

# Practical Guidelines for Sports Scene Parenting to Promote Adolescent Mental Health

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**Abstract:** *This paper discusses the role of sports scenarios in promoting adolescents' mental health, and reconstructs the core concept of sports scenarios. Based on the "dual-channel model", the study reveals that sports scenes improve mental health through the dual mechanisms of physiological channels (e.g., BDNF secretion to regulate neuroplasticity) and psychosocial channels (to satisfy the needs for autonomy, competence, and relatedness). A multi-dimensional approach is proposed to address the sensitivity and homogeneity of the current scenarios, including the construction of a "quadruple linkage" parenting ecology, differentiated scenario interventions, and data-driven personalised matching. The study provides a theoretical and practical basis for optimising the design of sports scenarios and intervening accurately in adolescent mental health.*

**Keywords:** *sports scene parenting; adolescent mental health; personalised intervention*

## 1. Introduction

### 1.1. Conceptual Reconstruction of Sports Scene

The sports scene is not a physical space in the traditional sense, but a comprehensive model that integrates art, science and technology, culture, social interaction and other forms of business. It not only includes the sports itself, but also covers the basic elements of sports services, venue facilities, service personnel, supporting services and environmental atmosphere. The construction of sports scene needs to meet the needs of different groups, such as parent-child groups and youth groups, whose characteristics include entertainment, comfort, novelty, professionalism, sociality, convenience and aesthetics[1], which together constitute the unique value of sports scene.

Sports scene education refers to the creation of real, vivid, contextual sports environment, so that students can get comprehensive development in the process of participating in sports activities. Different from the static attributes of the traditional "sports environment", "sports scene" is a dynamic concept with triple theoretical qualities: firstly, the dynamics of the context is reflected in the real-time interaction between the environmental elements and the sports behaviour; secondly, the subjectivity of the participants is manifested in the construction of the sports experience through autonomous decision-making; finally, the social constructive feature enables the same physical space to generate different meaning networks, and the organic combination of these three dimensions makes the sport scene a new type of carrier carrying the function of psychological intervention.

### 1.2. Scene Dilemma of Youth Mental Health Promotion

#### 1.2.1. Problem of scene sensitivity

Research has shown that there are systematic differences in the intervention effects of different scenes on adolescent mental health. Although campus closed scenes (such as standardised playgrounds and gymnasiums) have the advantage of convenient organisation and management, there are obvious limitations in their psychological intervention effects. Fixed spatial layout is prone to trigger psychological adaptive fatigue, especially for adolescent groups with anxiety and depression tendencies. Second, under the social pressure of teacher supervision and peer evaluation, some students (especially the socially anxious) exhibit participation avoidance behaviours. In contrast, open community settings (e.g., parks, greenways, street basketball courts) show unique intervention advantages, as their environmental richness (natural light, greenery, etc.) promotes emotion regulation through the Attention Restoration Theory[2]. However, the promotion and application of this type of scenario faces the challenges of organisational difficulty and resource imbalance, creating an obvious

contradiction in policy and practice.

### ***1.2.2. Problem of single scene***

Most of the current school physical education programmes use standardised playground scenarios, and this homogeneity leads to multiple problems: firstly, the problem of spatial solidification is prominent. The monotonous combination of running track + court cannot meet the differentiated needs of youth with different psychological characteristics. For example, children with ADHD (Attention Deficit Hyperactivity Disorder) need more complex environmental stimuli to improve their attention span, and it is difficult for standardised playgrounds to provide the appropriate environmental support. Secondly, the functional design of existing sports scenes focuses too much on physical fitness and neglects the potential impact of the environment on psychological dimensions such as emotions and socialisation. For example, the concrete playground environment is relatively hard and lacks natural elements, which tends to make people feel nervous and uneasy, and is not conducive to anxiety relief. The underlying reasons for this situation include: the logic of safety-first management leads to the restriction of scene innovation, and physical education teachers generally lack the professional knowledge of the "scene-psychology" connection, and there is the problem of "scene superficiality" in the creation of teaching scenes.

## **2. Theoretical foundation and mechanism analysis**

### ***2.1. Dual-channel model of scene nurturing***

#### ***2.1.1. Physiological channel: Neuroplasticity regulation mechanism***

Exercise-induced Brain Derived Neurotrophic Factor secretion is the core link of physiological channels. Exercise has positive effects in reducing inflammatory responses, increasing levels of Brain Derived Neurotrophic Factor and increasing hippocampal volume[3]. Physical exercise is able to increase the volume of the hippocampal cortex by stimulating the brain to produce BDNF, which is dependent on the secretion of neural stem cells in the hippocampus. This chemical specifically acts on the hippocampal neural stem cells to stimulate their regeneration and the production of new neurons, which in turn increases the volume of the hippocampal cortex and achieves the enhancement of learning and memory abilities. In addition, BDNF has the same effect on mature neurons. Synaptic plasticity is the cellular basis of learning and memory, and the axons, dendrites and dendritic spines of neurons form the structural basis of synaptic plasticity[4]. BDNF can enhance the strength and complexity of synaptic connections between neurons, thus enhancing the strength of the neural network of the whole brain, and strengthening the various functions of the brain.

BDNF expression is not only influenced by genetic factors (e.g. Val66Met polymorphism), but also regulated by environmental and behavioural factors. Scene characteristics modulate this process: for example, a naturally lit scene has a different effect on BDNF expression compared to a closed indoor scene, and light conditions were found to have a significant effect on BDNF expression. In a study on the effects of low-intensity treadmill exercise and bright light on neurogenesis and BDNF expression in the rat hippocampus, bright light significantly increased BDNF expression in the rat hippocampus. This suggests that naturally lit sports scenes may improve neurological function by promoting BDNF expression.

#### ***2.1.2. Psychosocial access: a mechanism for basic psychological needs fulfilment***

According to Self-Determination Theory, self-determination usually refers to an individual's ability to make choices and take action on his/her own initiative based on his/her own will, values, and goals, which emphasises that an individual's ability to stimulate intrinsic motivation and promote psychological well-being and sustained growth when the three basic psychological needs of autonomy, competence, and relatedness are satisfied.

Satisfaction of the autonomy need enhances an individual's intrinsic motivation and increases his or her job satisfaction and creativity, while reducing stress and anxiety. For example, open-ended scenes (e.g., parks) offer more freedom of choice than closed scenes. Students who independently choose their own exercise methods and areas have higher scores on the Intrinsic Motivation Scale test, and autonomy enhances an individual's ability to adapt when facing stress and challenges.

The fulfilment of the need for competence can enhance the self-efficacy of individuals and improve their ability to cope with stress and challenges. In sports, the fulfilment of competence needs is

significantly associated with athletes' positive emotions and overall well-being. For example, the scenario difficulty gradient design of a rock climbing wall promotes a progressive success experience for climbers, and the satisfaction of the sense of competence helps individuals maintain a positive mindset in the face of adversity.

The satisfaction of relatedness needs can enhance individuals' sense of social support and improve their well-being and mental health. In social situations, the satisfaction of relatedness needs is significantly associated with lower loneliness and higher daytime satisfaction. In physical education scenarios, the circular arrangement of the dance classroom led to an increase in the frequency of non-verbal communication among members, and the use of concentric circle stations in tai chi classes allowed new members to integrate into the team more quickly.

In the process of physical education, when the school environment can satisfy the three basic psychological needs of students, it can not only improve students' athletic ability, but also make students like sports more and enjoy sports[5].

## ***2.2. Classification and mechanism of action of sports scenes***

### ***2.2.1. Open Skills Scene: Cognitive Flexibility Cultivation***

Open-ended skills usually refer to those motor skills that are highly variable, unpredictable and require dynamic adaptation in the environment, such as tennis, basketball, football and so on. Selective attention skills are naturally trained in open-ended scenarios where participants need to quickly identify important information (e.g., location of teammates), and this ability can be transferred to cognitive tasks such as classroom learning. At the same time, rapid decision-making processes promote the development of executive functions, and this training significantly enhances the cognitive flexibility of participants who must constantly adjust their strategies in a rapidly changing game environment. Studies have shown that open skill exercise activates the dorsolateral prefrontal cortex (DLPFC) and the anterior cingulate cortex (ACC) and promotes the functional integration of brain regions related to working memory, thus reducing the tendency of impulsive behaviour, and this functional integration not only contributes to the learning of skills, but is also crucial for the improvement of cognitive control.

### ***2.2.2. Closed-loop skill scenarios: motor control reinforcement***

Closed-circuit motor skills refer to movements performed in relatively stable and predictable environments, such as gymnastics, weightlifting, martial arts routines, track and field and other sports are all closed-circuit motor skills. These types of sports emphasise repetition and rhythm of movements, providing participants with a stable and safe environment that contributes to long-term emotional stability and mental health. Studies have shown that tai chi and closed-circuit sports (e.g., gymnastics, martial arts routines) are more conducive to emotional stability[6]. At the same time, the pursuit of technical perfection fosters self-regulation; in order to master complex movements, adolescents must learn to monitor and adjust their performance, a metacognitive skill that is equally important for other domains as well as for mental health.

### ***2.2.3. Adversarial scenarios: mechanisms of emotion regulation***

Adversarial sports scenarios (e.g., boxing, fencing, etc. ) have a positive role in promoting adolescents' mental health. Adversarial sports scenarios can promote mental health by releasing emotions and stress. Rule-bound confrontation provides a safe channel for adolescents to express their emotions. Fencing not only requires athletes to possess high skills and precise reactions, but also requires them to remain calm, focused, and have good emotional control during intense confrontations[7]. Evidence suggests that the HPA axis is still developing during adolescence, neuronal plasticity and maturation increase, and emotional, cognitive, and stress system functions tend to mature[8], and moderate participation in confrontational sports can help adolescents establish a balanced stress response pattern.

### ***2.2.4. Periodic sports scenarios: mental endurance development***

Periodic sports (such as swimming, long-distance running, etc. ) have a unique impact on adolescents' mental endurance through their repetitive and continuous characteristics. Periodic exercise stimulates the brain to release endorphins, a chemical known as the "happy hormone", which can significantly boost mood and reduce stress and anxiety. Periodic exercise scenarios are also effective in reducing levels of stress hormones such as cortisol in the body, thereby reducing the negative effects of

chronic stress on mental health. Certain forms of cyclical exercise, such as yoga, tai chi and pilates, also have the effect of promoting positive thinking and clarity of thought.

#### ***2.2.5. Synergistic scenarios: a mechanism for team cohesion***

Synergistic exercise scenarios usually refer to forms of exercise that are team-based and highly interactive, such as team running, yoga and Tai Chi. These types of sports not only require participants to perform physical activities, but also emphasise interaction and cooperation between people. Based on the Social Brain Hypothesis, the effects of such sports scenarios are mainly reflected in the fact that movement synchronisation activates the mirror neuron system[9]. The core feature of the mirror neuron system is that when an individual performs an action or observes another person performing the same action, the system activates similar neural patterns, and this activation is not limited to the action itself, but also to the understanding of the intention of the action[10]. It has been found that when team members' actions are highly synchronised, their brain activity also shows stronger coupling. Common goal pursuit strengthens social identity, and the collective efficacy of team success enhances the sense of belonging, an experience that is particularly beneficial for socially anxious individuals. The interactivity induced by synergistic sports scenarios is one of the key factors promoting the secretion of oxytocin, an important neuropeptide that influences social interaction, emotional bonding, and social cognition by binding to the oxytocin receptor[11].

### **3. Multi-dimensional practice path of sports scene parenting**

#### ***3.1. Construction of multi-dimensional parenting sports ecology***

##### ***3.1.1. Main body synergy: quadratic linkage mechanism***

In the dimension of subject synergy, a four-dimensional mechanism of "teacher-student-parent-community" is constructed. Teachers' role is transformed from skill transmitters to scenario designers, replacing technical demonstrations with design thinking, organically combining spatial intelligence (site planning), interpersonal intelligence (social design) and movement intelligence, and possessing the ability to dynamically regulate and adjust scenario parameters according to real-time physiological data; parents are deeply involved through the Movement Partner Programme, which includes the construction of family movement profiles, intergenerational movement design, and the construction of a family movement profile. Parents are deeply involved through the "Sports Partner Programme", which includes the construction of family sports records and the inheritance of intergenerational sports programmes. For example, the "grandparent-grandson martial arts class" programme has significantly increased the satisfaction of parent-child relationship among participating families; the community, as an extension of the school and the family, can integrate physical spaces such as stadiums, green spaces and cultural squares within its jurisdiction to form a "mental health sports circle". The community, as an extension of schools and families, can integrate physical spaces such as sports venues and cultural squares to form a "mental health sports circle", as well as to cultivate a sense of social belonging among adolescents through informal sports groups to alleviate social anxiety.

##### ***3.1.2. Spatial expansion: three-circle scenario network***

In the dimension of spatial expansion, a three-circle scene network is formed, namely "core-middle-periphery". The core circle focuses on campus scene reconstruction, transforming the traditional playground into a multifunctional space that can be quickly converted. For example, a composite field equipped with deformable equipment can meet the differentiated needs of ADHD students and ordinary students, and reduce the number of classroom conflicts; the middle circle integrates community resources and establishes a "15-minute mental exercise circle", and a reasonably-configured community exercise circle can significantly increase the number of hours of independent exercise for young people each week; the peripheral circle extends to the virtual space, such as the meta-universe exercise community. The peripheral circle extends to virtual space, such as the meta-universe exercise community, which carries out progressive exposure therapy for socially anxious groups, sets the exposure level by itself, and improves the acceptance of exercise scenarios for socially fearful adolescent groups.

##### ***3.1.3. Time continuity: full-time coverage strategy***

In the dimension of time continuation, the full-time coverage strategy of "5+2+1" was implemented. The dual-track system of "basic + elective courses" is adopted for 5 days on weekdays, and the elective

courses give students the right to choose, which enhances exercise adherence through the transformation of endocannabinoid regulation to identity regulation; 2 days on weekends are for family exercise, and parent-child co-exercise activates the mirror neuron system, enhances emotional resonance, and reduces the stress response through the release of oxytocin; 1 month is for the implementation of "Exercise and Sport" during the summer and winter vacations. A one-month "sports growth camp", a continuous challenge-recovery cycle (e.g., outdoor development, team competitions) to enhance resilience through stress inoculation training.

### ***3.2. Multidisciplinary Integration and Interdisciplinary Thematic Learning***

#### ***3.2.1. Integration of neuroscience and physiological dimensions of exercise***

The STEM Integration Sports Programme is an educational model that combines Science, Technology, Engineering and Mathematics (STEM) with Physical Education (PE) and aims to promote students' understanding and application of STEM concepts through physical activities, while developing their physical fitness and general abilities. Physical education provides a visual and relevant context for complex STEM concepts, enabling students to develop a deeper understanding and appreciation of these disciplines. By integrating the principle of projectile motion in physics with basketball shooting training and enhancing students' self-efficacy through immediate biomechanical feedback (such as high-speed photography analysis), this embodied cognitive training can improve students' accuracy in understanding physical concepts and reduce their academic anxiety levels simultaneously. Combining STEM with sports can significantly increase student engagement and participation, which not only increases the fun of sports activities, but also develops cognitive abilities and mental health promotion in adolescents.

Neuroplasticity is the ability of the brain to adapt to new situations through structural and functional changes in the changing environment. Sports scenarios not only have a direct exercise effect on the body, but also enhance the structural and functional changes of the brain by promoting neuroplasticity, and the effects of specific sports scenarios are even more significant. For example, in the design of a cross-training module on "sports-maths", participants in orienteering need to quickly identify the features of the terrain, judge the direction, and formulate the optimal path. The spatial geometric representation ability of the hippocampus enables participants to quickly construct a cognitive map of the environment, while the decision-making ability of the prefrontal cortex helps them to choose the most effective path.

#### ***3.2.2. Integration of Humanities and Psychoeducation***

The construction of cultural identity in the sports scene is a complex and multi-level process involving cultural interaction and identity on an individual, group, national and even global scale. The sports scene is not only a carrier of physical activities, but also maps culture, history, values and social identity. The theme of the sports scene needs to be rooted in a specific culture, and through the scene to establish an emotional consensus with the participants to achieve deep emotional resonance. For example, the development of the "Traditional Sports Non-heritage +" curriculum system combines the learning of martial arts routines with Confucian ethical discussions, which enhances self-identity through cultural narrative therapy and helps individuals to re-examine and reconstruct their life experiences so as to build a more positive and complete self-identity.

Social and Emotional Learning refers to an educational approach that fosters students' personalised and holistic development through social interaction and engagement in the learning process[12]. Role-playing, as one of the practical teaching tools, helps students to practice and apply social-emotional skills in real or simulated situations. For example, in a sports education model, students can learn how to communicate and coordinate effectively in a team by assuming multiple roles. This kind of role assignment not only helps students understand the complexity of team functioning, but also enhances their sense of responsibility and leadership, so that students can better understand the feelings of others and improve their empathy and communication skills in their future academic life.

### ***3.3. Personalised Intervention and Accurate Scenario Matching***

#### ***3.3.1. Scene Matching Strategy Based on Psychological Characteristics***

Design differentiated sports scene intervention programmes for adolescents with different psychological characteristics, such as:

Anxiety inclined group: Priority should be given to scenes with sufficient natural light and open environment (e.g. park greenway, outdoor yoga), combined with periodical exercise or closed skill exercise, to reduce the anxiety level through regular movement and low competitive environment, such scenes can significantly reduce cortisol secretion and enhance emotional stability.

Groups with depressive tendencies: We recommend collaborative or confrontational scenarios, which promote oxytocin secretion and relieve loneliness through social interaction and emotional release. At the same time, the aesthetic features of the scenarios can be used to stimulate positive emotions in combination with "movement-art" fusion programmes (e.g. rhythmic gymnastics).

ADHD group: Use open skill scenarios or high stimulation intensity multi-task sports (e.g., obstacle course running, orienteering) to enhance attention allocation and cognitive flexibility through dynamic environmental stimulation.

### **3.3.2. Data-driven dynamic scene optimisation**

Physiological-psychological data monitoring: using wearable devices to collect real-time data on adolescents' exercise intensity, mood fluctuations, etc. , and combining them with AI algorithms to analyse the individual's response pattern to the scene. For example, stress levels are assessed through heart rate variability (HRV), and scene parameters (e.g., lighting, music) are dynamically adjusted.

Feedback-based scenario iteration: Establish a closed-loop "assessment-intervention-feedback" system. For example, for socially anxious students, we will gradually expose them to VR virtual scenarios (e.g., meta-universe basketball game) at the beginning, and then transition them to real team sports at a later stage, and optimise the social intensity of the scenarios according to the participation data.

### **3.3.3. Inclusive Scene Design for Special Groups**

Physically disabled youth: develop accessible sports scenarios, such as wheelchair basketball-specific venues and sound guidance systems for blind goalball, to ensure the adaptability of the physical environment to the form of the sport. At the same time, enhance their relevance needs fulfilment through mixed-ability team activities (e.g. seated volleyball).

Economically disadvantaged groups: Integrate low-cost community resources (e.g., street fitness zones, square dance communities) and design "zero-threshold" exercise programmes (e.g., rope skipping challenges) to reduce barriers to participation. Research has shown that informal community scenarios can significantly increase exercise adherence among this group.

## **4. Future Prospects and Direction of Research**

### **4.1. Room for expansion of theoretical research**

#### **4.1.1. Exploration of neural mechanisms of dynamic scenes**

The dose-effect relationship between scene elements and BDNF secretion can be further investigated. BDNF secretion is not only affected by dose, but also regulated by time, environmental factors and physiological activities. Scene elements have significant effects on BDNF secretion. For example, complex scenarios (e.g., climbing and maze training) promote BDNF secretion more than running alone. In addition, adolescence is a critical stage of brain development, especially in the prefrontal cortex, dopamine system, social cognition and emotion regulation, which show a high degree of plasticity. Therefore, how to promote the overall development of adolescents through appropriate sports scene intervention during this sensitive period, and accurately control the timing matching between the sensitive period of brain development and scene intervention are also important issues in the current education and mental health fields.

#### **4.1.2. Scene effects under cultural differences**

To supplement the unique manifestations of the "relatedness needs" in collectivist cultures based on cultural diversity, the master-apprentice relationship in traditional Chinese martial arts can be taken as an example. The master-disciple relationship has collective cohesion and constraints in the inheritance of martial arts. As a "parent", the master needs to manage the operation and development of the family and continue the survival of the group, playing the role of guardian, organiser and guide[13].

The moderating effect of urban-rural scenario resource differences on the efficacy of psychological

interventions is also a topic of research interest. The abundance of sports resources directly affects the effectiveness of psychological interventions, and the differences in sports resources also affect the selection and implementation of psychological intervention models. Therefore, future research should further explore the moderating mechanism of urban-rural sport resource differences on the efficacy of psychological interventions, especially how to improve the effectiveness of psychological interventions by optimising the allocation of sport resources under different cultural backgrounds and different socio-economic conditions.

## ***4.2. Application Prospects of Technological Innovation***

### ***4.2.1. Digital twin technology for meta-universe scenarios***

Constructing high-fidelity digital twin sports scenes to achieve real-time mapping between virtual training and real movements. For example, through motion capture and 3D modelling technology, the shooting movements of students practicing in the virtual basketball court can be synchronously transformed into the training data of the real venue, forming a closed loop of "training-feedback-optimization".

Supporting multiple people to participate in the same virtual game (e.g. global online football game) through digital alters in different physical spaces, the stronger the sports identity, the more likely that an individual will show sports behaviours consistent with the identity. As an extension of the individual in the virtual world, the digital doppelgänger can help users to establish and strengthen their sport identity, so that they can more easily experience the feeling of "sport as self" in the virtual environment, thus enhancing positive motivation.

### ***4.2.2. Generative AI and personalised content creation***

Based on students' exercise data (e.g., fitness, interest), AI automatically generates customised training scenarios. By monitoring students' physical fitness data, interest preferences, and sports performance in real time, personalised training scenarios are tailored for youths, thus enabling tailor-made education. For example, a highly dynamic obstacle course with multiple movement types (e.g., jumping, crawling, climbing, rounding, etc. ) and adapted scenarios is designed for ADHD students.

Generate anthropomorphic teaching dialogues and real-time action guidance through Large Language Model and action libraries, which can be physical actions (e.g., exercise instruction) or virtual actions (e.g., character behaviours in a game). By combining the LLM with the action libraries, the virtual trainer can generate an interactive experience that conforms to the linguistic descriptions as well as the actual action guidance.

## ***4.3. Practice Transformation and Standardisation***

### ***4.3.1. Regional scene database construction***

To build a regional scene database and establish a national database for matching the mental health of teenagers with sports scenes, aiming to systematically sort out the differences in the intervention effects of sports scenes on the mental health of teenagers in different regional environments, providing a scientific basis for formulating precise and regionally adapted sports education plans, filling the gap in the systematic analysis of regional variables in current sports scene research, and solving the limitations of "one-size-fits-all" scene intervention. For instance, typical scene characteristics in different regions are collected, and data on the psychological intervention effects of the scenes are labeled, including the improvement rate of depressive symptoms and the reduction value of social anxiety, etc.

### ***4.3.2. Hierarchical Adaptation Model Development***

Based on the ecological psychology theory and social cognitive model, a three-dimensional parameter system is constructed, including the regional dimension, cultural dimension, and psychological dimension. Through the process of "raw data collection→feature engineering→model training→programme generation→dynamic optimization", we can finally achieve accurate matching, dynamic adaptation and scientific decision-making for the promotion of adolescent mental health in sports scenes.

## 5. Conclusion

This study systematically elaborates the role of sports scene parenting in promoting adolescents' mental health, from theoretical mechanisms to practical paths, providing educators and policy makers with scientific basis. The dynamic and multidimensional nature of sports scenes makes them an effective vehicle for psychological intervention, which significantly improves emotional regulation, cognitive development, and social skills by meeting the physiological and psychological needs of adolescents. In the future, it is necessary to further explore the neural mechanisms and cultural differences of scenario-based interventions, and to combine personalisation and standardisation through technological innovation. The value of this study lies in bridging the gap between theory and practice, pointing out the direction for the construction of a healthy and comprehensive mental health promotion system for adolescents, which is of great significance in promoting the integration and development of physical education and mental health.

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