# Technical Analysis and Development of Single Bamboo Drifting from the Perspective of Education and Psychology

**Youji Wang[1]***

**Abstract**

Surprisingly, single bamboo drifting (SBD), which originated from indigenous boating in southwestern China, has evolved into a new and captivating sport. This research focuses on the competitive aspect of SBD, examining the oar-rowing strategies and techniques through which top athletes achieve success. The study aims to provide evidence-based training advice for participants by analysing the performance of five athletes selected based on their results in a 60-meter straight track event. Research methods include literature review, observation, video analysis, and statistical mathematics. The Dartfish sports technique video analysis system is employed to scrutinize precise movements and compare them to evaluate pole-rowing techniques. Findings indicate that athletes' positioning on the bamboo, the angle of pole entry into the water, rowing power and speed management, and bamboo direction control are crucial technical aspects affecting competitive outcomes. Correct posture and efficient pole-rowing techniques minimize water drag and enhance bamboo velocity. Effective force management ensures bamboo stability and rowing efficiency. Yawing phenomena during competition disrupt rowing rhythm and stability, hindering performance. The study conducts a comparative analysis of the pole-rowing tactics of three athletes, identifying differences in movement intricacies and effectiveness throughout the rowing cycle. The findings provide a scientific foundation for future training, offering specific recommendations such as using advanced technology for technical monitoring, enhancing physical training for better rowing efficiency, and practicing direction control under various conditions. These guidelines aim to help athletes optimize their techniques and improve competition performance. This research not only provides theoretical support for technical training in SBD but also offers practical instructions for the sport's scientific advancement and broader adoption.

**Keywords:** Single Bamboo Drifting, Pole-Rowing Technique, Technical Analysis.

## Introduction

The leisurely activity of riding a bamboo raft, colloquially known as the "dude bamboo boat" and technically referred to as "drawing bamboo poles," was historically a picturesque pastime in the Chishui River basin. This folk craft from northern Guizhou is both culturally rich and historically significant, reflecting a deep-seated tradition (Gong et al., 2023; Jianzhuo et al., 2019). Initially employed solely for navigating steep river waters, this practice has evolved into a traditional recreational activity. Over time, it has become a popular sport, characterized by bamboo rafts with obtuse angles and uneven surfaces, which test athletes' balancing skills and illustrate the harmonious relationship between human ingenuity and the natural environment. Originally a local tradition, single bamboo drifting (SBD) has gained recognition as an exhilarating sport, renowned for its breath-taking qualities.

In contemporary sports, the bamboo sweep style has undergone significant transformation from its early origins to the present day. This evolution encompasses not only the historical trajectory of the activity but also the integration of modern elements, such as standardized rules and scientific advancements. Recent modifications to the SBD activity have enhanced its competitiveness and entertainment value, attracting increasing numbers of participants and spectators. As a result, bamboo-based floating has enriched both local and international cultural environments, earning recognition as part of China's Intangible Cultural Heritage. Domestically, bamboo drifting is now regarded as an ethnic traditional sport and is featured in the National Ethnic Traditional Sports Games, making it a prominent representation of national culture and sportsmanship. Internationally, this traditional Chinese sport, characterized by its unique cultural essence, has garnered growing attention from global sports organizations, reflecting its rising prominence on the international stage.

Despite some progress in the competitive aspect of SBD, extensive scientific research in this field remains limited. Current studies predominantly address the historical and cultural dimensions of the sport, the evolution of competitive regulations, and the instruction of fundamental

[1]International College, Krirk University Bangkok, 10220, Thailand. ORCID iD: https://orcid.org/0000-0002-2573-3943,
Email: hcxywyj@163.com
*Correspondence: hcxywyj@163.com

practices. However, there is a notable deficiency in the comprehensive analysis of athletes' technical movements, training methodologies, and competitive strategies. Specifically, the fundamental aspect of stroke technique lacks organized studies to offer guidance for athletes' training and improve their performance in competitions (CHI et al., 2020; Morris et al., 2013).

The objective of this study is to analyse the stroke techniques of elite SBD athletes to identify the primary factors influencing competitive success. Additionally, this research aims to offer scientifically based training recommendations. The study recruited three national champion athletes as participants and utilized the Dartfish technical analysis system to meticulously observe and perform quantitative statistical analysis on their stroke mechanics. This research seeks to provide both theoretical support and practical recommendations to enhance the technical training and competitive performance of SBD athletes.

**Technical Analysis**: Begin by mastering the existing SBD technique, which is rooted in martial arts disciplines such as Tai Chi and Wushu.

**Breakdown of Movements:** Evaluate each aspect of the SBD technique, including initial positioning (facing the bamboo), balance, posture, hand positioning, and footwork.

**Understanding Physics:** The physical principles underlying the balance and movement of SBD, including centre of gravity, momentum, and equilibrium.

**Trial and Error:** Test various versions and adjust details to enhance customer stability and effectiveness.

**Observation**: Observe the experts in action and analyse their techniques to understand the nuances that contribute to their high level of performance.

## Educational Perspective

**Breaking Down Complexities**: Decompose the technique into fundamental components that are relatively straightforward for learners to understand and implement.

**Progressive Learning:** A stepwise approach should be developed, beginning with the simplest concepts. This method will provide students with a solid foundation, enabling them to understand and refine basic skills before progressing to more complex aspects of the technique.

**Visual Aids:** Utilize visualization tools such as diagrams, videos, or animations to illustrate key points, including proper form and execution.

**Hands-On Practice:** Encourage students to engage in hands-on practice with frequent feedback and corrections to facilitate mastery of the technique.

**Peer Learning:** Implementing team-building activities and partner quizzes can foster collaboration and help individuals build a network within the group.

**Safety Precautions:** Begin with safety as a priority by teaching proper falling techniques and providing adequate padding as prerequisites for beginners.

**Cultural Context**: By implementing these practices, help students acquire the historical and cultural contexts that highlight the significance of this fighting style within the broader martial arts traditions.

Incorporating Philosophy: Integrate topics such as mindfulness, consistent training, and respect for instructors into the learning process to promote a holistic approach to martial arts education.

## Development Process

**Iterative Approach:** Facilitate the development of the method collaboratively by involving experienced practitioners and learners of all levels to identify areas for improvement.

**Adaptation:** Adapt the technique to the audience by tailoring it to the specific needs and capabilities of individuals, considering factors such as age, physical condition, and level of experience.

**Research-Based Practices:** Leverage research in motor learning and skill acquisition to develop instructional methods and generalize them effectively to the learning process.

**Continuous Improvement:** Periodically update and incorporate new educational materials and teaching methods based on insights gained from previous experiences and observations.

## STEM Education Integration

High school students exploring potential career paths and college majors may find this project especially enlightening. Many students are unaware of the broad range of careers available in engineering and applied sciences. This project offers students the opportunity to manipulate boats to achieve optimal performance, presenting an open-ended research challenge with multiple solutions. This approach is likely to attract knowledge seekers, and competitive students will be enthusiastic about testing their boats against those of their peers. Students will acquire skills in measuring relevant properties of both liquid and solid materials, as well as observing and recording experimental data—skills that are emphasized in state and federal science and math academic standards. The inherently minimalist nature of the bamboo boat project aligns with state and national initiatives aimed at enhancing technology and engineering education. By challenging students to conceptualize, plan, and construct a boat with limited resources and minimal prior instruction, this project provides an excellent foundation for learning technological design and problem-solving. These skills are crucial for fostering the next generation of innovators and inventors.

The proposed bamboo floating project is designed for high school students, who are at a pivotal stage both environmentally and academically. This project is not merely an addition but a fundamental component of their educational experience. It primarily supports science and math education by providing practical applications. Through exploring how environmental factors affect the buoyancy of the bamboo boat, students will engage with real-world math applications, such as calculating volume displacement of water and determining geometric shapes to assess the area of the waterline and hull drag.

Technical analysis and development of SBD, from an educational perspective, involves examining the potential of bamboo-based technology and its applications in architecture. This study is conducted within an architectural design studio, particularly focused on architectural design technology during the 6th semester. The primary subject of this study is Structural and Construction, providing an opportunity to conduct an in-depth analysis of bamboo-structured technology and its architectural implementations. The studio's overarching theme is addressing community problems and challenges through architectural design, with a focus on real cases from rural communities across various regions in Indonesia. The study aims to explore how architectural design methodology can address local issues and produce buildings with high architectural value and low construction and maintenance costs.

## Curriculum Integration

The floating raft used for fishing in rivers has long captivated the curiosity of children, prompting questions such as "Why does it float?" This interest makes the single bamboo float an ideal introductory activity for practical and investigative learning in science and technology. By explaining the historical use of these floats and comparing them with modern floats and toys, teachers can facilitate a hands-on investigative activity. Students can create various rafts using classroom materials and then test them in a river or a nearby flowing water facility. This activity is particularly well-suited for upper primary school students.

## Science

In Brunei's primary science education, the emphasis is on imparting crucial knowledge, concepts, and investigative skills. The goal is to equip the next generation with scientific understanding, foster a positive attitude towards science, and build technological skills to manage future challenges. While this approach acknowledges the importance of scientific knowledge, it suggests that the method might not be optimal. At a young age, experiential learning is more effective, with knowledge and understanding developing as a result of hands-on experience. The objective is to establish a foundational approach that guides students towards future readiness by focusing on practical, experiential learning methods.

## Mathematics

The objective of our educational modules is to acquaint students with the extensive potential of bamboo as a sustainable building material and to stimulate their interest in incorporating it into their project work. While mathematics may not initially seem central to the use of bamboo, it is a critical component of the design process. We aim to demonstrate that the challenges associated with bamboo often differ significantly from those encountered with other materials. We will present a series of problems throughout the design and construction phases that will require students to apply and enhance their existing mathematical skills. This approach contrasts with traditional classroom mathematics and may challenge some of their preconceived notions about their abilities in the subject. The real-world context of these problems is intended to engage students who might be disinterested in abstract mathematics. Decision-making is crucial in real-world design scenarios, yet students often have limited practice in this area. We will incorporate decision-based tasks to help students understand the impact of their choices. Although expanding this into a computer-based simulation is beyond our current scope, all problems will be designed with a competitive element to encourage active participation from all team members.

## Engineering

A bamboo floating bridge exemplifies innovation and novelty. Constructing such a bridge integrates team problem-solving and interactive activities within engineering education. This project can be implemented as either a group or individual assessment and requires careful preparation. To foster creative and critical thinking, students will first design a blueprint for a bamboo floating bridge within a specified timeframe. Upon completion, they will present their designs, explaining their concepts to peers and instructors. Following the planning phase, students will proceed to the construction of their bamboo floating bridges. This hands-on activity is crucial for understanding engineering principles. During construction, students will document their work and rationalize their design choices. This process will help them identify and address problems, thereby developing problem-solving skills. After building their bridges, students will conduct tests to evaluate their bridges' buoyancy and load-bearing capacity. This testing phase adds a competitive element, as students will compare their bridges' performance in holding weight. The activity will conclude with a comprehensive analysis and evaluation of the construction process and the test results.

## Art and Design

Analysing the design method for the SBD Joint in comparison to traditional bamboo floating tools reveals distinct directional approaches in product design. The concept behind the SBD Joint aims to modernize and enhance the traditional fisherman's tool, transforming the classic bamboo float into a contemporary and efficient instrument. While this modern design represents a significant advancement, it retains the strength and tradition of the original tool. Fishermen often value traditional tools for their uniqueness and durability. The redesigned tool, while incorporating modern techniques, seeks to preserve these essential qualities. The design process involves technical analysis using current technology, including 3D modelling and Finite Element Analysis (FEA) simulations. The primary goal is to identify a superior alternative to existing products. Feedback from ten fishermen indicates that the redesigned bamboo float meets modern standards while remaining true to its traditional form and function. This positive reception suggests that the modernized tool is both practical and culturally acceptable. By integrating detailed technical analysis with effective learning strategies, it is possible to develop a comprehensive instructional course. This course will equip students with the knowledge needed to incorporate the SBD technique into their martial arts skillsets.

## The Effect of Psychology on Development of SBD

The development of SBD is significantly influenced by psychological factors operating at both individual and collective levels. The role of psychology in this context can be examined as follows:

**Motivation and Vision:** Psychology explores the underlying motivations driving individuals' actions. For SBD, the founders or developers may have been driven by goals such as sustainability, innovation, or cultural preservation. Examining these motivations offers valuable insights into the rationale behind the development of SBD and the conceptualization process.

**Creativity and Innovation:** Psychological research into creativity and innovation can illuminate the processes involved in developing concepts like SBD. Factors such as creative thinking, problem-solving abilities, and the capacity to think divergently are crucial psychological elements that contribute to innovation across fields such as architecture and engineering.

**Perception and Aesthetics:** The perception of beauty, aesthetics, and functionality is integral to architecture and design. Psychological research on aesthetics can guide the design of SBD structures, ensuring that they are both functionally effective and visually appealing.

**Social Influence and Collaboration:** The development of SBD likely involved collaboration among architects, engineers, environmentalists, and other stakeholders. Analysing social dynamics, communication patterns, and group decision-making processes can provide insights into how these collaborative efforts influenced the development of SBD.

**Environmental Psychology:** SBD, as a sustainable architectural concept, is closely related to environmental psychology. This branch of psychology examines how individuals interact with their built and natural environments. Insights into people's attitudes, behaviours, and perceptions regarding sustainability can guide the design and implementation of SBD projects.

**User Experience and Human-Centred Design:** Psychology enhances the design process by emphasizing the needs, preferences, and experiences of end-users. Applying human-centred design principles ensures that SBD structures are not only environmentally sustainable but also user-friendly, comfortable, and culturally relevant.

**Risk Perception and Decision-Making:** The development of SBD structures involves evaluating risks and making decisions under conditions of uncertainty. Psychology provides insights into how individuals perceive and assess risks, as well as their decision-making processes in uncertain situations. These psychological insights can inform effective risk management strategies during the planning and implementation phases of SBD projects.

## Role of Nervous System on Development of SBD

Although the nervous system might not appear directly related to the development of SBD, it plays a crucial role in several aspects:

**Sensory Perception:** The nervous system processes various types of sensory information, including visual, auditory, tactile, and proprioceptive inputs. Architects and designers involved in the development of SBD structures depend on these sensory perceptions to assess the environment where these structures will be constructed. For instance, considerations such as wind patterns, water currents, and sunlight exposure are crucial factors integrated into the design of SBD projects.

**Motor Control and Coordination:** Motor control, involving the coordination of muscles and movement, is essential in the construction and assembly of SBD structures. Engineers and builders require precise motor control to handle bamboo and other materials effectively, ensuring the structural integrity and stability of the completed project.

**Cognitive Function:** Cognitive processes, including attention, memory, and problem-solving, are critical during the planning and design phases of SBD development. Architects and engineers utilize these cognitive skills to envision, conceptualize, and address various aspects of SBD projects, encompassing structural design and sustainability considerations.

**Emotional Responses:** The nervous system regulates emotions and affective responses, which can impact decision-making and design choices in SBD development. Designers may aim to elicit specific emotional responses, such as tranquillity or awe, through the aesthetic and spatial qualities of SBD structures.

**Stress Response:** The development of SBD projects often entails challenges and stressors, such as budget constraints, technical difficulties, and regulatory hurdles. The nervous system's stress response mechanisms are crucial as individuals involved in SBD projects navigate these challenges, manage stress, and remain focused on achieving project objectives.

**Safety and Risk Management:** The nervous system is integral in assessing and responding to potential risks associated with the construction and use of SBD structures. Engineers and safety experts evaluate human factors such as perception, reaction times, and attentional capacity when designing SBD structures. This consideration ensures user safety and effectively mitigates risks.

**Environmental Adaptation:** The nervous system facilitates adaptation to environmental changes through sensory feedback, learning, and behavioural adjustments. Similarly, SBD structures must adapt to environmental factors such as fluctuations in water levels, erosion, or varying weather conditions. This necessitates continuous monitoring and adjustment mechanisms to maintain structural integrity and functionality.

Though the role of the nervous system in SBD development might not be immediately evident, its influence is pervasive. It affects how individuals perceive, interact with, and respond to the challenges and opportunities inherent in sustainable architectural innovation. The primary objective of this research is to explore the specific technical nuances and developmental trajectory of SBD techniques from a psychological perspective. The jing duan da bo, a fundamental skill derived from traditional martial arts, exemplifies the intricate balance between physical power, mental concentration, and emotional regulation. This study employs principles from cognitive psychology, behavioural analysis, and mindfulness to investigate the interplay between cognitive perception and physical movements during the execution of SBD techniques. By employing qualitative interviews, psychometric assessments, and empirical observations, the research delves into cognitive processes, emotional states, and psychological factors involved. The findings aim to enhance existing knowledge on psychological processes in sports training and offer practical recommendations for optimizing performance and maintaining personal well-being.

## Material and Methods

**Table 1**

*Details of Candidates*

| Candidate | The 11th National Democracy Games |
|---|---|
| 1 | Men's 60m, 100m and 200m straight racing champion |
| 2 | Women's 100m and 200m straight racing champion |
| 3 | Women's 60m straight racing championship |
| 4 | Men's 60m, 100m and 200m straight racing champion |
| 5 | Women's 100m and 200m straight racing champion |

We selected five outstanding athletes from our College's SBD Team, recognized for their exceptional paddling skills and championship victories in the National Democracy Games. A comprehensive analysis was conducted based on their performance in the 60-meter straight race during the SBD Trials at our College, using their participation as a case study.

## Methodology

Written or recorded information detailing a particular subject or process is crucial for understanding and instruction. For this research, we collected literature and resources on SBD Movement from the National Knowledge Infrastructure (CNKI) database, Google Scholar, and additional sources. We filtered the literature to focus on stroke technology, selecting authoritative, reputable, and relevant sources. The chosen materials were thoroughly examined and organized to provide comprehensive descriptions, analyses, and discussions on stroke technology. This process established a solid foundation for further in-depth study and understanding of the foundational concepts.

## Method of Observation

To gain insight into the practical application of stroke techniques, we visited the Drifting Training Base of our College. This on-site examination involved a detailed observation of athletes' training sessions, with a specific focus on the nuances of their stroke motions, strength, coordination, and other relevant factors. The analysis aimed to identify variations in stroke techniques among different athletes, providing a comprehensive understanding of individual differences and their impact on performance.

## Method for Analysing Videos

To ensure that regular athlete training continued while conducting research, we employed the Dartfish sports video analysis system to scrutinize the complete technical movements of exceptional single-bamboo rafting athletes. Our analysis focused on comparing and assessing the body posture of athletes during floating, as well as the angle at which the pole enters the water. We also examined the effects of technical factors, such as water entry depth and draw distance, on the speed of SBD. To evaluate these technical indicators effectively, we applied relevant theories from sports biomechanics.

This research approach employs a mixed-methods framework, integrating both qualitative and quantitative analyses to explore the psychosocial dimensions of the single-bamboo drifting technique. Qualitative data is gathered from various sources, including expert trainer tutorials, observations of training sessions, and historical instructional materials. Quantitative measures include advanced psychological tests that assess cognitive abilities, emotional intelligence, and mindfulness features among participants. Data triangulation and thematic analysis are utilized to identify prevalent features, themes, and relationships within the dataset.

## Statistics

Utilizing the SPSSAU online data analysis system, we conducted a comprehensive examination of the data acquired from the video analysis process. This analysis involved evaluating the angles of water entry and exit, as well as the forward movement of the body throughout various stroke cycles. Comparative assessments were made between the left and right sides of the same athlete, and across different athletes executing the same stroke on the same side. The investigation focused on discrepancies in speed and other performance metrics, leading to the identification of several significant findings and recommendations.

## Results and Analysis

Upon analysis, it has been established that the maximum weight capacity of a single bamboo float is 120 kilograms for an athlete. Generally, lighter athletes experience reduced resistance while moving forward on the bamboo float. However, insufficient body weight might also result in inadequate muscular power needed to propel the single bamboo drift effectively. Conversely, athletes with higher body weight may impose excessive pressure on the bamboo float, leading to increased resistance and diminished speed. Therefore, it is essential for athletes to achieve a harmonious coordination of their entire body to effectively apply force and execute stroke techniques.

The athlete's positioning on the bamboo float significantly affects their execution of sports skills and is a critical factor influencing the forward resistance of the float in water. To minimize water resistance, athletes should position themselves towards the rear of the central portion of the float. This positioning ensures that approximately two-thirds of the float's cross-sectional area remains above the water's surface. Athletes should adopt a stance with their feet oriented both forward and backward, ensuring that the arches of their feet are properly aligned with their torso to maintain stability. The distance between the feet should be approximately 1.5 times the width of the shoulders, with the toes angled inward. The front foot should form an angle of approximately 30 degrees with the bamboo float, while the rear foot should form an angle of around 45 degrees with the bamboo float (Li Guowei, 2020).

## Key Attributes of Stroke Methods Shown by Top Athletes

Elite athletes exhibit several common characteristics throughout the stroke process to optimize efficiency: maintaining a steady buoyant body posture, synchronizing stroke motions, and precisely controlling stroke force and velocity. Their exceptional performance is largely attributed to their superior physical conditioning and, more critically, their advanced paddling skills. Mastery of the stroke technique enables athletes to achieve rapid and consistent progress, resulting in outstanding outcomes. For illustrative purposes, a single stroke cycle can be segmented into four distinct phases: water entry, paddling, water departure, and aerial pole movement (see Figure 1).

***Figure 1:*** Sequential Stages of a Single Stroke Cycle Performed by an Individual Bamboo Rafting Athlete.

## Plunge into the Water

The athlete holds the pole with their hands positioned parallel and approximately twice shoulder-width apart. Upon water entry, athletes are required to adopt a forward-leaning posture, extend their hands as far forward as possible, and utilize a forward and backward motion of the lower limbs to optimize readiness for paddling. The torque and power generated during a stroke are influenced by the angle at which the stroke enters the water, as prescribed by principles of motion mechanics. To enhance the efficacy of the single bamboo float, athletes and coaches must carefully adjust the angle of water entry. When viewed from the front (see Figure 2), a larger water entry angle results in the entry point being closer to the bamboo drift, which leads to a deeper water entry depth of the paddle and generates greater torque, thereby improving paddling efficiency and increasing speed. Conversely, inconsistent water entry angles on both sides may cause yawing of the bamboo drift. Moreover, if the water entry point is too near the bamboo float, it increases resistance to forward motion. During the stroke's recovery phase, the paddle generates a force that displaces water, creating a low-pressure region. This low-pressure area induces a reverse flow of water, which provides counterforce against the buoyant object and impedes forward movement. Additionally, if the water entry point is too close to the body's centreline, the alignment of the athlete's feet may become too linear, weakening the support at the third point, thereby reducing body stability and adversely affecting stroke efficiency.

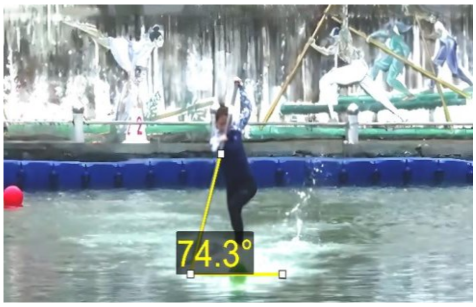


***Figure 2***: Athletes are Propelling Themselves Forward by Using a Paddle to Push Through the Water at a Certain Angle Known as The Stroke ***Angle***.

When the front stroke angle is less than 60 degrees, the depth of water penetration decreases, resulting in reduced resistance throughout the stroke. This condition also leads to a longer moment arm, which diminishes stroke efficiency if the athlete maintains the same level of effort (Chen Liyong, 2019). As the side angle of water entry increases (see Figure 3), the point of water entry shifts closer to the body. This alteration affects the stroke distance, decreasing its overall efficiency and necessitating greater physical exertion due to the need for frequent adjustments of the pole.

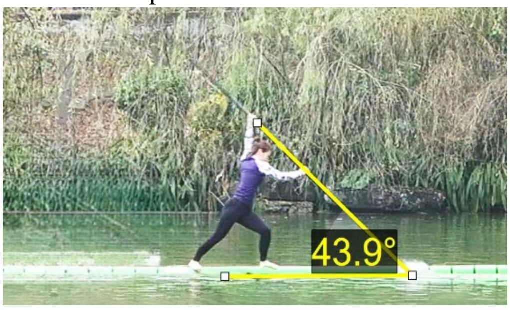


***Figure 3***: The Angle at Which the Athlete's Side Stroke Enters the Water.

An inadequate side angle of water entry causes water to splash significantly upon initial contact, which requires athletes to expend excessive physical energy to counteract the upward force experienced during the initial phase of the stroke. This additional energy expenditure disrupts the stroke rate and rhythm, thereby reducing overall stroke efficiency. Moreover, discrepancies in the water entry angles on either side of the paddle can lead to uneven stroke distances and, in extreme cases, cause the bamboo raft to yaw. Consequently, athletes must adjust the extent of their forward reach on the paddle according to specific conditions to optimize paddling efficiency.

## Stroke and Stroke

Stroking is a critical technical element in the sport of SBD. Athletes must ensure a consistent and fluid motion throughout the paddling process. According to the principles of sports biomechanics, the primary factors determining an effective stroke include strength, speed, coordination, and balance. The efficiency of paddling is closely related to the velocity of the bamboo float; thus, improvements in paddling efficiency are directly associated with increased forward speed of the bamboo float. A highly skilled athlete enters the water at a precise angle while gripping the rowing oar. The athlete assumes a forward-arching and back-pedalling stance, with a firm two-handed grip on the oar. The upper hand provides stability, while the lower hand drives the oar backward. Concurrently, the athlete pedals with their foot on the bamboo, causing the body's centre to move backward. The front leg remains straight, while the rear leg is slightly bent, executing the movement in a continuous, fluid motion to maximize stroke efficiency. Additionally, an excessively long stroke distance can affect the frequency of strokes during the competition.

Paddling requires maintaining dynamic equilibrium, with optimal physical fitness and advanced paddling techniques being crucial for stability and progress in the dynamic environment of both the paddle, the athlete, and the bamboo float. Athletes must consistently use the rowing oar for support to correct any deviations in the body's centre of gravity caused by vigorous paddling. Disruptions in stability can lead to movement errors and significantly reduce stroke effectiveness. Additionally, uneven force application and secondary stroke effects can cause the bamboo float to yaw, impacting the athlete's performance and strategic execution in subsequent phases of the game. To mitigate energy loss and prevent yaw, the paddle should be pulled as far back as possible in alignment with the bamboo float during the outward stroke.

To optimize paddling efficiency, it is essential to minimize both hydrodynamic and aerodynamic drag. For an athlete's weight, positioning on the bamboo float should ensure that two-thirds of the float head's cross-section remains submerged. While standing further from the float head can reduce strain on the float's cross-section, it simultaneously increases the float's overall weight, which can result in greater drag at the rear end without significant benefits. Considering wind resistance, with a wind force at level 0 and an athlete paddling at a speed of 3 meters per second, the wind resistance on the body's side will be less than that on the front. Therefore, to reduce drag, athletes should orient their bodies to minimize the time the front faces the wind.

## Swim Stroke

The recovery phase of the paddling motion is critical for seamlessly transitioning to the next stroke cycle. There is a notable correlation between the height of the paddle and the angle at which water exits the paddle. Specifically, as the height of the paddle increases, the angle of water exit also increases. Conversely, a decrease in paddle height results in a reduced exit angle. This relationship is essential for optimizing the efficiency of each stroke and ensuring effective progression in the paddling sequence. During the stroke process, a narrower angle of the stroke, as viewed from the side, results in increased pressure at the end of the stroke as the paddle exits the water. This heightened pressure causes a more significant splash, which in turn expends additional physical energy from the athlete. Moreover, the downward force transmitted from the paddle to the bamboo float through the athlete's body causes the end of the float to submerge, increasing water resistance and affecting the speed of the single bamboo float. Conversely, reducing the paddle height extends the length of the stroke immersed in the water, which, when combined with the athlete's power and balance, generates a more substantial propulsion.

## Aerial Manipulation

The mid-air pole shift represents the final stage of a single stroke cycle. Athletes must effectively manage this transition to prepare for the subsequent strokes. Exceptional single bamboo floaters demonstrate the ability to maintain bodily equilibrium and stability while manoeuvring the pole through the air, facilitating a seamless transition between strokes. This skill enhances both the consistency and velocity of the stroke, contributing to overall performance efficiency. Upon lifting the pole from the water, the motion of the pole begins as the athlete propels themselves out. During this phase, the athlete slightly elevates both hands while thrusting the lower hand diagonally forward. This action involves fully extending the arms and transitioning the upper hand to the lower hand. The athlete must effectively coordinate these movements in preparation for re-inserting the oar into the water and executing the subsequent stroke.

## Analysing the Impact of Stroke Styles Used by Professional Athletes

The Dartfish technical analysis program was employed to generate data on the stroke angles of three participants during the 60-meter straight race. All five athletes are right-handed. Huang adopts a position with his right foot forward (Table 2 and Figure 4). However, the correct stance for an athlete is to place the left foot forward. The initial two strokes were performed by positioning the front foot on the same side, as the athletes believed this alignment would better synchronize their body movements upon entering the water after receiving the starting instruction.

**Table 2**

*The Stroke Entrance Angles of 5 Highly Skilled Athletes Participating in the 60-Meter Competitive Unit: Academic Qualification*

| Athlete | Height C M | Weight K G | Front | | Side | | P Value |
|---|---|---|---|---|---|---|---|
| | | | Right | Left Side | Right | Left Side | |
| 1 | 174 | 63 | 70.87±2.43 | 71.89±2.58 | 44.54±2.34 | 43.21±2.32 | 0.02 |
| 2 | 164 | 61 | 69.98±2.48 | 68.03±2.47 | 40.21±3.37 | 37.79±2.22 | |
| 3 | 156 | 50 | 69.42±2.64 | 68.12±2.43 | 40.53±2.21 | 35.43±1.84 | |
| 4 | 166 | 62 | 70.57±2.88 | 69.03±2.82 | 41.12±2.58 | 42.76±1.77 | |
| 5 | 165 | 64 | 70.75±1.98 | 68.69±2.69 | 41.06±1.57 | 38.65±1.32 | |

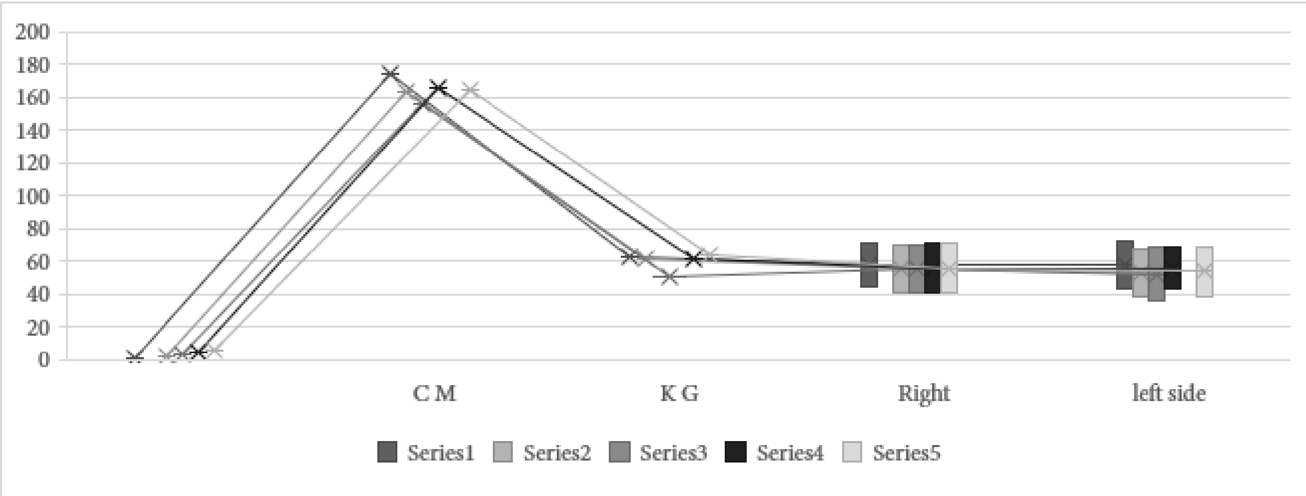


***Figure 4***: The stroke Entrance Angles of 5 Highly Skilled Athletes Participating in the 60-Meter Competitive Unit: Academic Qualification.

An analysis was performed on the water entry angles of the left and right sides of the paddle for three athletes. The results reveal no significant differences in the water entry angles between the front left and right sides, nor between the side left and right sides, for the same athlete. The data show statistical significance with a p-value of 0.02 (Table 3 and Figure 5). No notable differences were observed in the water entry angles between athletes on the left and right sides of the front. There is no variation in the angles of water entry on the right side of the paddle, and no substantial differences are found on the left side. Notably, Huang and Wei, who were only observed on the left side, exhibited a significant disparity in the water entry angle of the side rowing rod (P = 0.017), as indicated in Table 3.

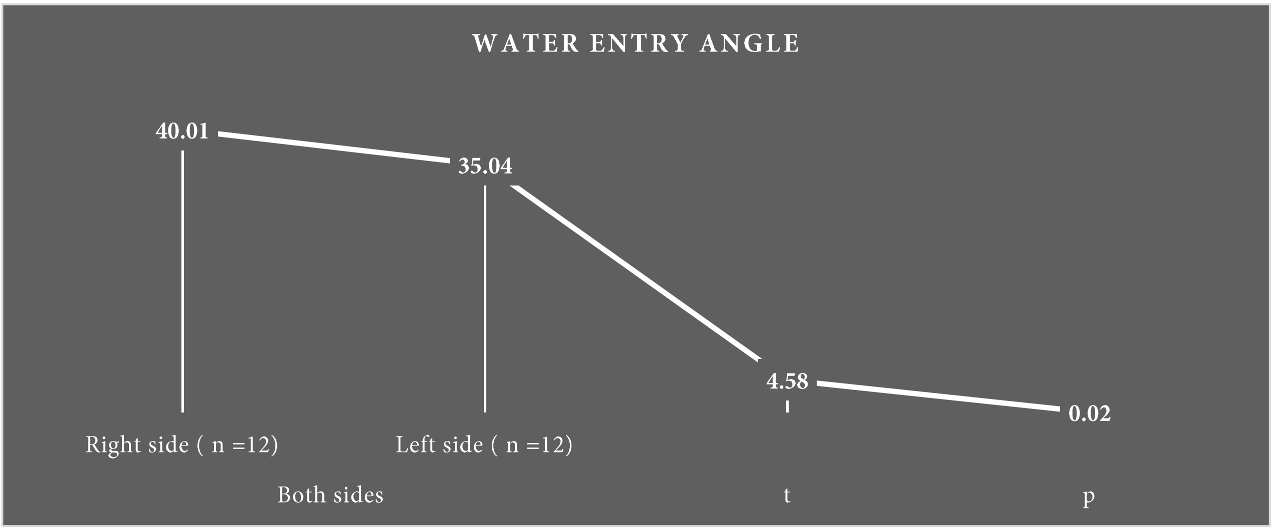


***Figure 5***: First Athlete Side Stroke Angle t Test Analysis Results.

**Table 3**

*First Athlete Side Stroke Angle t Test Analysis Results*

| | Both Sides | | *t* | *p* |
|---|---|---|---|---|
| | **Right Side (n =12)** | **Left Side (n =12)** | | |
| Water Entry Angle | 40.01±1.32 | 35.04±1.35 | 4.58 | 0.02 |

## Analysis of Frontal Angles

The heights of the three athletes vary; however, there is no significant difference in the water entry angles between the two sides when viewed from the front. The water entry angles on the left and right sides do not correlate with the athletes' heights. Larger average differences and standard deviations in water entry angles suggest that an athlete's body posture is not sufficiently stable during paddling. This instability forces the athlete to rely on the paddle for stabilization and force exertion. Uneven water entry angles result in inconsistent stroke depths, potentially causing the bamboo float's trajectory to skew towards the side with a lower entry angle. To maintain control and prevent swaying, the angle on the opposite side must be adjusted.

The force exerted during each stroke directly affects both stroke effectiveness and bamboo float velocity. Statistical analysis of water entry angles for the five athletes reveals that the first athlete had a slightly greater entry angle on the left side, while athletes two through five had somewhat larger angles on the right side. The high standard deviation in these angles is related to the athletes' positions or viewpoints on the bamboo raft. The first athlete places their right foot forward, using the left side for the inside stroke. Conversely, the second through fifth athletes position their left foot forward, utilizing the right side for the inside stroke. Additionally, variations in shoulder and hip joint flexibility, as well as core stability, contribute to these differences. A reduced water entry angle is observed in lateral strokes, with the inner stroke angle being slightly greater than the outer stroke angle. When these factors are not adequately addressed, yawing during competition can occur, as evidenced by the third athlete's inability to paddle effectively on the left side, resulting in exclusion from the top three positions (Table 4 and Figure 6).

**Table 4**

*The t-Test Analysis Findings for the Side Water Entrance Angle of the Paddle For the 2nd to 5th Athletes, Comparing the Entry Angle on the Left Side of Two Individuals Entering the Water.*

| | 2nd (n =12) | 3rd (n=12) | 4th(n=12) | 5th (n=12) | t | P |
|---|---|---|---|---|---|---|
| Water Entry Angle | 43.13±2.32 | 42.79±1.58 | 35.09±1.98 | 43.54±1.47 | 6.48 | 0.017 |


***Figure 6***: The t-Test Analysis Findings for the Side Water Entrance Angle of the Paddle for the 2nd to 5th Athletes, Comparing the Entry Angle on the Left Side of Two Individuals Entering the Water.

## Analysis of the Side Angle

The water entry angle of the stroke is influenced by the athlete's height, as observed from the side. Typically, the side angle of water entry is less than 45 degrees, determined by stroke length and the athlete's height. A taller athlete will experience a direct impact on the angle of water penetration due to their height. However, increased height poses challenges in maintaining bodily equilibrium. As the paddle enters the water, buoyancy gradually decreases from the start of the stroke until the paddle is perpendicular to the water surface. The athlete must counteract the upward force of the water, expending energy on compensatory efforts that can deplete physical strength. Additionally, significant discrepancies in water entry angles between the two sides of the stroke (Table 5 and Figure 7) may lead to yawing or reduced stroke efficiency, as the athlete must continuously adjust their heading.

**Table 5**

*The Disparity in the Mean Stroke Angles among the Three Top-Tier Competitors in the 60-Meter Competition Unit: Academic Qualification.*

| | Difference Between Left and Right Front | Difference Between Left and Right Sides |
|---|---|---|
| 1st | 1.81 | 0.95 |
| 2nd | 2.16 | 0.89 |
| 3rd | 1.80 | 5.02 |
| 4th | 1.79 | 0.89 |
| 5th | 1.82 | 0.58 |

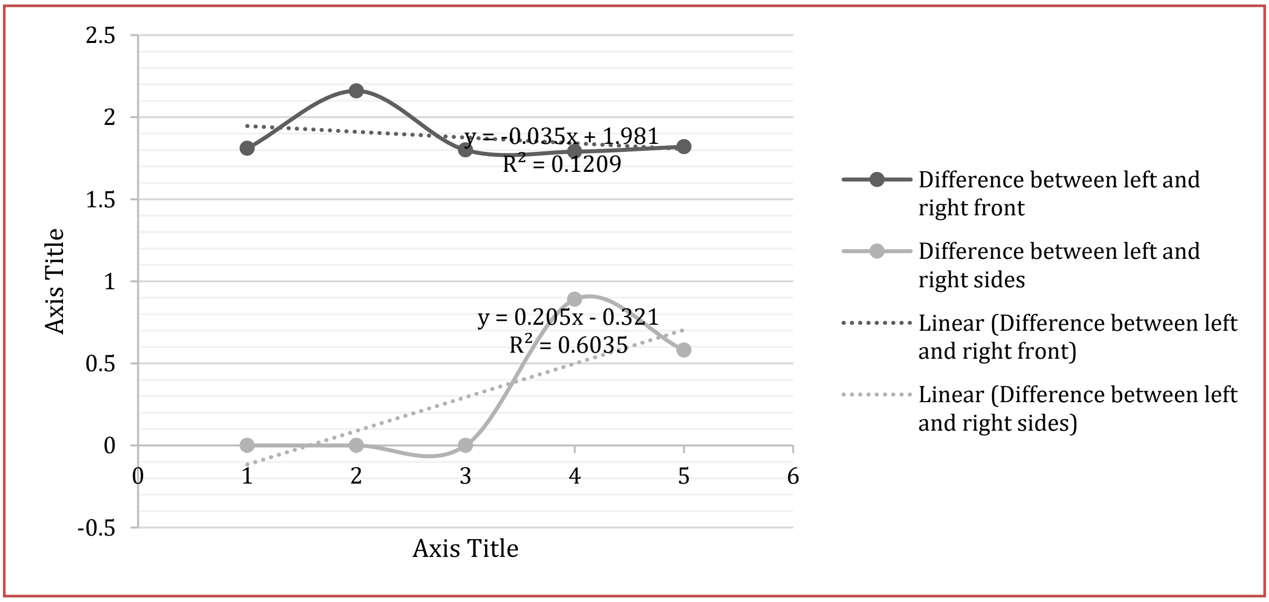


***Figure 7***: The disparity in the Mean Stroke Angles Among the Three Top-Tier Competitors in the 60-Meter Competition Unit: Academic Qualification.

## Regulation of Stroke Intensity and Velocity

Stroke force refers to the force applied by the athlete gripping the rowing oar to propel the bamboo raft forward. It is the sole propulsive force responsible for moving the bamboo raft. Discrepancies in paddling power on either side of the bamboo raft can cause yawing, negatively affecting the paddling rhythm and efficiency. In severe cases, this imbalance may result in lane infringement, leading to disqualification. Additionally, as demonstrated by vortex phenomena in fluid mechanics (Keren, 2023), significant splashing during a stroke disrupts water flow, creating vortices and turbulence. These disturbances generate drag and hinder the forward motion of the bamboo raft, with excessive splashing leading to energy loss and decreased propulsion. Therefore, minimizing splash is crucial. In the 60-meter straight race, the first athlete demonstrated consistent stroke effort and improved body stability throughout the stroke, effectively using the oar to counteract deflection and maintain body centre of gravity. In contrast, athletes two through five exhibited inadequate body stability while drifting. They made passive adjustments to their stroke focal point in the water to stabilize their centre of gravity, resulting in reduced stroke efficiency and adversely affecting their competition performance. All five exceptional athletes completed the 60-meter straight race with exactly 22 strokes each. Three individuals performed seven strokes over the course of their activity. Although the distance covered by each stroke did not show any noticeable variation, the time taken for each stroke differed, as shown in Table 6 and Figure 8. Consequently, an increase in the athlete's stroke force results in an increase in the speed of the bamboo float.

**Table 6**

*Statistical Data of 5 Exceptional Athletes' Individual Strokes in the 60-Meter Straight Race*

| | 7 Strokes | Single Time | Total Distance (Rice) | Total Time (Second) | Speed (m/s) |
|---|---|---|---|---|---|
| 1st | 2.88±0.41 | 1.11±0.05 | 21.06 | 7.53 | 2.69 |
| 2nd | 2.90±0.39 | 1.42±0.11 | 20.87 | 9.37 | 2.19 |
| 3rd | 2.87±0.21 | 1.51±0.12 | 21.04 | 10.09 | 1.98 |
| 4th | 2.91±0.43 | 1.40±0.13 | 20.98 | 10.45 | 1.97 |
| 5th | 2.86±0.33 | 1.49±0.15 | 20.78 | 10.87 | 1.95 |

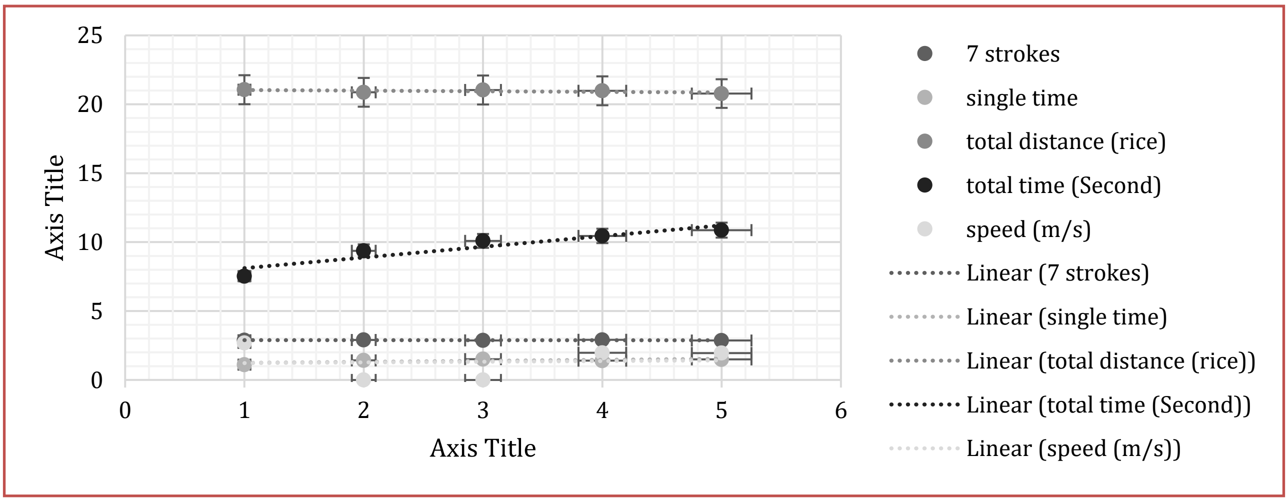


***Figure 8:*** Statistical Data of 5 Exceptional Athletes' Individual Strokes in the 60-Meter Straight Race.

It should be noted that increased penetration of the rowing rod into the water leads to greater resistance when rowing in the opposite direction. The magnitude of the water splash is inversely proportional to the disruption caused to the bamboo float's movement, with higher splash intensity resulting in more disturbance. Conversely, a more potent bamboo float will experience reduced disruption. Throughout the paddling process, all three competitors maintain a forward-arching position and exert force by pushing backward. Initially, they lower their centre of gravity and extend the stroke as it enters the water. Achieving a stable body posture enhances power output. Additionally, maintaining a regulated gap of 30-50 cm between the paddle and the bamboo float is crucial. The distance between the paddle and the bamboo float varies with athlete height, with a direct proportional relationship: as height increases, so does the distance. This relationship is adjusted based on individual height and flexibility. A stroke performed too close to the floating body may compromise the athlete's stability during force exertion.

When the paddle makes contact with the water, it is crucial to grip it firmly with both hands and promptly submerge it. As illustrated in Figure 9, the paddle should enter the water by moving from point A to point B. Once submerged, retract both hands horizontally from point B to point C. Create a fulcrum with the upper hand and use the lower hand to execute a backward stroke, facilitating a smooth shift of the body's centre of gravity backward. When the oar is positioned at an angle of approximately 45 degrees relative to the water surface, apply a diagonal upward force with both hands. Simultaneously, raise the oar diagonally with the lower hand while the upper hand exerts a downward force to effectuate a successful rod change. Point D signifies where the opposite end of the oar is prepared for re-entry into the water, aiming to minimize its size. The trajectory between points C (departure from the water) and D (re-entry into the water) results in a steeper gradient for segments A, B, and C D, while segments B and C exhibit greater stability. Maximizing power in a single stroke is essential, and the athletes could benefit from refining their stroke technique to enhance overall performance.

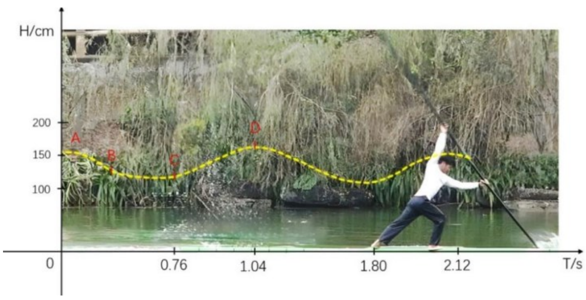


***Figure 9***: Illustrating the Trajectory of the Centre of Gravity for the First Athlete Throughout One Complete Cycle of Strokes on Both Sides.

## Management of Bamboo Drift Direction

The 60-meter sprint occurred on a man-made lake with calm, still water and mild wind conditions. Despite the calm environment, all three athletes experienced yawing during the competition, although none crossed into another lane. Several factors contribute to yawing of the bamboo float, including an unstable centre of gravity, uneven stroke strengths on either side, and varying stroke durations. These factors are significant and inevitably lead to yawing. Additionally, the inclination of the stroke, an often-overlooked aspect, also plays a crucial role in this phenomenon.

All three athletes employ an alternating left-right stroke technique. Viewed from the front, Cheng's technique resembles the "∞" character, sometimes referred to as the "8" glyph stroke technique (Figure 10). During the paddling motion, with the pole perpendicular to the ground, the upper hand exerts a diagonal upward force while the lower hand pulls upward. This occurs as the pole is close to the body. Subsequently, the pole is adjusted to initiate movement towards the opposite side. When the paddle is perpendicular to the water surface, one side penetrates the water, causing it to spread outward. Upon exiting the water, the angle of the front paddle is significantly smaller than the angle at which it entered. For instance, with the left stroke, this movement causes the tail to move away from the stroke's pole, resulting in the body drifting to the left. The athlete must then exert effort to correct the direction, disrupting the smooth flow of the stroke. Additionally, the abduction of the stroke affects the athlete's ability to maintain body posture throughout the race.

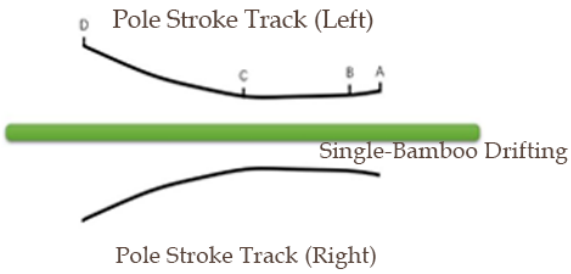


***Figure 10:*** Stroke Chart During the 60-meter straight race.

## Prospective of Psychology

The study findings reveal a multidimensional nature, encompassing various techniques aimed at optimizing single bamboo motion. Cognitive research indicates that successful performance of this technique requires a high level of attention focus and environmental awareness. Enhanced attentional focus and sensory processing contribute to improved decision-making. Emotional assessments unexpectedly highlighted the profound balance, centrality, and emotional resilience of the athletes, which fosters a holistic integration of mind and body. Furthermore, the observed level of concentration reflects a heightened state of current awareness and tolerance, characteristic of the SBD technique.

The findings of the present study highlight the interconnected role of psychology in martial arts training, demonstrating the significance of body experiences such as one-hand floating. The processes of enhancing cognitive clarity, emotional regulation, and meditation not only improve martial arts skills but also contribute to overall balanced health and well-being. These effects extend beyond martial arts, providing valuable insights into mental health promotion, stress management, and performance improvement across various domains. This research elucidates the intricate connections between psychology and martial arts training, particularly through the practice of single bamboo techniques. By highlighting the cognitive, emotional, and mindfulness dimensions of body movement, the study addresses existing gaps in understanding. It offers deeper insights into embodied cognition and its effects on human performance and well-being. Future research should extend these findings by exploring the long-term effects of martial arts training on psychological resilience, cognitive function, and emotional regulation.

## Conclusion

After analyzing pole-stroke techniques used by skilled single-bamboo athletes, it is recommended that training focus on key aspects: leaning forward and pushing back, diving into the water, keeping the pole straight, shifting the body's centre of gravity backward, lifting the pole out, and rising up. The stroke cycle includes pushing down, pulling forward, pushing forward, and pushing back. Enhancing these techniques optimizes efficiency and reduces energy loss, improving competitive performance. Key performance factors include athlete positioning, water entry angle, stroke force management, and float direction control. Effective posture and paddling techniques reduce resistance and improve paddling. Addressing yaw, which is linked to stroke strength discrepancies and angle, is crucial for maintaining stroke efficiency, rhythm, and stability. Using advanced tools like the Dartfish technical analysis system can help monitor and refine stroke techniques in real time. To further improve stroke efficiency and stability, focus on physical training for strength and core stability, enhance flexibility and coordination, and practice paddling under various conditions to adapt heading control. Additionally, control the paddle's angle when out of the water to minimize course deviations.

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