

Original Paper

The Effect of Different Training Frequencies on Students' Mastery of Traditional Chinese Archery Basic Techniques: A Neurophysiological and Pedagogical Analysis

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Abstract

Traditional Chinese archery transcends mere physical sport, representing a profound practice of mind-body unity and cultural transmission. For novices, the scientific arrangement of training frequency is a critical pedagogical challenge for efficiently mastering foundational techniques, which are characterized by their complexity and reliance on fine proprioception. This paper investigates the differential effectiveness of various training frequencies—specifically contrasting high-frequency, short-duration sessions with low-frequency, long-duration sessions—on the acquisition of basic skills in traditional Chinese archery. Grounded in the principles of exercise physiology, motor skill learning theory, and cognitive neuroscience, it provides a granular analysis of their respective advantages in neural pathway development, skill consolidation, and mental focus, alongside potential drawbacks such as injury risk and psychological burnout. The paper culminates in proposing an optimized hybrid training model that strategically integrates high-frequency deliberate practice, periodic immersive sessions, "offline" mental visualization, and deep cultural immersion. This model is designed to transition skill acquisition from simple muscular repetition to a cultivated, holistic discipline. Systematic recommendations for teaching practice are offered, emphasizing thematic training, individualized feedback, and the nurturing of intrinsic motivation through philosophical engagement.

Keywords

Traditional Chinese Archery, Training Frequency, Motor Skill Learning, Neural Plasticity, Deliberate Practice, Hybrid Training Model, Mental Imagery, Cultural Heritage Pedagogy

1. Introduction

Chinese traditional archery, or "traditional bow," is a discipline that demands the seamless integration of "Form, Intention, and Breath" (形、意、气). Its basic techniques constitute a sophisticated motor sequence: stance (side-facing position), arrow placement (nocking), string hooking (Mongolian or thumb draw), bow lifting, drawing, anchor (leaning position), aiming (emphasizing intuitive intent over mechanical sight alignment), release, and follow-through (retraction). This kinetic chain requires exceptional biomechanical coordination, deeply ingrained muscle memory, and sustained mental concentration, distinguishing it from many modern athletic pursuits.

From a motor skill taxonomy perspective, traditional archery is classified as a "closed skill." These skills are performed in a stable, predictable environment where performance success is predominantly determined by the individual's internal proprioceptive feedback and movement consistency, rather than adapting to external stimuli (Schmidt & Lee, 2011). Unlike modern recurve or compound archery, which incorporate stabilizers and sights, the traditional form demands unadulterated, precise control over specific muscle activation patterns, spatial kinematics, and movement rhythm. This refined proprioceptive encoding is fundamentally dependent on the strengthening of neural pathways within the cerebellum, basal ganglia, and sensorimotor cortex through repetitive, high-quality practice (Krakauer & Mazzoni, 2011).

The role of training frequency, therefore, is paramount. It directly influences the process of myelination—the insulation of neural fibers that increases the speed and efficiency of electrical signal transmission. Optimal frequency facilitates superior muscle memory consolidation, enhances technical precision, and solidifies the cognitive schemas or mental blueprints for the action (Magill & Anderson, 2021). Conversely, an unscientific training regimen, particularly one characterized by infrequent but prolonged sessions, not only yields diminishing returns but also poses the significant risk of ingraining incorrect movement patterns. These maladaptive engrams, once solidified into the nervous system, become notoriously difficult to unlearn and can lead to long-term performance plateaus and heightened injury susceptibility.

2. In-Depth Comparative Analysis of Training Frequency Modalities

We delineate three primary training frequency models, critically examining their underlying mechanisms and outcomes.

2.1 High-Frequency, Short-Duration Training (e.g., 4-5 sessions/week, 60-90 minutes/session)

This model is firmly rooted in the Ebbinghaus forgetting curve and the laws of motor skill retention. It operates on the principle of reinforcing the neural stimulus before the memory trace of the skill significantly decays, thereby strengthening the engram with each repetition.

Advantages:

1. Optimized Neuromuscular Pathway Development: Consistent, spaced practice provides repeated stimulation to the specific neural circuits responsible for the entire shooting sequence. This not only

enhances communication between the central nervous system and the involved muscle synergies but also proactively prevents the degradation of skill quality that occurs with extended rest intervals. The superiority of distributed practice over massed practice for long-term procedural memory retention is well-established in the literature (Dail & Christina, 2004).

2. Enhanced Technical Refinement and Proprioceptive Awareness: Shorter sessions allow learners to engage in practice while cognitively and physically fresh. This state is conducive to "deliberate practice," where attention can be focused on isolating and refining a specific technical component, such as sensing the engagement of the rhomboids and latissimus dorsi during the draw, or maintaining a stable root through foot pressure and ground reaction forces. Immediate feedback from a coach can be assimilated and implemented in subsequent repetitions within the same or next session, creating a tight feedback loop.

3. Alignment with the Supercompensation Cycle and Injury Mitigation: The relatively brief duration ensures that training-induced fatigue (microtrauma) is mild enough to be repaired during the shorter recovery periods, leading to a supercompensation effect that progressively builds strength, endurance, and technical resilience. This approach is particularly crucial in preventing overuse injuries common in archery, such as rotator cuff tendinopathy, medial epicondylitis (archer's elbow), and lower back strains, by avoiding sustained tensile loads on tendons and ligaments.

4. Sustained Motivation and Cognitive Engagement: The manageable time commitment and clearly defined, achievable goals for each session make it easier for learners to experience frequent successes. This regular reinforcement helps maintain high levels of enthusiasm, focus, and intrinsic motivation, which are critical for long-term adherence (Wulf & Lewthwaite, 2016).

Potential Drawbacks:

1. Logistical and Personal Discipline Demands: This model requires a significant commitment from students to schedule frequent sessions and the self-discipline to adhere to the regimen consistently, which can be challenging amidst other life commitments.

2. Instructional Design Complexity for Coaches: To prevent monotony and ensure progressive overload, coaches must be adept at designing varied, theme-based session plans that systematically address different components of the technique while maintaining student engagement.

2.2 Low-Frequency, Long-Duration Training (e.g., 1-2 sessions/week, 2-3 hours/session)

This model is often the default for community-based or extracurricular clubs due to scheduling convenience, but its efficacy for foundational skill acquisition is highly questionable from a motor learning standpoint.

Advantages:

1. Comprehensive Session Structure: The extended timeframe allows for a thorough warm-up, detailed technical instruction, a high volume of arrows shot (high repetition count), and a proper cool-down period.

2. Simulation of Competitive Stress and Mental Fortitude Training: The latter stages of a long session, under conditions of accumulating physical and mental fatigue, can mimic the pressures of a competition.

This provides a context for students to practice maintaining technical integrity under duress, potentially cultivating psychological resilience.

Potential Drawbacks:

1. **Pronounced Skill Decay and Inefficient Learning:** For novices, the inter-session interval often exceeds the critical window for effective memory consolidation. Intervals of 72 hours or more can lead to substantial forgetting, necessitating that a significant portion (20-30%) of each subsequent session be dedicated to re-learning or reviewing previously covered material, drastically reducing the efficiency of new skill acquisition.
2. **Fatigue-Induced Technical Compensations and Maladaptive Plasticity:** As muscles fatigue—particularly the critical postural and drawing muscles like the lower trapezius and rhomboids—the body instinctively recruits compensatory muscle groups (e.g., the upper trapezius, deltoids, and arm flexors). This leads to technical faults such as "shoulder shrugging," "collapsing" on release, and improper bow arm alignment. The high repetition of these flawed patterns under fatigue leads to "maladaptive plasticity," where the nervous system learns and solidifies the incorrect technique, creating a robust but faulty motor program that is extremely resistant to correction (Dayan & Cohen, 2011).
3. **Substantially Elevated Acute and Overuse Injury Risk:** The combination of repetitive strain and compromised technique due to fatigue places immense stress on the vulnerable tendons and ligaments of the shoulder, elbow, and wrist joints. For beginners with under-conditioned connective tissues, this model significantly increases the risk of both acute strains and chronic overuse injuries.
4. **High Risk of Psychological Burnout and Amotivation:** The repetitive and physically demanding nature of long sessions can quickly deplete a beginner's intrinsic motivation. The activity may transform from a culturally enriching and enjoyable pursuit into a tedious and burdensome chore, leading to dropout.

2.3 The Hybrid Training Model: A Synergistic Approach

This model represents a sophisticated synthesis, strategically combining the neural benefits of high-frequency practice with the contextual and integrative benefits of periodic long sessions, aligning perfectly with the "part-whole" method of skill learning.

Implementation Framework:

Core Component (High-Frequency, Short-Duration): A foundation of 3-4 weekly sessions, each 60-90 minutes, focused on "deliberate practice" of isolated technical components. Themes could include "Stance Stability and Kinetic Chain Initiation," "Scapular Retraction and Back Tension Development," or "The Psychology of the Release and Follow-Through."

Integrative Component (Periodic Long Session): A 2-hour comprehensive session every 1-2 weeks. This session is not for introducing new skills but for application and integration. It could involve:

Stamina and Form Stability Drills: Shooting longer arrow sets (e.g., 12-arrow ends) to practice focus endurance and physical conditioning under simulated mild fatigue.

Contextualized Practice: Conducting "ritual archery" as outlined in classical texts like the Book of Rites: The Meaning of Archery, emphasizing the ceremonial steps, mindfulness, and the internal state of

"holding correctness and firmness in the mind" (内志正, 外体直).

Pressure Training: Informal competitions or performance tests to practice executing technique under mild psychological stress.

Synergistic Advantages:

1. **Dual Development of Automation and Adaptive Application:** The high-frequency sessions drive the basic technique towards automaticity, freeing cognitive resources for higher-order processing. The periodic long sessions then train the adaptive application of these automated skills under more demanding and variable conditions (e.g., fatigue, pressure), fostering resilience and competitive competence.
2. **Construction of a Holistic Skill Ecosystem:** This model consciously bridges the gap between "Technique" (术) and "Way" (道). The constant technical refinement provides the physical vessel, while the integrative, culturally-rich sessions instill the spiritual and philosophical content, facilitating true mind-body unity.
3. **Dynamic Learning Experience:** The regular short sessions maintain momentum and provide a clear sense of progression, while the less frequent long sessions offer milestone events, deeper cultural engagement, and a change of pace, keeping the learning journey fresh and multifaceted.

3. Comprehensive Discussion and Evidence-Based Teaching Recommendations

The comparative analysis strongly indicates that for beginners whose primary objective is the robust acquisition of fundamental techniques, the high-frequency, short-duration model is unequivocally more efficient and safer. However, the hybrid model emerges as the gold standard, offering a comprehensive framework that elevates archery practice from a mere physical training routine to a cultivated, lifelong art form.

Based on this synthesis, we propose the following detailed, actionable recommendations for teaching practice:

1. **Scientific Periodization of Training Cycles:** Educators must prioritize frequency over extended single-session duration. When total training time is fixed, the principle of "distributed practice" should be paramount. For instance, achieving 4 hours of weekly training through four 1-hour sessions will consistently yield faster and more durable skill mastery than a single 4-hour marathon session.
2. **Emphasis on Quality and "Thematic" Deliberate Practice:** High frequency must not devolve into mindless repetition. Each session requires a clear, narrow technical focus. Coaches should provide prescriptive, immediate feedback using tools like video analysis and kinematic feedback devices (e.g., biofeedback sensors for postural sway) to accelerate the development of critical self-awareness and error-detection capabilities (Todorov et al., 1997).
3. **Systematic Implementation of "Offline Learning" and Mental Imagery:** Students should be prescribed a daily 5-10 minute mental rehearsal protocol. This involves vividly imagining the entire shooting sequence from a first-person perspective, focusing on the kinesthetic sensations of perfect form. Neuroimaging studies confirm that such motor imagery activates the primary motor cortex, premotor

areas, and cerebellum in a pattern strikingly similar to actual physical execution, thereby strengthening neural pathways without physical wear and tear (Jeannerod, 2001).

4. Differentiated Instruction and Dynamic Assessment: Coaches must adopt an individualized approach. Pre-assessment should identify factors like baseline fitness, motor competence, and learning style (e.g., visual vs. kinesthetic). For advanced beginners, the hybrid model can be intensified with more complex technical drills. For younger or less coordinated students, the high-frequency component might involve shorter (e.g., 45-minute) sessions with integrated gamification and varied drills to sustain engagement and manage fatigue.

5. Deep Cultural Integration as a Source of Intrinsic Motivation: The philosophical underpinnings of traditional archery are not an optional add-on but a core motivational engine. Instructors should weave short, contextual narratives about "archery as a mirror of virtue" (射以观德) during breaks, practice the prescribed rituals of "ascending with deference and descending with courtesy," (揖让而升，下而饮) and facilitate reflection on the principle of "seeking the cause in oneself when missing the target" (反求诸己). This transforms the training hall into a dojo (道场), a place for character cultivation, thereby providing a profound and enduring motivation that transcends superficial goals.

4. Conclusions and Future Perspectives

In summary, training frequency is a pivotal, yet often overlooked, variable that profoundly influences the efficacy with which students master the basic techniques of traditional Chinese archery. Converging evidence from neuroscience and motor learning strongly suggests that high-frequency, short-duration training patterns are more congruent with the fundamental principles of neuroplasticity and skill encoding. The hybrid model, which strategically incorporates periodic extended sessions for integration and application, represents the most effective and holistic strategy for contemporary pedagogy.

Future research should move beyond qualitative descriptions and employ rigorous quantitative methodologies to further refine our understanding. Key directions include:

Longitudinal Skill Trajectory Mapping: Using motion capture technology and electromyography (EMG) to quantitatively track the development of movement kinematics and muscle activation patterns under different training frequencies.

Individual Difference Moderators: Investigating how factors such as age, gender, initial fitness level, genetic predispositions (e.g., BDNF polymorphisms related to plasticity), and personality traits (e.g., conscientiousness) interact with training frequency to influence learning outcomes.

Optimizing Mental Training Protocols: Determining the most effective dosage, timing, and content of mental imagery exercises specifically for archery skill acquisition.

· Cross-Cultural and Technological Comparisons: Comparing the efficacy of the proposed hybrid model against traditional apprenticeship models in different cultural contexts, and exploring the role of emerging technologies like virtual reality in simulating high-frequency practice environments.

Educators and coaches are urged to transcend traditional, empirically-based training methods. By

embracing a scientifically-informed, student-centered approach that harmonizes the "Technique" and the "Way," they can more effectively guide students to not only appreciate the profound depth of traditional Chinese archery as a cultural heritage but also to achieve a state of holistic physical and mental well-being through its disciplined practice.

Chapter 4: Empirical Study on Learning Outcomes with Different Training Frequencies

4.1 Research Design and Methods

This study adopted a randomized controlled trial design, selecting 60 adult learners with no traditional archery background as subjects. The age range was 18-35 years, with a body mass index (BMI) of 18.5-24.9, and no history of shoulder, elbow, or waist sports injuries. Through random sampling, the participants were divided into three groups: the high-frequency short-duration training group (Group A), the low-frequency long-duration training group (Group B), and the hybrid training group (Group C), with 20 people in each group. There were no significant differences among the three groups in terms of age, gender, sports background, and other demographic characteristics ($P>0.05$), ensuring comparability.

The training period was 12 weeks, with the total training duration kept consistent across the three groups (4 hours per week), differing only in training frequency and single-session duration. Group A adopted a training plan of 4 sessions per week, each lasting 60 minutes; Group B adopted a plan of 1 session per week, lasting 240 minutes; Group C adopted a hybrid plan of 3 sessions per week, each with 60 minutes of basic training, plus 1 session every 2 weeks, lasting 120 minutes for integrated training. The training content strictly followed the traditional Chinese archery basic technical system, including 9 core components: stance, nocking the arrow, hooking the string, raising the bow, drawing the bow, anchoring, aiming, releasing, and following through. Teaching was implemented by the same group of experienced coaches to ensure uniform teaching standards.

Data collection indicators included technical action quality, skill stability, physical fitness level, psychological state, and injury incidence rate. Technical action quality was analyzed through a high-speed motion capture system (sampling frequency of 100Hz) to examine key kinematic parameters, such as the center of gravity deviation in stance, scapular retraction angle during drawing, and bow stability at the moment of release. Skill stability was evaluated using the standard deviation of scores in a set of 12 arrows. Physical fitness level was assessed through latissimus dorsi endurance tests, shoulder muscle strength tests, and core stability evaluations. Psychological state was quantitatively scored using the Sport Motivation Scale (SMS) and the Flow State Scale (FSS). Participants' physical discomfort and injury conditions were recorded weekly. All data were analyzed using SPSS 26.0 statistical software. Between-group comparisons were conducted using one-way analysis of variance (ANOVA), while within-group comparisons at different time points were performed using repeated-measures ANOVA, with $P<0.05$ indicating statistical significance.

4.2 Research Results and Data Analysis

4.2.1 Comparison of Technical Action Quality

After 12 weeks of training, the key technical action parameters of all three groups improved significantly

compared to the pre-training levels ($P < 0.01$). However, there were noticeable differences among the groups. Group A had a center of gravity deviation in stance of (2.1 ± 0.3) cm, significantly lower than Group B's (3.5 ± 0.5) cm ($P < 0.01$) and slightly lower than Group C's (2.3 ± 0.4) cm ($P > 0.05$). The scapular retraction angle compliance rate was 89.2% for Group A and 91.5% for Group C, both significantly higher than Group B's 67.8% ($P < 0.01$). There was no significant difference between Group A and Group C in bow stability at the moment of release ($P > 0.05$), but both were better than Group B ($P < 0.05$). The results indicate that high-frequency short-duration training and hybrid training are more advantageous in refining technical actions, while low-frequency long-duration training shows limited improvement in action standardization.

4.2.2 Changes in Skill Stability and Physical Fitness Level

In terms of skill stability, Group A had a standard deviation of scores in a set of 12 arrows of (3.2 ± 0.8) , and Group C had (2.9 ± 0.7) , both significantly lower than Group B's (5.1 ± 1.2) ($P < 0.01$), with Group C slightly better than Group A ($P > 0.05$). Physical fitness tests showed that the improvements in latissimus dorsi endurance and shoulder muscle strength were significantly higher in Groups A and C than in Group B ($P < 0.05$). Group C had the highest core stability score (86.3 ± 4.2) , significantly better than Group A (81.5 ± 3.8) and Group B (72.6 ± 4.5) ($P < 0.01$). This result suggests that high-frequency training can effectively enhance muscle endurance and strength, while the integration component in hybrid training further strengthens body coordination and core control, thereby improving skill stability.

4.2.3 Psychological State and Injury Incidence Rate Statistics

Psychological state scores showed that Group A and Group C had higher scores on the Sport Motivation Scale, with (68.5 ± 5.3) and (72.8 ± 4.9) respectively, significantly higher than Group B's (56.3 ± 6.1) ($P < 0.01$). Group C had the highest Flow State Scale score (75.2 ± 4.6) , significantly better than Group A (69.3 ± 5.1) ($P < 0.05$). In terms of injury incidence rate, Group B had a total of 8 injuries, including 3 cases of rotator cuff tendinopathy, 2 cases of archer's elbow, and 3 cases of lumbar strain, with an injury rate of 40%. Group A had 2 cases of mild shoulder discomfort, with an incidence rate of 10%. Group C had only 1 case of mild lumbar soreness, with an incidence rate of 5%. The results indicate that high-frequency short-duration training and hybrid training can effectively maintain learners' intrinsic motivation and reduce the risk of injury, with hybrid training showing the best performance in psychological immersion and safety.

4.3 Discussion of Results and Mechanism Explanation

The empirical results of this study are highly consistent with the theories of motor skill learning and neural plasticity principles. High-frequency short-duration training, through regular stimulation four times a week, continuously strengthens the neural pathways between the cerebellum, basal ganglia, and sensorimotor cortex, promoting myelination and making the neural encoding of technical actions more efficient. This is the core mechanism for the rapid improvement of technical action quality and physical fitness level in Group A. Meanwhile, the 60-minute short-duration training effectively avoids muscle overfatigue, reduces the solidification of incorrect movements, and lowers the risk of injury, consistent

with the conclusion by Dail and Christina (2004) that "spaced practice is superior to massed practice." The hybrid training group had the best overall performance, mainly due to the synergistic effect of "high-frequency basic training + regular integrated training." High-frequency basic training achieved the automation of technical actions, freeing up cognitive resources, while the integrated training every two weeks, by simulating fatigue and stress situations, trained learners' adaptive application of automated skills and promoted the integration of "technique" and "philosophy." Moreover, the etiquette archery and cultural immersion components in the integrated training enhanced learners' psychological immersion and intrinsic motivation, in line with Wulf and Lewthwaite's (2016) emphasis on the "promotive effect of motivation on skill acquisition."

The low-frequency long-duration training group performed poorly, mainly due to two key issues: First, the training interval exceeded 72 hours, leading to significant decay of skill memory traces, requiring 20-30% of the training time to review previously learned content, which reduced the efficiency of new skill acquisition. Second, long-duration training caused muscle fatigue, leading to excessive involvement of compensatory muscle groups, forming incorrect movement patterns, and triggering "maladaptive plasticity," consistent with the research conclusions by Dayan and Cohen (2011). Additionally, the psychological fatigue caused by long-duration repetitive training reduced learners' motivation levels, further affecting learning outcomes.

It is worth noting that the hybrid training group had the lowest injury incidence rate, not only due to the progressive strengthening of muscles and tendons by high-frequency short-duration training but also closely related to the targeted physical fitness training and posture stability exercises in the integrated training. The improvement in core stability effectively dispersed the pressure on the shoulders and waist, reducing the excessive load on local tissues and providing a safety guarantee for skill acquisition.

5. Cultural Integration and Innovative Practice in Traditional Chinese Archery Training

Traditional Chinese archery, as a "living heritage" carrying thousands of years of cultural genes, is not only a process of technical acquisition but also a process of cultural inheritance, personality shaping, and mental and physical cultivation. In the contemporary educational context, mere technical training can no longer meet learners' needs for cultural depth, practical experience, and personalized development. Based on the theoretical analysis and empirical research in the previous chapters, this chapter constructs a modernized system for traditional Chinese archery training from three dimensions: pathways for cultural integration, innovation in training models, and optimization of teaching practice, to achieve an organic unity of technical refinement and cultural inheritance.

5.1 Pathways for Cultural Integration in Training: From Formal Imitation to Spiritual Internalization

The cultural connotations of traditional Chinese archery are not isolated elements added to the technique but the core soul that permeates the entire training process. To achieve a deep integration of culture and training, it is necessary to break through the superficial model of "emphasizing technique over culture" and build a three-level integration path of "form - connotation - spirit," allowing learners to experience

culture in technical practice and improve their skills in cultural immersion.

5.1.1 Routine Integration of Ritual Culture

Rituals are the visible carriers of traditional Chinese archery culture. The "Book of Rites" explicitly states that "archery is the way of benevolence. Archery seeks to correct oneself first, and then to shoot," closely linking archery rituals with moral cultivation. To integrate ritual culture into training, it is necessary to avoid mechanical imitation and achieve a natural connection between rituals and techniques. Before training, learners are organized to perform the rituals of "washing hands, tidying clothes, and paying respects," cultivating a sense of reverence through standardized actions. Before nocking the arrow, the principle of "raising the bow as if holding a baby, nocking the arrow as if welcoming a guest" is practiced, integrating humility and solemnity into the technical preparation stage. After training, a "review and pay respects" session is conducted, where learners pay respects to each other, reflect on the gains and losses of the training, and practice the philosophy of "if the shot misses, seek the reason within oneself."

Coaches need to provide cultural explanations during ritual practice. For example, when explaining "be respectful when ascending the steps, be modest when descending," they can combine it with the Confucian "Doctrine of the Mean" to explain the self-cultivation concept behind the rituals. When demonstrating the stance in the "archery ritual," they can relate it to the cultural connotation of "uprightness within and without," helping learners understand the unity of technical actions and personal cultivation. Through routine ritual practice, culture is transformed from an abstract concept into perceptible and actionable behavioral norms, achieving the training goal of "cultivating people through rituals."

5.1.2 In-depth Penetration of Philosophical Thought

The philosophical core of traditional Chinese archery is embodied in the three major concepts of "unity of heaven and man," "unity of body and mind," and "unity of knowledge and action," which provide deep guidance for technical training. To integrate philosophical thought into training, it is necessary to transform abstract theories into specific training principles and practical methods. The concept of "unity of heaven and man" requires learners to follow natural laws and pay attention to environmental changes during training, such as adjusting stance and aiming strategies according to wind direction and light, cultivating the ability to "go with the flow." At the same time, it emphasizes the harmony between the body and nature, avoiding muscle stiffness caused by excessive force, and pursuing the state of "bow and person as one."

The concept of "unity of body and mind" emphasizes the coordination of actions and consciousness. During training, it is necessary to guide learners to focus on their own perception and avoid distractions from irrelevant thoughts. For example, during the drawing phase, learners are encouraged to feel the coordination between breathing and the rhythm of drawing, raising the bow when inhaling and drawing when exhaling, achieving muscle relaxation and concentration through breathing regulation. At the moment of release, the state of "acting without intention" is emphasized, discarding the utilitarian desire to pursue a high score, and letting the technical actions flow naturally. Coaches can combine the Taoist

concept of "governing by non-action" to explain the technical essence of "aiming with intention, releasing without intention," helping learners break through the technical bottleneck of "over-control."

The concept of "unity of knowledge and action" requires combining technical learning with practical application and moral cultivation. During training, by simulating ancient archery scenes (such as the village archery ceremony and the grand archery ceremony), learners can understand the social functions and cultural values of archery in practice. Learners are encouraged to transfer the qualities of concentration, perseverance, and self-discipline cultivated during training to daily life, achieving the ultimate goal of "cultivating virtue through archery." For example, when facing training bottlenecks, learners are guided to persist in practice with the spirit of "perseverance," while reflecting on their own shortcomings, achieving "mutual promotion of knowledge and action."

5.1.3 Contextual Reconstruction of Historical Context

The development of traditional Chinese archery carries a wealth of historical and cultural information. Integrating historical context into training can enhance learners' sense of cultural identity and mission of inheritance. During training, methods such as "historical scene reconstruction" and "analysis of classic cases" can be used to let learners touch history and feel tradition. For example, when explaining the Mongolian hooking technique, the historical background of the development of archery culture in the Yuan Dynasty is combined to explain the historical origin and regional characteristics of the technique. When practicing "ritual archery," the process and equipment of ancient archery ceremonies are restored to let learners experience the cultural atmosphere of "ancient archery."

In addition, stories of famous archers in history can be introduced. For example, the anecdote of Confucius "shooting in the garden of Ju Xiang, with spectators like a wall" can be used to show the cultural status of archery in ancient times. The connection between Yue Fei's "loyalty to the country" and archery training can be told to convey the national sentiment of "defending the country through archery." Through the contextual reconstruction of historical context, training is no longer a mere repetition of techniques but a cross-temporal cultural dialogue. Learners not only master the techniques but also become inheritors and disseminators of traditional culture.

5.2 Contemporary Innovation of Training Models: From Singular Repetition to Diverse Synergy

Based on the research on different training frequencies in the previous chapters and considering the needs and characteristics of contemporary learners, it is necessary to break through the traditional "master-apprentice" training model and build an integrated training model of "technical training + physical training + psychological training + cultural training" to achieve comprehensive development in skills, physical fitness, psychology, and culture.

5.2.1 Refinement and Personalization of Technical Training

The core of innovation in technical training lies in "refinement" and "personalization," avoiding homogeneous repetitive practice. In terms of refinement, modern technological means are employed to enhance the precision of training. Motion capture systems are used to analyze learners' movement trajectories, identifying subtle technical deviations such as center of gravity deviation in stance and

abnormal muscle coordination during drawing. Electromyography (EMG) devices monitor muscle activation patterns to help learners optimize their muscle usage and reduce unnecessary expenditure. Pressure sensors analyze the grip strength on the bow and finger pressure distribution at the moment of release to achieve "precise force application."

Coaches develop personalized training programs based on technological monitoring data. For visual learners, guidance is provided through video playback and action demonstrations. For kinesthetic learners, a combination of "decomposition practice + integration practice" is used to reinforce muscle memory. For younger or less coordinated learners, technical actions are gamified, such as designing "stance stability challenges" and "release accuracy quests," to increase engagement. Meanwhile, the training content is dynamically adjusted according to learners' technical levels. The beginner stage focuses on standardizing basic movements, the intermediate stage emphasizes skill stability and flexibility, and the advanced stage highlights personalized and artistic expression of techniques.

5.2.2 Targeted and Systematic Physical Training

Physical fitness is the foundation for the performance of traditional Chinese archery techniques. The traditional tendency of "emphasizing technique over physical fitness" often limits learners' technical improvement and may even lead to injuries. Contemporary training models need to build a targeted and systematic physical training system, focusing on physical qualities closely related to archery techniques. Core stability training is the key to physical training. As the "support hub" of the body, the core muscles directly affect stance stability and movement coordination. Training content includes a combination of static and dynamic exercises such as plank, glute bridge, and bird dog, scheduled 2-3 times a week for 30 minutes each session, gradually enhancing the endurance and control of the core muscles. The shoulder and back muscles are the primary force-generating areas for archery and need targeted training to increase strength and endurance. Resistance band exercises can be used to strengthen the contraction of the rhomboid and latissimus dorsi muscles, while dumbbell lateral raises can improve the stability of the deltoid muscles, avoiding over-reliance on arm muscles for force generation.

In addition, flexibility and balance training are essential. Flexibility training focuses on key joints such as the shoulders, waist, and wrists, combining static and dynamic stretching to increase joint range of motion and reduce the risk of sports injuries. Balance training can be conducted through exercises like single-leg standing and balance pad practice to improve stability during dynamic movements, ensuring precise execution of technical actions. Physical training needs to be organically integrated with technical training, avoiding isolated practice. For example, a 15-minute targeted warm-up before technical training and a 10-minute relaxation stretch after training can achieve coordinated development of physical fitness and technique.

5.2.3 Normalization and Scientification of Psychological Training

Traditional Chinese archery has extremely high requirements for psychological state. "If the mind is not calm, the arrow will not be accurate." Psychological factors often become the key variables affecting technical performance. Contemporary training models need to normalize and scientify psychological

training to help learners develop stable psychological qualities to cope with various challenges in training and competition.

Mental imagery training is one of the core methods. Based on Jeannerod's (2001) research conclusions, 5-10 minutes of mental rehearsal is arranged daily, allowing learners to vividly imagine the entire shooting sequence from a first-person perspective, focusing on the kinesthetic feelings and details of the movements. For example, imagining the sensation of the feet against the ground in stance, the contraction of the back muscles during drawing, and the relaxation of the fingers at release, mental simulation can strengthen neural pathways and improve the proficiency and stability of the technique. Meanwhile, mindfulness training is integrated to guide learners to focus on their current physical sensations and breathing rhythm, discarding distractions and cultivating concentration.

Stress coping training needs to simulate real competition scenarios. By setting up "timed shooting," "shooting under public observation," and "win-lose reward mechanisms," moderate psychological pressure is created, allowing learners to practice maintaining technical integrity under pressure. Coaches need to guide learners to use positive self-suggestion and emotional regulation methods to cope with stress, such as silently repeating "I am ready, my movements are natural and smooth" before shooting and relieving nervousness through deep breathing. In addition, regular psychological exchange activities are conducted, allowing learners to share their psychological confusion in training and receive targeted guidance from coaches to help them build confident and resilient psychological states.

5.2.4 Experiential and Lifelike Cultural Training

The innovation of cultural training lies in breaking the singular mode of "classroom lectures" and integrating culture into daily training through experiential and lifelike methods. In terms of experiential training, learners are organized to participate in traditional archery cultural activities, such as visiting archery museums, watching ancient archery ritual performances, and attending intangible cultural heritage inheritors' lectures, to enhance cultural perception. "Cultural theme training weeks" are also held, such as "Ritual Archery Culture Week" and "Ancient Archery Weapon Culture Week," designing training content and cultural practices around the theme to deepen cultural understanding.

In terms of lifelike training, learners are encouraged to integrate traditional archery culture into daily life. For example, they can practice the concept of "cultivating virtue through archery," maintaining humility and self-discipline in life; apply the concentration cultivated in training to study and work; and share traditional archery culture through social media to raise awareness and interest in this intangible cultural heritage. Meanwhile, the integration of traditional archery culture with modern life is promoted, such as designing cultural and creative products incorporating traditional archery elements, conducting parent-child archery experience activities, and holding campus archery festivals, to bring new vitality to the culture in contemporary life.

5.3 Optimization Strategies for Teaching Practice: From Experience-Dominated to Science-Empowered

Traditional Chinese archery teaching has long relied on the personal experience of coaches, resulting in inconsistent teaching outcomes. Contemporary teaching practice needs to be guided by scientific theories

and combined with empirical research results to systematically optimize teaching objectives, methods, and evaluation from three dimensions, thereby constructing a scientific, efficient, and sustainable teaching system.

5.3.1 Hierarchical Construction of Teaching Objectives

The optimization of teaching objectives needs to break through the limitation of "single technical goals" and build a hierarchical system of "technical goals + physical goals + psychological goals + cultural goals" to balance short-term improvement and long-term development. The beginner stage (Weeks 1-4) focuses on the standardization of basic techniques and the cultivation of interest. Technical goals concentrate on the correctness of basic movements such as stance, nocking the arrow, and hooking the string. Physical goals emphasize the enhancement of core stability and foundational strength of shoulder muscles. Psychological goals aim to develop initial concentration and learning interest. Cultural goals involve understanding the basic etiquette and historical overview of traditional archery.

The intermediate stage (Weeks 5-8) emphasizes skill stability and cultural understanding. Technical goals reinforce the coordination and consistency of key movements such as drawing the bow, anchoring, and releasing. Physical goals focus on improving muscle endurance and balance. Psychological goals aim to cultivate resilience and self-regulation. Cultural goals involve a deeper understanding of the etiquette and philosophical ideas of traditional archery.

The advanced stage (Weeks 9-12) targets skill personalization and cultural internalization. Technical goals aim to develop a personalized archery style. Physical goals achieve a comprehensive and balanced development of strength, endurance, and flexibility. Psychological goals reach the state of "unity of mind and action." Cultural goals involve internalizing traditional archery culture as personal character and lifestyle. The hierarchical teaching objectives provide a clear direction for teaching practice, ensuring a gradual and targeted teaching process.

5.3.2 Diversified Integration of Teaching Methods

The optimization of teaching methods needs to discard the "rote teaching" approach and adopt diversified teaching methods to meet the needs of different learners. The demonstration and explanation method should focus on "accurate demonstration + easy-to-understand explanation." Coaches demonstrate from multiple angles (front, side, back) and combine slow-motion video playback to allow learners to clearly observe technical details. Explanations should avoid jargon and use simple metaphors such as "drawing the bow like stretching a rubber band, applying even force without stiffness" to help learners grasp the technical essentials.

Situational teaching creates real cultural and competitive contexts to enhance immersion and practicality. For example, when teaching "ritual archery," the ancient shooting ritual's venue layout and costumes are recreated to let learners experience the etiquette process. In the skill improvement stage, small competitions are organized to simulate the pressure of real competitions, allowing learners to enhance their skill application abilities in practice.

Feedback teaching is key to improving teaching effectiveness. Coaches should combine "immediate

feedback + delayed feedback" and "positive feedback + constructive feedback." Immediate feedback corrects obvious technical errors, such as promptly reminding learners to adjust their stance if it is off. Delayed feedback guides self-reflection, such as allowing learners to summarize their performance after a set of shots before the coach provides comments. Positive feedback reinforces correct actions, such as "Your finger relaxation during release was spot on this time; keep it up." Constructive feedback points out areas for improvement, such as "Your scapular retraction during drawing was insufficient; try to feel the back muscles' engagement next time."

Additionally, cooperative learning can be introduced, dividing learners into groups to foster teamwork through mutual observation, error correction, and joint progress. Personalized teaching methods can also be adopted, tailoring training plans and strategies based on learners' age, gender, learning style, and physical condition to achieve "teaching according to individual aptitude."

5.3.3 Comprehensive Implementation of Teaching Evaluation

The optimization of teaching evaluation needs to break through the "single result evaluation" model and build a comprehensive evaluation system combining "process evaluation + result evaluation" and "quantitative evaluation + qualitative evaluation" to objectively reflect learners' overall development levels. Process evaluation focuses on performance during training, including the improvement of technical movements, training attitude, participation, and cultural practice. Information is collected through coaches' observations, learners' self-reports, and group peer evaluations, with a weekly summary evaluation to identify issues and adjust teaching strategies promptly.

Result evaluation focuses on comprehensive outcomes at the end of the training period. Quantitative evaluation includes key technical parameters (such as center of gravity deviation and release stability), skill test scores (such as the average score and standard deviation of a set of 12 arrows), physical test data, and psychological scale scores. Qualitative evaluation includes the degree of cultural understanding, etiquette practice, and learning reflections, conducted through interviews and learning portfolio analysis. The application of evaluation results should emphasize "incentive + developmental" approaches. Evaluation should affirm learners' progress to boost confidence while analyzing shortcomings to provide personalized suggestions for future training. For example, for learners with standardized technical movements but insufficient physical fitness, targeted physical training is recommended. For those with excellent skills but shallow cultural understanding, relevant cultural books and activities are suggested. Comprehensive teaching evaluation not only objectively reflects teaching effectiveness but also provides a scientific basis for teaching optimization, promoting the improvement of both teaching and learning.

6. Conclusion

The cultural integration and practical innovation of traditional Chinese archery training are key to the living inheritance of this intangible cultural heritage. By following the cultural integration path of "form - connotation - spirit," learners can experience the cultural charm during technical training and achieve "cultivating virtue through archery." The diversified and coordinated training model of "technology +

physical fitness + psychology + culture" promotes learners' comprehensive development. The optimization of hierarchical teaching objectives, diversified teaching methods, and comprehensive teaching evaluation enhances the scientificity and effectiveness of teaching.

In the contemporary social context, traditional Chinese archery training needs to maintain its cultural roots, inherit its core techniques and cultural connotations, and keep pace with the times to meet the needs and characteristics of modern learners. By empowering with technology and innovating methods, this ancient cultural heritage can be revitalized. In the future, further exploration is needed to integrate traditional archery with modern education and the sports industry, promoting the wider dissemination and inheritance of traditional archery culture. This will enable more people to achieve harmonious physical and mental development through archery training and experience the profound charm of Chinese excellent traditional culture.

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