Psychological Characteristics and Cognitive Intervention of Flow State in Sports

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Abstract

This article explored how athletes' performance is influenced by their flow state, suggesting cognitive interventions to enhance their experiences and improve performance. The experiment recruited 120 athletes, covering various sports such as basketball, soccer, volleyball, table tennis, sprinting, long jump, high jump, swimming, and weightlifting, yielding 100 valid questionnaires were obtained. Athletes' flow states, measured by the Flow State Scale (FSS), showed connections with psychological traits. Tailored cognitive interventions improved athletes' flow states, leading to significant enhancements in FSS scores and overall sports performance. The research findings indicate that using cognitive intervention methods to enhance athletes' flow states not only improves their skill performance but also provides valuable insights for enhancing sports training methods and psychological intervention policies, thereby promoting athletes to better unleash their potential and elevate the overall level of competition.

Keywords: Flow State, Cognitive Intervention, Pearson Correlation Coefficient, Psychological Characteristics, Physical Sports.

Introduction

Flow state is crucial for peak sports performance and can be enhanced through cognitive interventions. Scholars like Xia (2018) and Liew et al. (2019) emphasized its significance. Flow state, or "being in the zone," involves deep engagement and effortless focus, linked with optimal performance and motivation. Cognitive intervention aims to improve motor ability, focus, confidence, and goal setting, guided by frameworks such as flow theory and self-efficacy theory in sports intervention. Flow states in sports are characterized by heightened attention and altered time perception, benefiting from cognitive interventions. Price and Duman (2020) proposed a model addressing cognitive deficits, and David et al. (2018) demonstrated the efficacy of rational emotive behavior therapy (REBT). Swann et al. (2018) emphasized a critical approach to flow state research, and Gavrilova and Donohue (2018) stressed the importance of mental health interventions for athletes. Carrança et al. (2019) found that cognitive intervention positively influenced athletes' psychological traits, flow state, and performance in football. In response to the problem that some athletes in sports do not have a clear flow state, which leads to unsatisfactory performance, this article conducted cognitive intervention on various psychological characteristics that appear in the flow state and improved the flow state and performance in sports by intervening in psychological characteristics. The FSS scale was used to determine whether it was in a flow state. The questions of each scale were classified based on psychological characteristics, and the correlation between different psychological characteristics and flow states was measured. Psychological characteristics with high correlation were emphasized for intervention, and finally, the feasibility of cognitive intervention in improving flow state in sports was judged by comparing sports performance before and after intervention. The research results provide athletes with better psychological support and intervention methods, promoting their smoother performance and more efficient experience in sports, which is of great significance for the development and practical application of sports psychology.

The Significance of This Study Is Shown as Follows

Analyzing the psychological characteristics of athletes' flow states during sports and using cognitive intervention methods to improve these characteristics, thereby helping athletes enter flow states more frequently.

· Through empirical research, exploring in depth the relationship between flow states and athletes' psychological characteristics, providing strong empirical support for the application of flow state theory in the field of sports.

· The cognitive intervention methods employed, including concentration, self-involvement, and goal clarity, offer new insights and tools for athletes' psychological training.

The overall structure of the article is as follows:

Part 2 reviews the development and current status of flow state theory, summarizing the research findings and

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shortcomings regarding flow state psychological characteristics and cognitive intervention methods. Part 3 provides a detailed introduction to the experimental design, participants, measurement tools (FSS Flow State Scale), and data analysis methods (Pearson correlation coefficient). Part 4 presents data collection and preliminary analysis. Part 5 analyzes the relationship between flow states and athletes' psychological characteristics based on experimental data and discusses the impact of different cognitive intervention methods on flow states. Part 6 provides an in-depth discussion of the experimental results. Part 7 summarizes the main findings and contributions of the study, identifies limitations, and suggests future research directions.

Literature Review

In sports, athletes' performance hinges not only on physical prowess and technical proficiency but also on psychological factors, particularly the state of flow (Love, Kannis-Dymand, & Lovell, 2021; Mouelhi-Guizani et al., 2023). Flow represents an optimal psychological state where athletes are fully immersed in their activity, leading to heightened performance and satisfaction (Kunz & Santomier, 2020; Nagy et al., 2021). Yet, accessing and maintaining flow poses challenges (Noetel et al., 2019). Hence, strategies to facilitate more frequent entry into flow and its sustained presence during sports are of significant interest.

Past research has extensively explored the concept of flow state. Glass et al. (2019) conducted a randomized controlled trial of a mental training program with collegiate athletes, demonstrating the effectiveness of mindful sports performance enhancement (Glass et al., 2019). Cohen and Bodner (2019) investigated the relationship between flow and music performance anxiety among professional classical orchestral musicians, shedding light on the intersection of flow state and psychological factors in performance contexts (Cohen & Bodner, 2019). Buil, Catalán and Martínez (2019) conducted an empirical study on the influence of flow on learning outcomes, providing insights into the educational implications of flow theory (Buil et al., 2019). Liew et al. (2019) conducted a systematic review of mental toughness in sports, offering valuable perspectives on psychological factors related to athletic performance (Liew et al., 2019). Additionally, Koehn and Díaz-Ocejo (2022) conducted a single-case study with middle-distance runners in Qatar, exploring the efficacy of imagery intervention to increase flow state (Koehn & Díaz-Ocejo, 2022). However, existing studies mostly focus on describing and theorizing about flow state (Narayanan, 2020; Wang & Demerin, 2023). There are still many shortcomings regarding how to intervene effectively to enhance athletes' flow state and how to integrate these intervention methods with specific sports.

To address the existing issues, some researchers have begun to explore the use of cognitive intervention methods. Some have employed cognitive intervention techniques such as focused attention (Harris et al., 2023; Marty-Dugas & Smilek, 2019), self-immersion (Chen & Liu, 2023; Jackman et al., 2019), and clear goal setting (Meggs, Chen, & Koehn, 2019) in their studies, aiming to help athletes enhance their flow state. Zhu et al. (2022) conducted a study on the acute effects of mindfulness-based intervention on athlete cognitive function, utilizing fNIRS investigation (Zhu et al., 2022). Carrança et al. (2019) conducted a pilot study of a mindfulness-based program (MBSoccerP), investigating the potential role of mindfulness, self-compassion, and psychological flexibility on flow and elite performance in soccer athletes (Carrança et al., 2019). Additionally, Hut et al. (2023) conducted a randomized controlled study of mindful sport performance enhancement and psychological skills training with collegiate track and field athletes (Hut et al., 2023). Corbally, Wilkinson and Fothergill (2020) conducted a systematic review on the effects of mindfulness practice on performance and factors related to performance in long-distance running (Corbally et al., 2020). Furthermore, Drigas, Mitsea and Skianis (2021) explored the role of clinical hypnosis and VR in special education (Drigas et al., 2021). Research has shown that through these intervention methods, athletes can more easily enter a state of flow and demonstrate superior performance during competitions (Ajilchi et al., 2019; Rutrecht et al., 2021). While existing methods have achieved some degree of success, challenges persist in practice (Huang, Wei, & Leung, 2020; Hussey, Weinberg, & Assar, 2020). These include insufficient personalization of intervention methods and a lack of systematic research evidence support.

The paper delves into the correlation between athletes' flow state and their psychological characteristics during sports activities and proposes innovative strategies to optimize athletes' psychological characteristics in a flow state through cognitive intervention methods. The research finds that athletes' skill performance in flow state is closely associated with their psychological states. Implementing cognitive intervention techniques including attentional focus, self-involvement, and goal clarity, ~~it~~ can effectively assist athletes in more frequently achieving a flow state, enhancing their mental qualities and sports performance.

This method elucidates the specific relationship between different psychological characteristics in a flow state. Through experimental verification, it has been found that the scores of the flow state scale for athletes have significantly improved, and the overall sports performance index has increased from 0.508 to 0.637. This provides a new and effective way for athletes to improve their psychological training and performance.

Cognitive Intervention and Experimental Design

Cognitive Restructuring and Flow Experience Cultivation

Cognitive restructuring is a cognitive intervention method that promotes positive psychological experiences and states by changing an individual's way of thinking and belief system (Yang, 2022). In sports, cognitive restructuring is widely applied to cultivate athletes' flow experiences, aiming to enhance their sports performance and psychological state (Stone et al., 2018). The key lies in adjusting the athlete's perception of challenges and abilities and establishing positive thinking patterns. There are three commonly used cognitive restructuring techniques and strategies: self-dialogue, the establishment of positive thinking patterns, and development of focus.

By adjusting their perception of challenges and abilities, establishing positive thinking patterns, and cultivating focus, athletes can more easily enter a flow state, improving their sports skills and performance. However, what is worth noting is that cognitive remodeling is an individualized process and each athlete's needs and circumstances may be different. Therefore, individualized cognitive intervention programs and instruction are important to develop cognitive remodeling strategies tailored to each athlete's characteristics and needs.

Experimental Design

Participants: 120 athletes across various sports were recruited, yielding 100 valid responses.

Experimental Design: The study had two phases. Firstly, cognitive intervention targeted specific psychological traits, such as self-involvement, concentration, challenge alignment, time perception, goal clarity, and fulfillment sense (Shadiev & Huang, 2020). Then, the Flow State Scale (FSS) (Garcia et al., 2022) measured athletes' flow states before and after interventions.

Cognitive Intervention Methods: Utilizing cognitive restructuring (Duan & Bu, 2019), including self-dialogue and positive thinking, interventions focused on enhancing self-involvement, concentration, challenge alignment, time perception, goal clarity, and fulfillment sense.

The study not only focuses on the psychological characteristics of athletes' flow states and cognitive intervention methods during competition but also strictly adheres to ethical principles to ensure the scientific integrity of the research and the protection of participants' rights: Before recruiting athletes for this study, we ~~clearly~~ informed them of the purpose, methods, potential risks, and expected benefits of the research. Each participant signed an informed consent form, explicitly stating their voluntary participation in the study and agreeing to the assessment and intervention of their psychological characteristics during sports. We strictly adhere to principles of privacy protection, ensuring the confidentiality of all participants' personal information and assessment data. During the research process, we collected data anonymously to prevent the disclosure of participants' identities. Furthermore, all research data are used solely for this study and may not be used for any other purpose without the participants' consent.

The FSS was used to measure athletes' flow states, with 36 questions categorized into five aspects as shown in Figure 1:

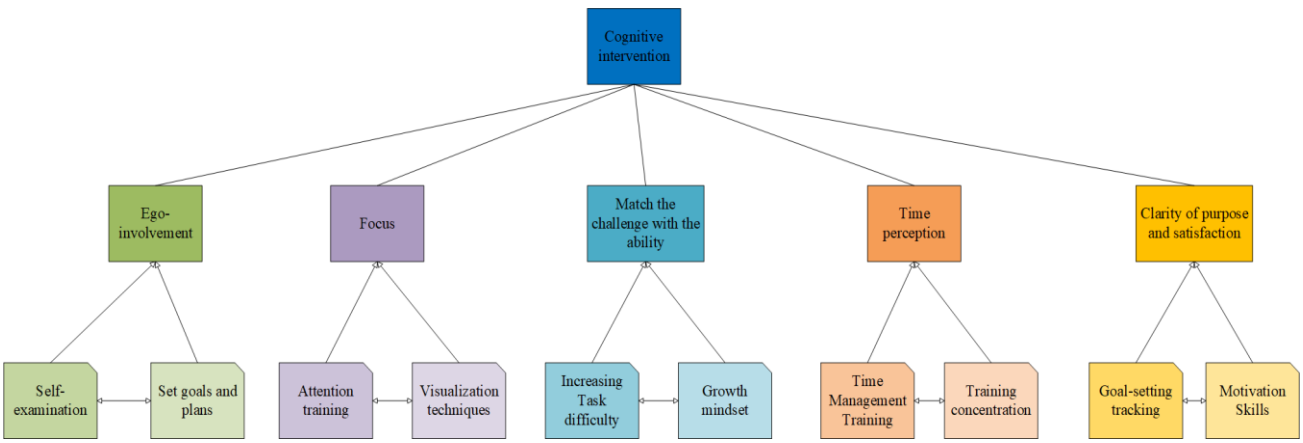

Figure 1: Cognitive Intervention Plan.

Self-involvement: Includes reflection exercises and setting goal-oriented action plans.
Level of Concentration involves attention control training and visualization techniques.
Challenge and Ability Matching comprises gradually increasing difficulty and emphasizing growth mindset.
Perception of Time covers time management skills training and focus training.
Clarity of Goals and Sense of Fulfillment includes goal setting and tracking, as well as motivation techniques.
Pearson correlation coefficients were used to analyze the correlation between the total scores of basketballs and high jump athletes and the scores of various psychological characteristics to evaluate the effectiveness of cognitive intervention.
In the empirical research and effectiveness evaluation stage, the effectiveness of the cognitive intervention was assessed by comparing the flow state scale scores before and after the intervention. Pearson correlation analysis was employed to further understand the specific effects and mechanisms of cognitive intervention by examining the correlation between various psychological characteristics and athletes' flow states.

Data Collection and Analysis

This experiment effectively measured athletes' flow states using the FSS scale, encompassing both competition and training scenarios. A total of 120 athletes participated, yielding 100 valid questionnaires covering nine different sports: basketball, soccer, volleyball, table tennis, sprinting, long jump, high jump, swimming, and weightlifting. The measurement results were recorded under category numbers from 1 to 9.

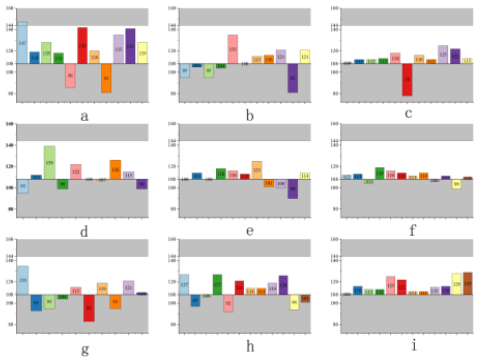

Figure 2: Scores of Various Sports Scales.

(Figure 2 (a): Score situation of basketball scale; Figure 2 (b): Score situation of football scale; Figure 2 (c): Score situation of volleyball scale; Figure 2 (d): Score situation of table tennis scale; Figure 2 (e): Score situation of sprinting scale; Figure 2 (f): Score situation of long jump scale; Figure 2 (g): Score situation of high jump scale; Figure 2 (h): Score situation of swimming scale; Figure 2 (i): Score situation of weightlifting scale)
Figure 2 illustrates the measurement results for different sports. The scale adopts a five-point system with a maximum score of 180, thus dividing scores into five levels: 36, 72, 108, 144, and 180. Observations indicate that basketball players generally scored between 115 and 135, with the highest score reaching 147, suggesting a tendency toward a flow state. Soccer player scores ranged from 95 to 121, while volleyball players showed a more concentrated distribution, with most scores near 108. Table tennis players exhibited a relatively even distribution of scores. Sprinters demonstrated a uniform distribution of scores, indicating a moderate flow state. However, high jump athletes showed relatively poor flow states despite some high scores, which were less frequent. Swimming athletes showed a fairly even distribution of scores, whereas weightlifting athletes lacked individuals with high flow states.
The total scores of the scales for athletes in these 9 sports were plotted in a box plot, as shown in Figure 3. As can be seen from the results of the scale measurement, basketball is the sport that has a higher frequency of fluency, and compared to other sports, its flow state is more significant. However, there are also two relatively low situations inside, with an extreme distribution. The sport with a more concentrated distribution of scales is the long jump, with data ranging from 99 to 119, and the overall flow of the team is relatively average.

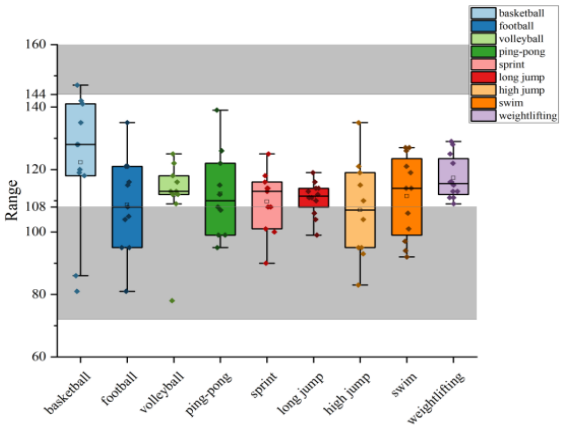

Figure 3: Box Plots of 9 Movements.

This experiment focused on analyzing basketball and high jump. Basketball players had an overall average FSS score of 122, indicating a relatively high level among the nine sports, while high jump athletes had an average score of approximately 107. Four basketball and high jump athletes were selected for the study, and their performance data during matches were collected, including shooting accuracy, fouls, turnovers, successful passes, assists, rebounds for basketball, and jump height, start speed,

landing control, technique score, physical stability, and pace for high jump. These data were plotted on radar charts, as shown in Figure 4. In basketball, Sacker and Anna's performances were significantly better than Spike and Rebecca's. In the high jump, Ava's performance far exceeded the other three, with a comprehensive average score of 0.88, compared to the lowest comprehensive average score of 0.45 among the other three.

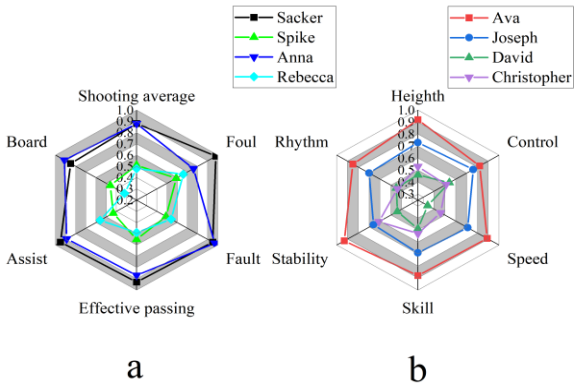

Figure 4: Radar Plots of Two Types of Sports Performance Abilities.

(Figure 4 (a): Radar chart of basketball performance ability; Figure 4 (b): Radar chart of high jump performance ability) Based on the FSS scale measurement results and performance data in Tables 1 and 2, a comprehensive analysis revealed a clear relationship between flow state and athletic performance. In basketball, individuals with scores below 108 exhibited poorer flow states, suggesting a need for cognitive intervention to improve their athletic performance.

Table 1

Basketball Performance Ability Data

	Sacker	Spike	Anna	Rebecca
Shooting average	0.88	0.51	0.88	0.48
Foul	0.98	0.59	0.76	0.66
Fault	0.95	0.49	0.97	0.54
Effective passing	0.93	0.55	0.87	0.49
Assist	0.95	0.43	0.89	0.56
Board	0.85	0.46	0.91	0.32

Table 2

High Jump Performance Index

	Ava	Joseph	David	Christopher
Heighth	0.92	0.73	0.46	0.53
Control	0.82	0.76	0.54	0.51
Speed	0.89	0.71	0.34	0.46
Skill	0.88	0.69	0.49	0.53
Stability	0.93	0.66	0.44	0.61
Rhythm	0.85	0.7	0.45	0.44

Empirical Research and Assessment

Psychological Feature Classification and Correlation Analysis

After collecting the questionnaire data, we categorized the 36 questions in the FSS into five psychological aspects: self-involvement, degree of concentration, challenge and ability matching, time perception, and clarity of goals and satisfaction. Statistical analysis was conducted based on the scores of each psychological aspect category, and the situation at the moderate level was depicted. Analysis of the psychological characteristics of basketball test subjects is presented in Figure 5.

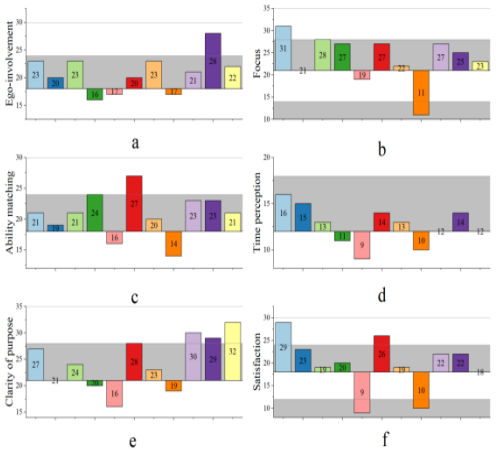

Figure 5: Score of Each Characteristic.

(Figure 5 (a): Ego-involvement scores; Figure 5 (b): Focus level scores; Figure 5 (c): Ability matching scores; Figure 5 (d): Time perception scores; Figure 5 (e): Purpose clarity scores; Figure 5 (f): Satisfaction scores)

Pearson correlation analysis was employed to analyze the correlation between the scores of various features. The distribution of total scores of basketballs and high jump test subjects was separately analyzed against the scores of corresponding psychological features, yielding Tables 3 and 4.

Table 3

Table of Correlation Coefficients Between the Total Score and Various Characteristics of the Basketball Scale

Psychological characteristic	Correlation	P-value
Ego-involvement	0.6792	0.0215
Focus	0.8699	0.0004
Ability matching	0.8293	0.0016
Time perception	0.8037	0.0029
Clarity of purpose	0.8110	0.0025
Satisfaction	0.9219	0.0000

Table 4

Table of Correlation Coefficients Between Total Scores and Various Characteristics of the High Jump Scale

Psychological characteristic	Correlation	P-value
Ego-involvement	0.5901	0.0725
Focus	0.7767	0.0082
Ability matching	0.5454	0.1029
Time perception	0.8153	0.0040
Clarity of purpose	0.5479	0.0014
Satisfaction	0.6878	0.0279

Table 3 indicates a high correlation between athletes' flow state and satisfaction, reaching 0.9219, indicating a strong correlation. The correlations of other psychological features ranked from high to low are concentration, skill matching, goal clarity, and time perception, with coefficients of 0.8699, 0.8293, 0.8110, 0.8037, and 0.6792, respectively. In basketball, satisfaction is closely related to the flow state, followed by skill matching, goal clarity, concentration, and time perception, while self-involvement shows a lower correlation.

Table 4 reveals that in the high jump, the flow state is associated with concentration and time perception. Differences in the flow state and related psychological features between basketball and high jump are influenced by various factors, including sports characteristics, individual skill levels, sports environment and atmosphere, personal interests, and preferences, as well as psychological readiness and expectations. Different sports may lead to variations in individual psychological experiences.

Furthermore, a strong correlation is observed between the flow state and time perception among high jumpers, reaching 0.8153. The correlations of other psychological features, from high to low, are concentration, satisfaction, self-involvement, goal clarity, and skill matching, with coefficients of 0.7767, 0.6878, 0.5901, 0.5479, and 0.5454, respectively. These findings indicate that in the high jump, satisfaction is closely related to the flow state, followed by concentration, satisfaction, self-involvement, and goal clarity, while skill matching shows a lower correlation.

Comparative Analysis before and after Cognitive Intervention

Regarding the issue of insufficient self-engagement, the experiment adopted the method of keeping a diary or recording training experiences and goals. After each training session, athletes spent 10-15 minutes engaging in self-reflection. To improve concentration, athletes underwent 5-10 minutes of breathing control training daily to focus their attention on breathing and ignore distractions. To address the challenge of matching abilities with tasks, the training difficulty was gradually increased to help athletes cope with challenges. In terms of time perception, athletes developed weekly time management plans to schedule training, rest, study, and leisure time effectively. Regarding setting clear goals, athletes were assisted in establishing specific, measurable short-term objectives.

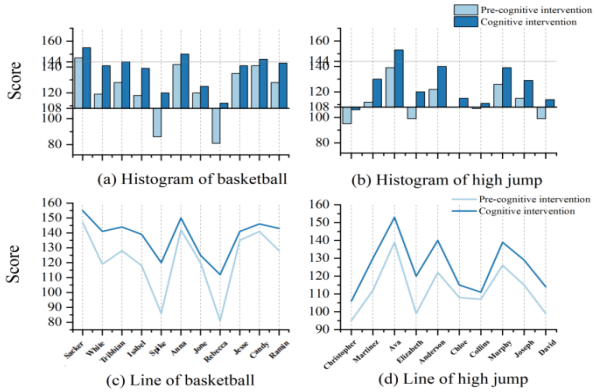

Figure 6: Comparison of Images of Athletes After Intervention.

(Figure 6 (a): Comparison bar chart of basketball; Figure 6 (b): Comparison bar chart of high jump; Figure 6 (c): Comparison line chart of basketball; Figure 6 (d): Comparison line chart of high jump)

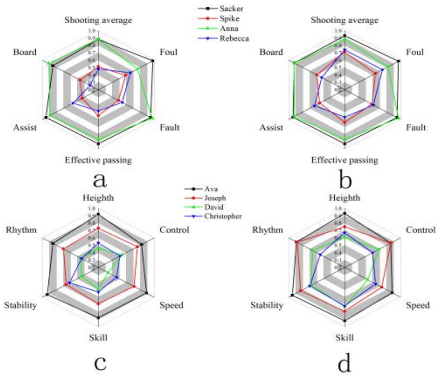

Figure 7: Comparison of Radar Images Before and After Intervention.

(Figure 7 (a): Radar before basketball intervention; Figure 7 (b): Radar after basketball intervention; Figure 7 (c): Radar after high jump intervention; Figure 7 (d): Radar after high jump intervention)

Table 5

Comprehensive Indexes of Sports Before and After Intervention

Basketball			High jump		
Name	Before	After	Name	Before	After
Sacker	0.923	0.940	Ava	0.882	0.905
Spike	0.505	0.623	Joseph	0.882	0.905
Anna	0.880	0.897	David	0.453	0.650
Rebecca	0.508	0.637	Christopher	0.513	0.647

As shown in Figure 6, the experiment conducted a re-evaluation of athletes' flow states before and after intervention and compared them with the pre-intervention scores. In basketball tests, scores for various psychological characteristics generally increased, especially for athletes whose total scores were below 108 previously, showing significant improvement. In basketball tests, Spike's rebounding ability and assist index increased from around 0.5 and 0.3 to around 0.6 each. In the high jump tests, after cognitive intervention, athletes' flow states improved, although the psychological impact on high jump performance was relatively minor, overall performance improved.

As shown in Figure 7, statistical analysis of the performance of basketball and high jump athletes revealed a significant improvement in athletic abilities overall. In basketball, Spike's rebounding ability and assist index increased from around 0.5 and 0.3 to around 0.6 each. In high jump, David's overall rhythm score increased from 0.45 to 0.6, and Christopher's technique score increased from 0.53 to 0.72.

As shown in Table 5, a comparison was made of the comprehensive performance index of basketball and high jump athletes before and after the intervention. In basketball, athletes who were already in a state of flow (Sacker, Anna, Ava, and Joseph) showed a relatively small change in their athletic indices after cognitive intervention. For instance, Sacker's athletic index increased from 0.923 to 0.940, with a change of only 0.017. In contrast, athletes who were not in a state of flow previously (Spike, Rebecca, David, and Christopher) showed significant changes. For example, Spike's athletic index increased from 0.505 to 0.623, with a change of 0.118. This indicates that cognitive intervention had a minor effect on improving athletic performance for athletes already in a state of flow, while its effect was more significant for athletes not in a state of flow, this is consistent with the findings of Reinebo et al. (2024).

Discussion

In this study, Pearson correlation analysis was employed to explore the relationships between different psychological features. According to the analysis results, in basketball tests, the correlation between flow state and satisfaction reached 0.9219, indicating a strong correlation between the two. Additionally, psychological features such as concentration, skill matching, goal clarity, and time perception exhibited varying degrees of correlation. The correlation coefficients for concentration and satisfaction were 0.8699, and for skill matching and goal clarity were 0.8293 and 0.8110, respectively. The data indicates that there are complex and close relationships among the psychological features of athletes in basketball.

In high jump tests, different correlation patterns were observed. The correlation between flow state and time perception reached 0.8153, indicating a high correlation. However, the correlations of other psychological features were slightly different, for example, the correlations of concentration and satisfaction were 0.7767 and 0.6878, respectively. These results suggest that the correlation patterns of psychological features in the high jump may differ from those in basketball, which is influenced by the characteristics of the sports themselves (Meggs & Chen, 2021).

In the comparative analysis of athletes before and after intervention, some interesting phenomena were observed. For athletes already in a state of flow, the improvement in athletic performance after cognitive intervention was relatively small. For example, in basketball, athlete Sacker's comprehensive athletic index increased from 0.923 to 0.940, with a change of only 0.017. In contrast, athletes not previously in a state of flow showed more significant improvements in athletic performance after cognitive intervention. For instance, Spike's athletic index increased from 0.505 to 0.623, with a change of 0.118. This indicates that the impact of cognitive intervention on athletes in different psychological states varies, providing important insights for future intervention research.

In conclusion, the importance and interrelationships of different psychological features vary across different sports. Cognitive intervention plays a significant role in improving athletes' psychological characteristics and performance. This finding provides theoretical support for personalized sports psychology interventions, which can help optimize athletes' training and performance.

Conclusions

This study delved into the flow state and psychological characteristics of athletes in sports, enhancing their flow experience through cognitive intervention. By conducting an in-depth analysis of athletes with varying sports performances, significant positive correlations were found between the flow state and various psychological characteristics through Pearson correlation coefficient analysis. To improve athlete fluency, diverse intervention methods were implemented tailored to the psychological characteristics of different sports. The results demonstrated that cognitive intervention significantly enhanced athletes' flow and psychological characteristics. Notably, both individuals already in a flow state and those not in that state previously exhibited substantial improvements during sports, with the FSS index rising from lows of 81 and 86 to 120 and 112, respectively. Regarding sports performance and ability, the rebounding index increased from less than 0.5 to 0.6, and

the assist index rose from around 0.3 to approximately 0.6. These improvements across various indices underscore the efficacy of the intervention. Practical and policy recommendations involve integrating cognitive interventions into athlete development programs and fostering collaboration between sports psychologists, coaches, and athletes to optimize psychological support systems. Further study could explore the long-term effects of cognitive interventions on athlete performance sustainability and investigate the interaction between cognitive interventions and athlete personality traits to enhance understanding of their effectiveness in diverse sports contexts.

Statements & Declarations

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Competing Interests

The authors have no conflict of interest.

Author Contributions

Conceptualization, L.D.; methodology, S.Z.; software, C.W.; formal analysis, S.Z.; writing—review and editing,L.D.; project administration, C.W..All authors contributed to the study conception and design. All authors read and approved the final manuscript.

Informed consent

We declare that all the authors have informed consent.

Data Availability

Data is available in the manuscript.

Ethical approval

The paper does not deal with any ethical problems.

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