A Study on the Correlation between Balance and Proprioception in Dance Sport and the Coordinated Training Strategy

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Abstract: This paper focuses on the field of dance sport, delving into the relationship between balance and proprioception and proposing targeted collaborative training strategies. By analyzing the theoretical implications of balance and proprioception and integrating them with the specific characteristics of dance sports, this paper explores the interaction between the two in dance sports. The study found that balance provides a stable foundation for proprioception, while proprioception regulates balance. Their coordinated development is crucial for improving a dancer's movement quality and expressiveness. Based on this, this study constructs a collaborative training strategy based on three dimensions: strengthening foundational skills, specialized equipment training, and integrating dance scenes. The aim is to provide theoretical reference and practical guidance for dance sport teaching and training, helping dancers improve their performance.

1. Introduction

As a sport that blends art and competition, dance sports places extremely high demands on the dancer's body control abilities. Balance and proprioception are key factors influencing the quality and expressiveness of a dancer's movements. Across all dance sports movements, from static modeling to dynamic rotations and jumps, dancers require excellent balance to maintain stability. Dancers rely on precise proprioception to perceive the position and movement of various body parts, as well as their relationship to the surrounding environment, enabling them to make timely adjustments. Exploring the relationship between balance and proprioception in dance sports is crucial for optimizing training methods and improving training effectiveness. This study aims to systematically analyze the inherent connection between the two through a variety of research methods, and to propose scientifically effective collaborative training strategies to provide theoretical support and practical guidance for dance sports teaching. Compared to previous studies, this study innovates by organically integrating balance and proprioception training from a collaborative training perspective, focusing on their integrated application in specific dance sports scenarios.

2. Theoretical Basis of Balance and Proprioception in Dance Sports

2.1 The Connotation of Balance

Balance is the comprehensive ability of the human body to maintain a stable center of gravity in various static and dynamic environments through the regulation of the neuromuscular system. It is fundamental to normal physiological activities and movement, and is particularly important in sports such as dance sport, which require extremely high levels of body control [1]. Balance can be categorized into static and dynamic balance. Static balance refers to the ability to maintain a stable center of gravity on a support surface while at rest or in slow motion. Dance sport requires dancers to maintain static balance for extended periods, demonstrating graceful and stable posture. Therefore, the dancer's body must coordinate, adjusting muscle tension to maintain balance. Dynamic balance refers to the ability to continuously adjust the center of gravity to adapt to changes in motion and maintain stability during movement, such as walking and running. Dance sport requires dancers to be

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aware of shifts in the center of gravity during rapid body movements and posture changes, adjusting their posture through rapid muscle contraction and relaxation to ensure smooth and accurate movements.

2.2 Definition and Function of Proprioception

Proprioception is the ability of the human body to perceive the position, movement, muscle tension, and relationship between the body and its surroundings through receptors in muscles, tendons, and joints. It does not require the involvement of external senses such as vision; it is an internal sensory system that provides the central nervous system with real-time information about body movements. In dance sports, proprioception plays an indispensable and crucial role. First, it helps dancers accurately perceive movements. During dance movements, dancers rely on proprioception to perceive the changes in joint angles, the degree of muscle contraction, and the body's spatial position, enabling them to accurately execute the required movements. For example, during a spin, dancers use proprioception to detect the speed and angle of rotation, adjusting their posture promptly to ensure a stable and smooth rotation [2]. Second, proprioception assists dancers in adjusting their posture. During a dance performance, dancers must constantly adjust their posture to the rhythm of the music and the style of the dance. Proprioception provides real-time feedback on body posture, enabling dancers to promptly correct deviations and maintain graceful movement. Finally, proprioception helps improve the coordination and accuracy of movements. Dance sports movements often require coordination between various parts of the body. Proprioception integrates and transmits movement information from various parts of the body to the central nervous system, enabling the central nervous system to precisely regulate the movements of various parts of the body, thereby improving the coordination and accuracy of movements. Figure 1 illustrates the importance of proprioception.

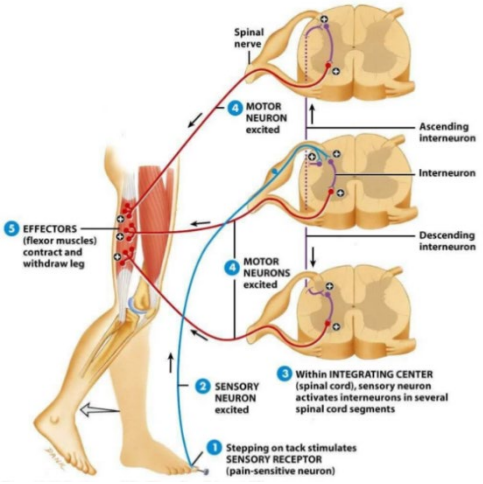

Fig 1. The importance of proprioception

2.3 Special Demand Characteristics of Dance Sport

Dancesport is typically characterized by the high integration of artistry, competitiveness, and dual-person collaboration, which imposes multi-level special requirements on dancers' balance ability and proprioception. From the perspective of artistry, dance sport emphasizes the aesthetic feeling, fluency, and emotional expressiveness of movements. Dancers need to convey musical connotations and dance artistic conceptions through graceful body language, which requires individuals to maintain physical stability and elegant posture when completing movements. Balance ability serves as the foundation for achieving this requirement. Meanwhile, dancers need to accurately control the rhythm, strength, and amplitude of movements. Proprioception provides a guarantee for perceiving movement details and adjusting movement texture, making individual movements more artistically appealing.

In terms of competitiveness, movement difficulty, completion quality, and stability are core evaluation indicators in competitions. With the improvement of competitive levels, high-difficulty movements such as rotations, jumps, and lifts are increasingly emerging, placing higher demands on individual balance ability. Dancers need to maintain physical stability during complex movements to

avoid mistakes, and proprioception helps them perceive physical states in real-time and make rapid adjustments, thereby improving movement completion quality.

What is more critical is the special demand brought by the characteristic of dual-person collaboration. In pair dancing, dancers must maintain personal balance and physical perception while also establishing a "dual-person balance system". For example, in the holding posture, both parties need to perceive each other's center of gravity shift through muscle tension. For example, men can perceive the tilt angle of women's bodies through their arm muscles. In contrast, women adjust their balance based on men's support to jointly maintain the stability of the overall center of gravity on the supporting surface, thereby avoiding deformation of dual-person movements due to one party's imbalance.

Proprioception should be developed to include "dual-person spatial perception." Dancers need to accurately judge their partner's body position, movement trajectory, and movement intention through joint receptors and muscle tension feedback. For instance, during rotation movements, men need to perceive changes in women's rotation speed and centrifugal force and adjust the supporting strength promptly; women need to predict the rotation direction through men's guidance signals and adjust their body posture in advance to achieve synchronization.

In addition, the strong sense of rhythm in dance sport requires both partners to accurately complete movement transitions in musical beats. It requires not only the cooperation of individual balance ability and proprioception but also the ability of dancers to perceive each other's movement rhythm deviations, adjust the physical coordination relationship in real-time, and make dual-person movements perfectly integrate with music.

3. Research on the Correlation between Balance and Proprioception in Dancesport

3.1 The Supporting Role of Balance on Proprioception

Good balance provides a stable foundation for accurate proprioception. In dance sports, when dancers maintain balance, the forces acting on various parts of the body are relatively stable. It allows receptors in muscles, tendons, and joints to more accurately perceive the body's position and motion, resulting in more precise proprioceptive information [3]. For example, when performing static poses, dancers maintain balance and relatively stable joints. Proprioception can accurately perceive joint angles and muscle tension, enabling better control of posture and graceful movement. Conversely, if a dancer has poor balance and an unstable body, the forces acting on different parts of the body will constantly change. This variation disrupts the receptors responsible for sensing the body's position, resulting in inaccurate proprioception. Consequently, this affects the dancer's control and coordination of movement. Balance training can effectively enhance the acuity and accuracy of proprioception. Through systematic balance training, dancers' neuromuscular systems are strengthened, enhancing the body's ability to regulate balance. Additionally, it can increase the sensitivity of receptors in muscles, tendons, and joints. Furthermore, in tests of perceiving body position, dancers' perceptual errors were significantly reduced, indicating that the acuity and accuracy of their proprioception had been strengthened. This is because during balance training, dancers need to constantly adjust their body posture to maintain balance [4]. This process stimulates the activity of receptors, improving their ability to perceive changes in body position and thus promoting the development of proprioception. Figure 2 illustrates the connection between balance and proprioception.

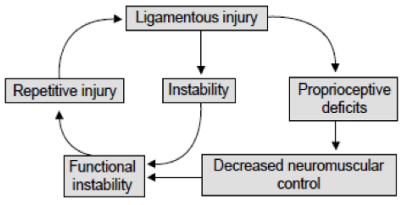

Fig 2. The relationship between balance and proprioception

3.2 Proprioception Regulates Balance

Proprioception provides crucial information for maintaining and adjusting balance by sensing the body's state in real time. During dynamic dance sports movements, such as spins and jumps, a dancer's center of gravity constantly shifts. Proprioception can promptly detect shifts in the center of gravity, changes in joint angles, and changes in muscle tension, and rapidly transmit this information to the central nervous system. Based on this information, the central nervous system analyzes and assesses the body's state of motion, then issues commands to adjust the contraction and relaxation of relevant muscles, thereby dynamically maintaining balance. For example, during a spin, the dancer's center of gravity shifts as the speed of rotation changes. Proprioception detects this shift and transmits information to the central nervous system, which then commands the relevant muscles to contract and relax, adjusting the body's posture to restore the center of gravity to a stable position and maintain balance during the spin. Accurate proprioception can significantly enhance a dancer's balance control ability during complex movements. Dance sports incorporate many complex combinations of movements, such as continuous spins, jumps, and poses, which place extremely high demands on the dancer's balance control. Dancers with precise proprioception can accurately perceive the position and movement of various body parts during movement, anticipate changes in the body's center of gravity, and make timely adjustments [5].

3.3 Practical Verification of Relevance

Through long-term training and performance, elite dancers develop a high degree of collaboration between their balance and proprioception. Dancers maintain stability and precision when performing challenging movements, such as rapid spins and large limb extensions. Analysis of their movements reveals that their balance provides a stable foundation for proprioception, enabling them to accurately perceive their body's state. Simultaneously, proprioception regulates their balance in real time, adjusting muscle contraction and relaxation according to changes in body state to ensure smooth execution of the movements. For example, when performing continuous spins, elite dancers rely on their excellent balance to maintain stable rotations. Proprioception accurately perceives the speed and angle of rotation, allowing them to adjust their center of gravity on time to avoid imbalance and demonstrate superb dancing skills. Systematic synergistic training in balance and proprioception significantly improves the correlation between the two and their performance.

A study on competitive ballroom dance couples provides empirical evidence for the interplay between balance, proprioception, and dual-person collaboration [6]. The researchers recruited 16 elite couples (average partnership duration: 5.3 years) and 16 intermediate couples, measuring their performance in a standardized axis rotation task: the male dancer maintained a single-leg stance as the axis. At the same time, the female rotated around him, maintaining bodily contact.

Using motion capture and electromyography recordings, they found elite couples exhibited significant differences in key metrics: the axis dancers showed 37% lower sway of the center of pressure during rotation, indicating superior balance control. Meanwhile, both partners demonstrated 42% faster electromyographic response time to each other's movement deviations, reflecting enhanced proprioceptive feedback. Notably, elite couples maintained consistent inter-body distance during rotation, while intermediate couples showed 3.8cm variability. Post-experiment interviews revealed elite dancers relied on "tactile-proprioceptive coupling"—the axis dancer perceived rotational forces via arm muscle tension, and the rotating partner adjusted posture through hip joint position sense, forming a closed-loop feedback system.

This experiment confirms that long-term dual-person training strengthens the mutual regulation between individual balance, proprioception, and collaborative awareness, directly supporting the relevance between these abilities in sports and dance.

4. Synergistic Training Strategies for Balance and Proprioception in Dance Sports

4.1 Basic Capability Strengthening Strategy

Core strength training is the basis of improving the balance and proprioception of single and double

dancers. The core muscle group plays a crucial role in maintaining body stability. In double cooperation, core strength serves as the central hub, facilitating the transfer of the center of gravity and the perception of the partner's strength. Strengthening core stability through flat support, supine leg lifting can not only improve individual balance control ability but also enable dancers to accurately perceive the power transmission of their partners in the holding state. For example, maintaining continuous tension in the core during flat support can enhance the ability of deep muscle groups to regulate body posture, thereby laying the groundwork for the rapid response of "strength feedback-posture adjustment" in double action. When training, we should pay attention to the standardization of actions, insist on 30 seconds to 1 minute at a time, and gradually increase the duration and difficulty.

Joint stability training needs to take into account both single-person control and double-person collaborative perception. The stability of the ankle joint, knee joint, and hip joint directly affects personal balance. In contrast, the stability of upper limb joints such as the shoulder joint and elbow joint is the key to force transmission and posture perception in a double grip. For the joints of lower limbs, it is suggested to use training such as standing on one foot and tiptoeing to improve the balance foundation; For the joints of upper limbs, it is suggested to enhance the control ability and receptor sensitivity of muscles around the joints through exercises such as dynamic grip stability, so that dancers can more accurately perceive the direction and strength changes of their partners in the interaction.

4.2 Special Equipment Training

Balance board training is an effective method for improving balance and proprioception. Balance board training can be done with two people, which can further strengthen their balance systems. Single-person static standing and dynamic moving training on the balance board (such as moving back and forth, left and right) can improve individual balance control and proprioception [7]. On this basis, two people can train on the balance board by standing together, adjusting their body's center of gravity through holding posture, and feeling each other's center of gravity shift and muscle tension change as they maintain overall balance. For example, when two people synchronously complete the knee flexion-standing action on the balance board, they need to adjust their force through the feedback of their arms and core muscles in real time to avoid imbalance. This process can significantly improve the perception and control ability of the couple to the "common center of gravity". Training should be gradual, beginning with static coordination and gradually incorporating dynamic actions, with each training session lasting 10-15 minutes.

Yoga and Pilates training can be integrated into the coordinated action design of two people to promote the two-way transmission of proprioception. Yoga's "double-balanced pose" (such as double-tree, lateral stretching, and mutual support) requires both sides to perceive each other's posture stability through physical contact and adjust muscle tension to maintain common balance. Pilates double core control exercises can strengthen the cooperative contraction ability of core muscles and improve the perception accuracy of strength in double movements. During training, it is necessary to pay attention to the coordination of breathing and movement, relax the body through deep breathing, and enhance the sensitivity of the body to the partner's action signal.

4.3 Dance Scene Fusion Strategy

When arranging the action combination, it is necessary to add elements that depend on the balance and perception of two people: In choreographing movement combinations, integrate balance and proprioception training into rotation-based dual-person interactions, where one dancer serves as the axis with single-leg weight-bearing while the other rotates around them. For example, in a waltz "axis rotation" sequence, the male dancer stabilizes on one leg as the axis, with the female rotating around him in a continuous spin. During rotation, the axis dancer must precisely perceive the rotational centrifugal force through core and leg muscle tension, adjusting hip alignment in real-time to maintain stable weight distribution on the supporting leg.

The rotating partner relies on proprioception to gauge their spatial position relative to the axis, using subtle arm and torso movements to regulate rotation speed. Through grip strength feedback,

both dancers synchronize: the axis dancer signals rhythm changes via slight arm tension adjustments. In contrast, the rotating dancer responds by modifying leg extension angles to avoid disrupting the axis's balance. Training emphasizes decomposing each rotation phase, focusing on real-time perception of mutual force changes. By repeating this sequence under varying tempos, dancers develop neuromuscular memory for "axis stability-rotation coordination," ensuring smooth, balanced execution even in high-pressure performance scenarios, thus enhancing the artistic coherence of dual-person movements.

The training of simulated game scenes should emphasize the balance regulation and perceptual cooperation under the pressure of two individuals. Set up an environment that closely resembles the real competition, and require dancers to complete the double combination action under pressure. For example, to simulate the "quickstep dance" competition segment, the dancer needs to keep the stability of the double grip during the fast movement, and correct the center of gravity deviation caused by the speed change in real time through proprioception. In tango modeling action, it is necessary to maintain the aesthetic feeling of posture while perceiving the subtle action intention of the partner through muscle tension, thereby realizing the precise synchronization of modeling transformation. Interference factors (such as slight external touch and temporary change of music rhythm) can be introduced in training to improve the dancer's ability to regulate the balance of two people and the anti-interference ability of proprioception in a complex environment.

5. Conclusion

In dance sports, the relationship between balance ability and proprioception is evident not only at an individual level but also in the deep interactive mechanisms involved in the cooperation of two dancers. The single person's balance ability provides a stable foundation for the individual's proprioception. In contrast, the maintenance of "common balance" in two-person cooperation relies on the real-time interaction between the two sides' proprioception. Through the perception of muscle tension, joint position, and power transmission, the two can achieve synchronous adjustments of the center of gravity and accurate matching of action intentions. The development of the two ensures an improvement in the quality of single-player movements and the tacit performance of double-players.

The strategy of strengthening basic ability, special equipment training, and dance scene fusion put forward in this study can effectively promote the basic development of single-person balance-proprioception and the improvement of perception-regulation ability in double-person collaboration, and provide a practical way for the comprehensive optimization of dancers' sports performance.

References

[1] McShane J M, Shah M M. Balance and proprioception training and enhancement devices[P]. US5613690A, 2025-08-05.

[2] Shim A, Steffen K, Hauer P, et al. The effects of balance training on stability and proprioception scores of the ankle in college students[J]. Journal of Science & Medicine in Sport, 2017, 20(suppl_S1): e34. DOI: 10.1016/j.jsams.2017.01.098.

[3] Marjani F, Rahnama N, Etemadifar M, et al. Comparison of the Effect of Selected Exercises with TRX and Aerofitness on Balance and Proprioception in Patients with Multiple sclerosis[J]. Journal of ilam university of medical sciences, 2022.DOI:10.52547/sjimu.30.1.42.

[4] Batson G. Update on proprioception: considerations for dance education[J]. Journal of Dance Medicine & Science, 2009, 13(2): 35-41. Bristol: J. Michael Ryan Publishing Inc.

[5] Wang H, Ji Z, Jiang G, et al. A Study on the Influence of Latin Dance and Tai Chi Exercise on Balance and Knee Joint Proprioception[J]. IEEE Computer Society, 2016.DOI:10.1109/IIKI.2016.50.

[6] Kinoe Y, Sato M. Analysis of Nonverbal Interaction Among Competitive Ballroom Dance Couple[C]//International Conference on Human-Computer Interaction. Springer, Cham, 2022.DOI:10.1007/978-3-031-06509-5_18.

[7] Hutt K, Redding E. The Effect of an Eyes-closed Dance-specific Training Program on Dynamic Balance in Elite Pre-professional Ballet Dancers: A Randomized Controlled Pilot Study[J]. Journal of Dance Medicine & Science, 2014, 18(1):3-11. DOI:10.12678/1089-313X.18.1.3.