport where situations can change rapidly. Implicitly learned skills may enable athletes to adapt their movements more readily to unforeseen circumstances or last-minute tactical changes,

potentially leading to improved performance under pressure (12)

Finally, the "reinvestment theory" proposes that successful implicit learning frees up cognitive resources previously devoted to skill acquisition (11). These resources can then be reinvested in other aspects of performance, such as anticipation, decision-making, and emotional regulation, which are crucial under pressure situations.

4. The Psychological Pressure Cooker: How Football Performance Gets Tested

Elite football is an intense crucible where physical prowess meets daunting mental challenges. Beyond honing technical skills and athletic conditioning, footballers must navigate the psychological pressures that permeate the game. These pressures manifest in various forms, adversely impacting performance and contributing to the dreaded phenomenon of "choking under pressure," as highlighted in recent research (1).

Several sources contribute to the psychological pressure experienced by footballers. Performance anxiety, fueled by the fear of failure and the desire to meet expectations, can disrupt focus, lead to overthinking, and hinder decision-making (3). High-stakes situations, such as penalty kicks, game-winning free kicks, or crucial matches, significantly elevate pressure levels, exacerbating anxiety and potentially leading to performance breakdowns (2). External expectations from coaches, teammates, fans, and media can weigh heavily on athletes, breeding self-doubt and a fear of letting others down (13). Moreover, the fiercely competitive nature of professional football creates a pressure-cooker environment where athletes constantly vie for playing time, face the threat of replacement, and compete against other skilled players, adding another layer of psychological stress (14).

Under the weight of psychological pressure, several mechanisms can negatively impact performance. Attentional narrowing can restrict an athlete's focus, causing them to become hyper-focused on specific aspects of a skill while neglecting crucial details or peripheral cues, leading to technical errors and an overall performance decline (3). Increased anxiety can flood athletes' minds with negative thoughts, self-doubt, and intrusive worries, interfering with their ability to concentrate on executing skills effectively (15). Additionally, the fight-or-flight response triggered by pressure can disrupt finely tuned motor skills, causing muscle tension, tremors, or difficulty coordinating precise

movements, resulting in a loss of control and decreased accuracy (2).

The combined effects of these factors often culminate in the phenomenon of "choking under pressure," where athletes underperform in crucial situations despite possessing the necessary skills (1). This phenomenon highlights the importance of developing mental resilience alongside physical skills to thrive in the high-pressure environment of football. To address psychological pressure and enhance performance, several strategies can be employed, such as mental skills training (e.g., relaxation exercises, mindfulness training, and cognitive-behavioral therapy) to equip athletes with tools to manage anxiety, improve focus, and develop mental toughness (2). Imagery training, where athletes visualize successful performance in pressure situations, can build confidence and enhance focus (16). Additionally, setting realistic and achievable goals can help manage expectations and promote a growth mindset that emphasizes learning and improvement over perfection (13).

5. Navigating the Storm: How Implicit Learning Can Buffer the Effects of Pressure in Football

The high-stakes world of football presents a unique challenge for athletes: maintaining peak performance under intense psychological pressure. While explicit learning, with its reliance on conscious instruction, can be susceptible to disruption under pressure, implicit learning emerges as a promising strategy to enhance performance in these demanding situations (1, 4).

Explicit learning involves consciously acquiring a skill through instructions and focused practice. While effective for initial skill development, its dependence on conscious focus creates a vulnerability under pressure (6). When faced with heightened anxiety or performance expectations, athletes may struggle to maintain focus on the intricate details of a skill (3). This can lead to technical errors, a breakdown in execution, and ultimately, the dreaded "choking under pressure" phenomenon (2).

In contrast, implicit learning offers a potential pathway to mitigate the negative effects of pressure on performance. This form of learning occurs unconsciously, through repeated exposure and practice, without explicit instructions or awareness of the learning process itself (4, 5). The resulting skills become automated, requiring minimal conscious attention to execute effectively (7). Implicit learning can be a game-changer under pressure by reducing cognitive load, offering resilience to pressure interference, and enhancing adaptability.

Implicitly learned skills free up valuable cognitive resources that would otherwise be consumed by consciously attending to every detail of a movement (8). Under pressure, when cognitive resources become strained by anxiety, this allows athletes to maintain focus on crucial aspects of the game, like tactical decision-making or anticipating opponent movements, instead of getting bogged down in the mechanics of skill execution (6). Moreover, implicit learning bypasses the need for conscious control, offering a more resilient pathway for skill execution even when anxiety levels rise (12).

Additionally, the automated nature of implicitly learned skills allows for quicker adjustments during gameplay, a crucial advantage in the dynamic environment of football (14). Implicit learning fosters a more intuitive understanding of movement patterns, enabling athletes to adapt their motor skills more readily to unforeseen circumstances or last-minute tactical changes, potentially improving performance under pressure (11). However, it's important to note that implicit learning doesn't happen by accident. Specific training designs are needed to promote this type of unconscious skill acquisition, such as incorporating variable practice routines and avoiding explicit instructions (9).

6. Unveiling the Power of Implicit Learning: A Look at the Evidence in Football

The potential of implicit learning to enhance football performance under pressure has captured the imagination of researchers and coaches alike. While the theoretical benefits hold promise, a closer look at existing research offers valuable insights through empirical results and experimental evidence.

One of the most compelling findings comes from Navarro et al. (9). Their study investigated the impact of implicit learning on penalty kicks, a pressure-laden situation in football. The researchers compared two training groups: one receiving explicit instructions on kicking technique and the other practicing with a variable routine that emphasized implicit learning principles. The results revealed a significant advantage for the implicit learning group. They displayed greater shot accuracy compared to the explicit instruction group, suggesting that implicit learning may enhance performance under pressure in football.

While the study by Navarro et al. (9) focused on penalty kicks, the potential benefits of implicit learning might extend to other football skills. Farkasová (17) investigated the effects of implicit and explicit learning interventions on football goalkeepers. While the study did not directly

examine performance under pressure, it suggests that implicit learning might be equally effective in acquiring various football skills. Further research exploring the broader application of implicit learning across different football skills and pressure scenarios is needed to confirm this possibility.

Observational data from studies like Verburgh et al. (18) offer additional clues regarding the potential benefits of implicit learning. This study compared implicit and explicit learning approaches in youth elite and non-elite football players. Interestingly, the researchers observed a higher level of implicit learning in the elite players. This suggests that elite players may rely more heavily on implicit learning, potentially contributing to their superior performance under pressure.

While these initial findings are encouraging, it's important to acknowledge the limitations of existing research. Cabral et al. (10) conducted a systematic review highlighting the need for more rigorous studies to explore the effectiveness of implicit learning in mitigating the negative effects of pressure on football performance. Future research with larger sample sizes, more controlled experimental designs, and a focus on various pressure conditions is crucial to solidify the evidence base.

7. Bridging the Mental Gap: Cognitive Theories of Implicit Learning and Pressure Performance

The ability to perform at one's best under pressure is a hallmark of elite athletes. In football, where split-second decisions and precise movements can determine the outcome of a game, understanding how the mind processes and executes skills under pressure is crucial. Here, we explore the intersection of cognitive theories of implicit learning and psychological theories of stress and performance, shedding light on how implicit learning might enhance football performance under pressure.

Implicit learning refers to the unconscious acquisition of knowledge and skills through repeated exposure and practice, without explicit instructions or awareness of the learning process itself (5). Several cognitive theories attempt to explain how implicit learning occurs, including the Statistical Learning Theory (19), which proposes that the brain extracts statistical patterns and regularities from the environment through repeated experiences. The Associative Learning Theory (20) emphasizes the formation of associations between stimuli and responses through repeated pairings. Additionally, the Skill Automaticity Theory (21) suggests that with repeated practice, skills become more

automated, requiring less conscious attention to execute effectively.

Psychological theories of stress and performance provide valuable insights into the negative effects of pressure on athletic performance. Under pressure, athletes experience physiological and psychological changes as the body prepares for a fight-or-flight response (2). The Attentional Narrowing Theory (22) suggests that under pressure, attention becomes focused on specific aspects of a task, neglecting crucial peripheral cues, which can lead to technical errors and a decline in overall performance. The Cognitive Interference Theory (15) proposes that increased anxiety under pressure can flood athletes' minds with negative thoughts, self-doubt, and intrusive worries, interfering with their ability to focus on executing skills effectively. These factors can culminate in the "choking under pressure" phenomenon (1), where athletes underperform despite possessing the necessary skills, highlighting the importance of mental skills training alongside physical skills.

By understanding how implicit learning and stress impact performance, we can see how implicit learning might offer a potential buffer against the negative effects of pressure. Implicitly learned skills are automated, requiring minimal conscious attention to execute (7). This frees up valuable cognitive resources that would otherwise be consumed by consciously attending to every detail of a movement under pressure (6). Athletes can then focus on strategic decision-making, situational awareness, and emotional regulation, crucial aspects of performing at their best in high-stakes football situations.

Moreover, explicit learning relies on conscious control, which can be disrupted by the physiological and psychological effects of pressure (1). Implicit learning, on the other hand, offers a more resilient pathway for skill execution. Even when anxiety levels rise, athletes can continue to perform well-rehearsed, implicitly learned skills without experiencing the same degree of performance decrements seen with explicit learning (12).

In conclusion, cognitive theories of implicit learning and psychological theories of stress and performance offer complementary perspectives on the mental processes at play in football under pressure. While pressure can disrupt performance, implicit learning, through its ability to automate skills and reduce cognitive load, presents a promising strategy for enhancing performance in this demanding sport. Further research exploring the optimal training methods for maximizing the benefits of implicit

learning in football can pave the way for coaches to equip their players with the mental tools they need to thrive under pressure.

8. The Intricate Dance of Mind and Muscle: Skill Acquisition Theories and Neuropsychological Perspectives in Sports

The mastery of athletic skills in sports is a fascinating interplay between physical practice, cognitive processes, and the underlying workings of the nervous system. Skill acquisition theories shed light on the learning process, while neuropsychological perspectives offer a glimpse into the brain's role in skill development.

Numerous theories attempt to explain how athletes acquire and refine complex motor skills. Theories of Stages of Learning, like Fitts & Posner's (23) three-stage model, propose a progression from an initial cognitive exploration stage to a more automated and refined autonomous stage. Feedback Theories emphasize the importance of internal (sensory) and external (coaching instructions) feedback for skill improvement. Attentional Focus Theories explore the role of attention, suggesting that deliberate practice with a focused attentional approach can lead to faster learning (24).

Neuropsychological perspectives offer insights into the brain's mechanisms involved in skill development. The motor cortex plays a central role in planning, executing, and controlling movements, with strengthened connections and pathways enhancing skill proficiency through practice (25). The basal ganglia are involved in motor learning and skill automaticity, refining movement patterns with repetition (26). The cerebellum is crucial for coordinating complex movements and adjusting them based on sensory feedback, leading to smoother and more precise movements as skills are refined (27).

The synergy between skill acquisition theories and neuropsychological perspectives provides valuable insights for coaches and athletes in optimizing training programs. Understanding the stages of learning allows for stage-specific training, with clear instructions and skill breakdown for beginners, and opportunities for deliberate practice and feedback as athlete's progress. Knowing the importance of attentional focus enables coaches to incorporate strategies like visualization or verbal cues to help athletes direct their attention during practice. Designing training drills with progressive complexity and variable practice routines can promote the development of automaticity in well-learned skills, freeing up mental resources for decision-making during competition.

While these theories and perspectives offer valuable insights, further research is needed to bridge the gap between them. Integrating brain imaging techniques with behavioral studies can provide a more complete picture of how the brain changes during skill acquisition. Additionally, exploring the impact of factors like genetics, sleep, and nutrition on brain function and learning can add valuable layers to our understanding of how athletes master complex skills. Continued research and integration of different perspectives can empower coaches to develop training programs that optimize skill development and propel athletes towards peak performance.

Research on implicit learning in football has opened up exciting avenues for optimizing training methods and enhancing skill acquisition. One area of focus should be identifying and refining training protocols that maximize the benefits of implicit learning. This could involve exploring variable practice routines, minimizing explicit instructions, and incorporating elements of play-based learning to encourage unconscious skill acquisition. By investigating different training approaches, researchers can develop more effective methods for athletes to acquire skills implicitly, without relying heavily on conscious, step-by-step instructions.

9. Future Research Directions

The potential benefits of implicit learning might extend beyond penalty kicks to other crucial football skills like dribbling, passing, and goalkeeping. Future research should explore the effectiveness of implicit learning in these areas and examine how it interacts with different levels of expertise among athletes. By studying the application of implicit learning across various football skills and skill levels, researchers can gain a more comprehensive understanding of its potential impact on overall performance.

While existing research suggests implicit learning might be more resilient under pressure, a deeper understanding is needed. Studies manipulating pressure through audience presence, time constraints, and opponent difficulty can provide valuable insights into the effectiveness of implicit learning under various high-stakes scenarios. By systematically manipulating pressure factors, researchers can better understand how implicit learning holds up in demanding situations and identify strategies to enhance its effectiveness under pressure.

Integrating brain imaging techniques with behavioral studies can offer a deeper understanding of the neural mechanisms underlying implicit learning in football. Examining changes in brain activity during implicit learning tasks can provide valuable insights into how the brain adapts to acquire complex skills under pressure. By combining neuroimaging data with behavioral measures, researchers can gain a more comprehensive understanding of the cognitive and neural processes involved in implicit learning.

It is important to recognize that athletes may have varying capacities for implicit learning. Future research should explore individual differences in learning styles and how these might influence the effectiveness of implicit learning-based training programs. By accounting for individual differences, researchers can develop personalized training approaches that cater to each athlete's unique learning preferences and maximize the benefits of implicit learning.

Furthermore, more research is needed to understand how well implicit learning translates to long-term retention of skills and performance under pressure over extended periods. By conducting longitudinal studies that track skill retention and performance over time, researchers can evaluate the lasting effects of implicit learning and identify strategies to enhance long-term skill maintenance and transfer to competitive situations.

10. Conclusion

The potential of implicit learning to empower footballers to perform at their peak under pressure is a compelling prospect. By reducing cognitive load, enhancing resilience to pressure interference, and promoting automaticity, implicit learning offers a powerful tool for athletes and coaches. As future research refines training methods and explores the full potential of implicit learning across different football skills and pressure situations, we can move closer to unlocking the secrets of peak performance under pressure in this demanding sport. Ultimately, a deeper understanding of this learning mechanism can equip coaches with innovative training strategies and empower footballers to overcome the mental hurdles that often stand between them and achieving their full potential on the pitch.

Authors' Contributions

A.P. conceptualized the review topic and conducted the systematic search across various scholarly databases. E.M.-P. supervised the review process, provided critical insights into interpreting the findings, and led the drafting and

revising of the manuscript. O.K. and H.N. assisted with data extraction, contributed to the literature review, and supported the synthesis of findings. All authors critically reviewed and approved the final version of the manuscript for publication.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

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Ethics Considerations

Not applicable.

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