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Increasing 100-Meter Freestyle Swimming Speed: Through Imagery Training And Pre-Performance Routines Viewed From Concentration

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Abstract: *This study aims to determine: (1) the difference in the effect of imagery training and pre-performance routines on increasing 100-meter freestyle swimming speed. (2) The difference in the effect between high and low concentrations on increasing the 100-meter freestyle swimming speed. (3) The interaction between imagery training and pre-performance routines in terms of concentration on increasing 100-meter freestyle swimming speed. This research method is quantitative with an experimental method using a factorial design 2 x 2. The results showed that: (1) There is a difference in the effect of imagery training and pre-performance routines on increasing 100-meter freestyle swimming speed with a sig value of 0.002 <0.05, athletes who are given mental imagery training are better than pre-performance routines with an average difference in post test of 1.77 seconds (2) There is a difference in the effect between high and low concentration on increasing the ability of 100-meter freestyle swimming speed, proven by the F value of 5.447 and a significance value of p 0.006 <0.05, Swimming athletes who have high concentration are better than those who have low concentration, with an average posttest difference of 0.59. (3) There is an interaction between imagery training and pre-performance routines in terms of concentration aspects (high and low) on increasing 100-meter freestyle swimming speed, with an F value of 39.87 and a significance value of p 0.000 <0.05. The conclusion is that the imagery training model is a more effective method for athletes who have high concentration, and the pre-performance routines training model is more effective for athletes who have low concentration.*

Keywords: *imagery; pre-performance routines; concentration; swimming*

Introduction

Swimming is one of the aquatic sports that has a significant contribution to the development and development of sports achievements at the national or international level. In obtaining optimal performance, swimming sports require systematic efforts to achieve maximum results in various competition numbers, whether free style, breast style, back style, or butterfly style, at various distances (Ivanenko et al., 2020). Of the various events, the free style is the most common event in formal swimming competitions, both at national and international levels, including the Olympic Games and FINA World Championships (Beganović, 2019). The free style has a complete range of distances from 50m, 100m, 200m, 400m, 800m (girls), to 1500m (boys). Not only that, the free style is also used in relay events such as 4×100m and 4×200m. This makes the free style the style with the most medal donations in one championship (Makar et al., 2022).

Swimming freestyle occupies a strategic and fundamental position in the world of performance swimming. Not only is the number of competition numbers dominant, but free style reflects the efficiency of the method, physical capacity, and is a universal benchmark of achievement. Therefore, in the coaching and development of athletes, the ability of free style is often the priority before athletes are shown other styles that are more environmental or specialized. As one of the Olympic sports, swimming not only requires good method skills, but also the integration of various components of physical conditions such as strength, endurance, flexibility, speed, and coordination of movements (Lahart & Metsios, 2018; Ockta & Sabillah, 2025). Psychological factors such as concentration, mental preparedness, and stress management also play a crucial role in determining athlete performance (Ben-Zaken et al., 2022). At medium to long distances, swimming speed is greatly influenced by the athlete's mental skills to withstand fatigue, muscle soreness, and willingness to give up. Athletes with great mentality are more able to maintain speed

in the final session of the race and increase the pace when the opponent begins to slow down (Overbury et al., 2023). This suggests that mental aspects have a direct contribution to swimming speed.

Mental training is very important for speed of swimming athletes because it can help athletes to build confidence, correct mental methods, and prepare for maximum response to the pressure of competition. Saint-Martin et al., (2020) asserted that visualization of the right method increases the efficiency of movement and compresses neuromuscular responses, thus indirectly increasing the speed of performance. Mental aspects such as concentration, anxiety management, mental toughness, visualization, and emotion regulation contribute significantly to swimming speed. Not only that, but concentration is a fundamental component of sports performance. Athletes with high levels of concentration are able to selectively focus their attention on relevant data and ignore distractions (Zhan & Xue, 2022).

The interaction between psychological training methods and concentration levels can have different effects on athlete performance outcomes, making it meaningful to evaluate their efficacy in a more structured context. Concentration is a crucial psychological component in sport, affecting athletes' ability to stay focused on task-relevant cues while ignoring distractions from the immediate area (Samełko et al., 2018). Athletes with great concentration tend to be able to show a more normal and precise method of performance, especially under great pressure. In short events such as the 50m and 100m freestyle, the response time to the start signal and the precision of the method when the swimmer enters the water largely ensure the final result. Athletes who have great concentration and control over distractions tend to have faster and more effective start times (Olanescu-Vaida-Voevod et al., 2022). Moreover, a split-second lapse in focus can have a huge impact on total travel time. In training and coaching athletes, the sport psychology approach should not be ignored and must be integrated with the method and exercise program so that swimming speed can reach peak performance.

But based on the results of field observations in April 2025 with Yogyakarta swimming coaches, it was found that the speed skills of free-style swimming athletes were still low and not optimal. This matter is evidenced by the information obtained during the early test found that the average score of swimmer speed was recorded at 180 seconds; the matter is listed in the type of lack. This matter is due to the training procedures that are running only focus on training methods and bodies, so that mental training is neglected. Meanwhile, the mental aspect in this matter also means paying attention to. If this matter continues to be left until it will affect the increase in the performance of swimming athletes.

One method that is thought to be able as a solution to improve the speed skills of free-style swimming athletes is by sharing imagery exercises and pre-performance routines (PPR). In this context, psychological methods such as imagery and pre-performance routines (PPR) have been widely researched to improve athlete performance. Imagery is a mental method that involves creating sensory images in the mind to represent certain experiences or movements. Previous research has shown that imagery can improve athletes' methods, confidence, and mental readiness (Duarte-Mendes et al., 2019). On the other hand, pre-performance routines are a series of systematic actions that are attempted in the time before competition to condition mental focus and reduce anxiety (Richard et al., 2021; Rupprecht et al., 2024). The implementation of pre-performance routines has invariably been associated with improved performance in various sports, although research in the context of swimming is limited.

Although some research has confirmed that imagery and pre-performance routines can individually improve sports performance, research that directly equates the two in the context of aquatic sports such as swimming is still very scarce (Orbach & Blumenstein, 2022). Not only that, but not many studies have explored how the effectiveness of both procedures can be affected by people's concentration levels. Most research first considers only the direct effects without considering the interactions between psychological variables, while in the context of real performance, such interactions are very likely to occur and ensure the outcome of mental training (Hufton et al., 2024).

Recent research shows that imagery and pre-performance routines can improve swimming performance. For example, one study found that imagery can improve swimmers' 1000-yard training times (Yadolahzadeh, 2021). Not only that, another study showed that PPR can improve swimming performance by producing psychological stability and focus (Yao et al., 2020). However, there is limited research that directly equates these two methods in the context of swimming. Not only that, but recent research has shown that concentration levels can moderate the influence of psychological methods on performance. One study found that good concentration allows athletes to stay focused on their movements, strategies, and competition conditions without being distracted by external or internal aspects (Oli-

ver et al., 2021). The interaction between psychological training methods and concentration levels can have different effects on athlete performance outcomes, making it meaningful to evaluate their efficacy in a more structured context.

This study aimed to identify whether the implementation of imagery or pre-performance routines can significantly improve free-style swimming skills, and to what extent these effects are influenced by athletes' concentration levels. The results of this research are expected to contribute empirically to the development of fact-based psychological interventions in competitive sport and serve as a reference for coaches and sport psychologists in designing mental training programs that are structured and based on athlete characteristics.

Materials and Methods

Research Design

This research method is quantitative, with this type of research being an experimental 2 x 2 factorial design. This experimental research uses two different treatment groups, namely the provision of imagery training methods and pre-performance routines.

Research Participants

The population in this study was all Yogyakarta swimming athletes, totaling 38 athletes. In this study, the inclusion criteria were applied to determine the sample of this study, which is based on certain criteria desired by the researcher, including: Aged between 15-18 years, Mastering the basics of freestyle techniques, Having no history of severe injury in the last 6 months, Willing to follow the intervention program during the study period. While the exclusion criteria in this study are things that cause the sample not to meet the criteria to be sampled, such as not following the entire intervention training session, or getting injured during the study. Grouping of samples is taken from athletes who have high concentration, as much as 27% and athletes who have low independence, as much as 27% of the data that has been ranked. Based on this, a sample of 10 athletes who have high concentration and 10 athletes who have low concentration is obtained, so that a total sample of 20 athletes is obtained. This study has received approval from all samples who have filled out a statement of willingness to become research samples and have met the requirements of the research ethics code.

Research Procedure

The data collection method in this research is test and measurement. Before the pretest and posttest measurements were taken, the sample was first measured for concentration to determine high and low concentrations. To measure concentration in this study is to use the Grid Concentration Test 0.89 was used, and a reliability value of 0.803 (Greenlees et al., 2006). The test to measure the speed of freestyle swimming athletes in this study used a stopwatch. The research process was carried out for 12 meetings, where in one week, 3 meetings were held. Imagery group: Structured visualization exercises, 10-15 minutes per session, and PPR Group: Consistent practice of pre-match routines. And ended with taking a final test or post-test to measure the speed ability of freestyle swimming athletes with the aim of recognizing the comparison of scores after the treatment.

Data Analysis

The data analysis method used in this research is SPSS version 24, using ANOVA 2 path (ANOVA two-way) at the level of significance = 0.05. Next, to compare the average treatment effect, the Tukey test is used (Santoso, 2018). Before arriving at the utilization of Anova 2-way (Anova two-way), prerequisite tests need to be tried, including: (1) normality test and (2) homogeneity of variance test, and hypothesis testing.

Results

The chapter on research results and discussion will be presented sequentially, including: (1) research data, (2) pre-requisite test analysis, and (3) hypothesis testing. Hypothesis testing in this study will be presented sequentially including: (a) the difference in influence between imagery training methods and pre-performance routines on increasing 100-meter freestyle swimming speed; (b) the difference in influence between high and low concentration on increasing 100-meter freestyle swimming speed; and (c) the interaction between imagery training methods and pre-

performance routines and concentration on increasing 100-meter freestyle swimming speed. The complete results will be presented as follows:

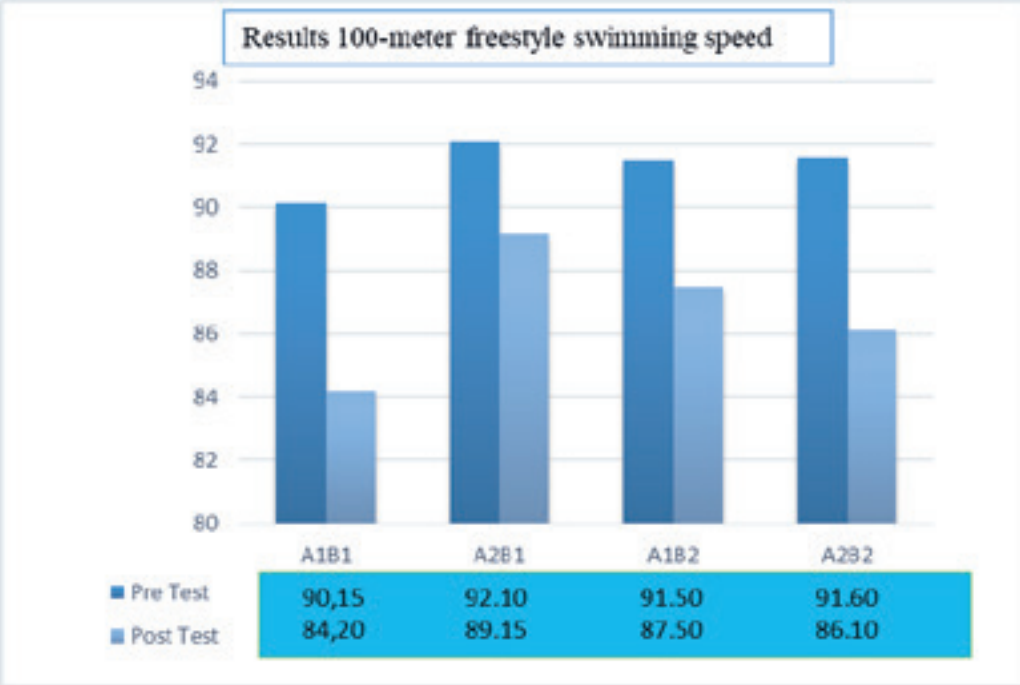

Figure 1. *Bar diagram of pretest and posttest swimming speed*

Description:
A1B1: A group of athletes is given an imagery training method with high concentration.
A2B1: A group of athletes is given the pre-performance routines training method with high concentration.
A1B2: A group of athletes given the imagery training method with low concentration
A2B2: The group of athletes given the pre-performance routines training method with low concentration.

Based on the graph 1 above, it shows that the A1B1 group's average prestest freestyle swimming speed was 90.15 and increased during the posttest by 84.20, the A2B1 group's average prestest was 92.10 and increased during the posttest by 89.15, the A1B2 group's average prestest was 91.50 and increased during the posttest by 87.50, the A2B2 group's average prestest was 91.60 and increased during the posttest by 86.10.

1. Prerequisite Test Results

a. Normality Test

The data normality test in this study used the Shapiro-Wilk method. The results of the data normality test conducted on each analysis group were carried out with the SPSS version 24.0 for Windows software program with a significance level of 5% or 0.05. The summary is presented in Table 1 as follows.

Table 1. *Summary of freestyle swimming speed normality test results*

Group	P	Significance	Description
Pretest A1BI	0.814	0.05	Normal
Posttest A1B1	0.814		Normal
Pretest A2B1	0.421		Normal
Posttest A2B1	0.421		Normal
Pretest A1B2	0.421		Normal
Posttest A1B2	0.421		Normal
PretestA2B2	0.814		Normal
Posttest A2B2	0.201		Normal

Based on the statistical analysis of the normality test that has been carried out using the Shapiro-Wilk test, all pretest and posttest data on freestyle swimming speed are obtained from the results of the data normality test significance value p> 0.05, which means that the data is normally distributed.

b. Homogentis Test

The homogeneity test is carried out to test the equality of several samples, namely, homogeneous or not. The homogeneity test is intended to test the similarity of variance between the pretest and posttest. The homogeneity test in this study was the Levene Test. The homogeneity test results are presented in Table 2 as follows.

Table 2. *Summary of homogeneity test results*

Variable	F	df1	df2	Sig.
Freestyle Swimming Speed	0.161	3	16	0.921

Based on the statistical analysis of the homogeneity test that has been carried out using the Levene Test. The calculation results obtained the significance value of freestyle swimming speed of $0.921 \geq 0.05$, which means that the data group has a homogeneous variance. Thus, the population has a similar variant or is homogeneous.

3. Hypothesis Test Results

Research hypothesis testing is carried out based on the results of data analysis and interpretation of the two-way ANOVA analysis. The sequence of hypothesis testing results adjusted to the problem formulation is as follows:

a. Hypothesis of the Difference in Influence between Imagery Training Methods and Pre-Performance Routines on Improving 100 Meter Freestyle Swimming Ability.

The first hypothesis reads "There is a difference in the influence between the Imagery Training Method and pre-performance routines on the Improvement of 100-meter freestyle Swimming Ability". Based on the results of the analysis, obtained data in Table 3 are as follows:

Table 3. *Anova test results of differences between Imagery Training Method and pre-performance routines on improving 100 Meter Freestyle Swimming Ability*

Source	Variabel	Type III Sum of Squares	Df	Mean Square	F	Sig.
Training Method	Swimming speed	45.000	1	45.000	19.169	0.002

From the ANOVA test results in Table 3 above, it can be seen that the significance value of swimming speed p is 0.002 and the F value is 19.169. Because the significance value of p is 0.002 <0.05, it means that H0 is rejected. Thus, there is a significant difference in influence. Based on the results of the analysis, it turns out that the imagery training method group on the variable swimming speed average travel time of 85.85 seconds is better than the pre-performance routines training group on the variable swimming speed average travel time of 87.62 seconds, with a posttest average difference of 1.77 seconds. This means that the research hypothesis, which states that "There is a significant difference in influence between the Imagery Training Method and pre-performance routines on Improving 100 Meter Freestyle Swimming Ability," has been proven.

b. Hypothesis of the difference in influence between high and low concentration groups on increasing freestyle swimming speed.

The second hypothesis, which reads "There is a difference in the effect between high and low concentration groups on increasing freestyle swimming speed". The calculation results are presented in Table 4 as follows:

Table 4. *ANOVA test results of high and low concentration groups on increasing 100-meter freestyle swimming speed*

Source	Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Concentration	Swimming speed	12.800	1	12.800	5.447	0.006

From the ANOVA test results in Table 4 above, it can be seen that the motorcycle significance value p is 0.006 and the F value is 5.447. Because the significance value of p is 0.006 <0.05, it means that H0 is rejected. Thus, there is a significant difference in influence. Based on the results of the analysis, it turns out that the group of athletes who have high concentration on the variable swimming speed average travel time of 86.67 is higher than the group of low concentration athletes on the variable swimming speed average travel time of 86.08, with an average posttest difference of 0.59. This means that the research hypothesis, which states that "There is a significant difference in influence between high and low concentration groups on improving the ability of 100 meters freestyle swimming speed," has been proven.

c. Interaction between imagery training methods and pre-performance routines and concentration (high and low) on increasing 100-meter freestyle swimming speed.

The third hypothesis, which reads "There is a significant interaction between training methods (imagery and pre-performance routines) and concentration (high and low) on improving the ability of 100-meter freestyle swimming speed". The calculation results are presented in Table 5 as follows.

Table 5. *Anova test results of interaction between training methods (imagery and pre-performance routines) and concentration (high and low) on improving the ability of 100-meter freestyle swimming speed*

Source	Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Training Method	Swimming speed	64.800	1	64.800	39.877	0.000

From the ANOVA test results in Table 5 above, it can be seen that the motorcycle obtained a significance value of p of 0.000 and an F value of 39.877. Since the significance value of p is 0.000 <0.05, it means Ho is rejected. Based on this, it means that the hypothesis stating "There is an interaction between imagery training and pre-performance routines as well as high and low concentration on increasing 100 Meter Freestyle Swimming Speed" has been proven. After the interaction is tested, it is necessary to conduct further tests using the Tukey test. Further test results can be seen in Table 6 below:

Table 6. *Summary of post hoc test of 100-meter freestyle swimming speed*

Group	Interaction	Mean Difference	Std. Error	Sig.
A1B1	A1B2	-2.5000*	0.82023	0.002
	A2B1	-1.2000	0.82023	0.47
	A2B2	1.0000	0.82023	0.619
A1B2	A1B1	2.3000*	0.82023	0.002
	A2B1	3.5000*	0.82023	0.019
	A2B2	4.5000*	0.82023	0
A2B1	A1B1	1.2000	0.82023	0.47
	A1B2	-2.3000*	0.82023	0.039
	A1B2	2.2000	0.82023	0.051
A2B2	A1B1	-1.000	0.82023	0.619
	A1B2	-3.5000*	0.82023	0
	A2B1	-2.2000	0.82023	0.052

Based on Table 6, the results of the Tukey test calculation on the asterisk sign (*) show that pairs that have interactions or pairs that are significantly different (significant) are: (1) A2B1-A2B2, (2) A2B1, (3) A2B1-A1B2, (4) A2B2-A1B2 while the other pairs declared to have no difference in influence are: (1) A2B1-A2B2 (2) A2B1 - A2B2. (3) A1B1-A2B1.

Discussion

The discussion of the results of this study provides further interpretation of the results of the data analysis that have been stated. Based on hypothesis testing, there are three groups of analysis conclusions, namely: (1) There is a significant difference in influence between the main factors of the study; (2) there is a difference in influence between high and low concentration groups on improving the ability of 100 meters freestyle swimming speed; (3) there is a significant interaction between the main factors in the form of two-factor interaction. The discussion of the results of the analysis can be further described as follows:

1. The effect of Imagery and Pre-Performance Routines training methods on increasing 100-meter freestyle swimming speed

Based on hypothesis testing, it is known that there is a significant influence between the Imagery and Pre-Performance Routines training methods on increasing 100-meter freestyle swimming speed. These results are from the research of Ferrari et al., (2018), which states that there is a significant effect of the imagery training method on increasing the speed of aquatic athletes. Another study conducted said that the imagery training method is effective for improving the accuracy of tennis players' service. Besides that, the increase in 100-meter freestyle swimming speed can also be seen from the Pre-Performance Routines training. This is in accordance with the results of the study (Holter, 2023), which states that there is a significant effect of the Pre-Performance Routines training model on athlete performance. This is supported by previous research by Zohar et al., (2017), which says that pre-performance routines training has a significant effect on agility ability. The pre-performance routines model affects increasing the speed of 100-meter freestyle swimming athletes because the training model is effective in increasing psychological stability.

However, based on the results of the data analysis test, it was found that the imagery training method group was better) than the pre-performance routines group on increasing the speed of 100-meter freestyle swimming athletes. This is reinforced by a study (Richard et al., 2021) which shows that Pre-Performance Routines can increase psychological stability and focus, but do not significantly increase travel time in freestyle swimming. (Nopiyanto et al., 2025) said that imagery training will have an impact on an athlete's stimulus unit and response unit to skills. The stimulus provides information relative to the content of the skill, while the response provides information on individual responses to situations experienced by athletes. For example, participants have imagined a skill or performance in a training or competition, the athlete's stimulus unit seems to be seeing himself and seeing others, and can feel the crowd of spectators, while the athlete's response unit has an impact on increasing the pulse rate and sweating. Previous researchers (Jose et al., 2018) revealed that imagery training methods can improve athletes' performance in continuous tasks such as swimming. Imagery can increase the activation of the motor system, thereby strengthening the synaptic pathways used in swimming movements. Intense imagery training increases the efficiency of large and small muscle movements relevant in freestyle swimming.

2. Differences in the effect between high and low concentration athlete groups on improving freestyle swimming speed ability

The results of the analysis show that athletes with high concentration ability are better than athletes who have low concentration ability in freestyle swimming speed. Concentration in this case has an important role in influencing the technique performed or the results of a sports match. Attention and concentration are often interpreted as the same, even though they have different definitions. Concentration is the process of direct awareness of the information (stimuli) received to decide on an action (response). Concentration is a person's ability to focus attention on selected stimuli (one object) within a certain time. Uludağ et al., (2021) revealed that concentration is very important for a player in performing on the field. The main component of concentration is to focus attention on a particular thing and not be distracted by irrelevant internal stimuli or external stimuli. This is by research (Purnomo & Yendrizal, 2020) conducted by which states that athletes who have a high level of concentration have a significant effect on the shooting accuracy of petanque sports. In the context of freestyle swimming, concentration is very important to maintain technique and movement efficiency.

3. Interaction between imagery and Pre-Performance Routines training methods, and concentration on improving the 100-meter freestyle swimming speed ability

Based on the results that have been stated in the results of this study indicate that there is a significant interaction between imagery training and (Pre-Performance Routines) and concentration (high) and (low) on improving the abil-

ity of 100 meters freestyle swimming speed. The results showed that the imagery training method is a more effective method for athletes with high concentration levels, and the Pre-Performance Routines method is more effective for athletes with low concentration levels. The interaction between psychological training techniques and concentration levels can produce different effects on athlete performance results. This suggests that imagery is more effective in improving freestyle swimming performance, especially when combined with high concentration. Elite swimming athletes often use imagery before the start, imagining the following sequence: 1) Position on the starting blocks, 2) Jump and streamline into the water, 3) The rhythm of the hand pull and leg movement, 4) The breath and turn at the end of the course, 5) The sprint to the finish wall. This repeated visualization helps improve their actual speed in the race. The 100-meter freestyle is a swimming race that relies on speed, technical efficiency, fast start, optimal turnover, and anaerobic stamina. In this event, mental focus and tactical readiness determine the final result. Therefore, mental imagery is an important tool to: 1) improve visualization of race technique and strategy, 2) accelerate mental adaptation to competition pressure, and 3) improve movement efficiency through motor representation. This is by the functional equivalence theory, which states that brain activation when performing imagery is similar to when performing real movements (Rhodes et al., 2024). Mental imagery training has a positive and significant effect on 100-meter freestyle swimming speed. Through motor stimulation, strengthening procedural memory, and increasing psychological readiness, imagery can be an integral part of an athlete's training program (Lindsay et al., 2023). This approach is also very useful in the tapering phase or when athletes cannot train fully due to injury or fatigue.

Conclussion

Based on the results of the research and the results of the data analysis that has been carried out, the following conclusions are obtained: 1) There is a significant difference in influence between imagery training methods and pre-performance routines on improving the ability of 100-meter freestyle swimming speed. The imagery training model group is better than the pre-performance routines group in improving the speed ability of 100-meter freestyle swimming athletes. 2) There is a significant difference in influence between athletes who have high and low concentration on improving freestyle swimming speed ability. Athletes who have high concentration are better than athletes who have low concentration at improving their ability to swim 100 meters. 3) There is a significant interaction between training models (imagery and pre-performance routines) and concentration (high and low) on improving the ability of 100-meter freestyle swimming speed. The results showed that the imagery training model is a more effective method for athletes who have high concentration, and the pre-performance routines training model is more effective for athletes who have low concentration.

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Conflict of Interest

We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could affect the results. As the corresponding author, I confirm that the manuscript has been read and approved for submission by all named authors.

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