

# THE STUDY OF IMPLICIT LEARNING FOOTBALL SKILLS BASED ON GENETIC ALGORITHM AND ITS APPLICATION

GUANGXIN LI

Institute of Physical Education, Jilin University, Changchun 130012, Jilin, China

E-mail: [915332871@qq.com](mailto:915332871@qq.com)

## ABSTRACT

It usually occurs that in important matches, athletes often play abnormal of their sport technique as they are too concerned about the competition result, and this is called Choking phenomenon. How to explain and control this from the perspective of the present psychology has become a widely discussed hot issue in the field of sports psychology. By research on the occurrence conditions of athletes' Choking, this article builds a regression model of the problem, with athletes' Choking index as dependent variable and competition trait anxiety, personal self-awareness, positive and avoidant response and public self-awareness as independent variable. By means of utilizing adaptive value function of genetic algorithm, conduct mental regulation to athletes based on implicit learning and examine the result of excitation. Finally, conduct data analysis of football players' competition status. Data analog and results analysis demonstrate the influencing factor of these data variables on the Choking phenomenon and contribute to the control of athletes' errors effectively as well.

**Keywords:** *Football, Choking Phenomenon, Implicit Learning, Genetic Algorithm*

## 1. INTRODUCTION

The definition of Reber implicit learning was first put forward in 1967. In 1980s, implicit learning became a well concerned cognitive psychology in research field and people began to pay attention to the research of sports skills in implicit learning gradually [1-3]. For a long time, people mainly follow the three step process of motor skill learning, i.e. cognition, coupling and automation. As a classical theory of motor skill learning research, it has been flourished [4-7].

With the modern sports event development up to now, even the most excellent athletes miss the deserved medals inevitably sometimes. Emmons, a famous athlete from the United States, played a 4.4 ring at the last short in the men's 50m rifle 3 × 40 final in the Athens Olympic Games, triggering an "Emmons curse" debate. Miss of the gold medal and bonuses is a result of psychological fluctuation, which is just the reflection of overlarge motivation to win during the game. In the same Olympic Games, a Chinese player made a low grade and fatal error of walking approach in the diving three meter broad project and missing the championship in the end, becoming a frustrated hero just as Emmons [8-11]. When asked why they were so stunned after the game, their answers generally attributed to the huge pressure triggered by psychological tensions or desire for success.

Abnormal play in such top-level competition can be expressed as "Choking" phenomenon too. As a result, this article intends to explain the phenomenon from a psychological point of view and try to manage and take control of it, eventually. This has become a widely researched hot issue in sports psychology recently [1, 3]. Masters is one of the scholars studying abnormal performance of athletes under high pressure in court. By means of implicit learning, he explored and studied on the issue and pointed out that athletes would reduce technical interruption in low explicit conditions when training professional athletes. It is well known that athletes' faults can be greatly reduced via implicit learning. It would be better that if solves the athletes' abnormal performance problem through the internal as well as the external factors. Based on combination of the origin of athletes' Choking phenomenon and genetic algorithm, this article builds a model and conducts case analysis. In the end, put forward the reason and method that cause the "Choking" phenomenon by analyzing the result, and hold survey on case implementation.

## 2. THE BACKGROUND CONDITIONS TRIGGERING ATHLETES' CHOKING PHENOMENON

As the experiment shows, implicit learning of sport skills possesses certain superiority over explicit learning. Implicit practice of sport skills is

under super load in the initial stage, showing better stability under stress conditions according to the compulsory exercise than explicit learning. This article covers the operation scene of working memory in three kinds of sport skills learning. The implicit experiment adopts the dual task experimental model and discusses the effect of working memory on football players' performance. The psychological factor of "Choking" is revealed with balanced experimental design methods. 16 female athletes and 32 male athletes participate in the experiment, all of whom have attended numerous matches and a wealth of experience on the spot. Athletes, whose shoot skills are still non-automated, are rejected from the experiment. According to the set criterion of shot hit rate bigger than 50% for athletes, there are 45 athletes left joining the experiment. It can be considered that the Choking phenomenon takes place when these athletes with better technique make faults.

The experiment tasks can be done under natural or high pressure conditions. In order to avoid the occurrence of error sequence, the 45 athletes stayed are divided into two groups randomly. One group conducts the experiment of kicker shot in the sequence of high pressure conditions and natural conditions; the other group in the reverse order,

Natural conditions are situations like:

- (1) There is only one chief examiner responsible for Picking up the ball and recording results and the examiner is very easygoing;
- (2) Experiment scoring is announced to no one and the result doesn't matter;
- (3) Athletes can kick and shot the ball whenever they are prepared, in a much relax and happy atmosphere;

High pressure conditions are situations like:

- (1) Many other athletes and the coaches are present in the court, besides 4 requisite staff during game. Meanwhile, the present of sports psychology expert add to the psychological stress for the athletes;
- (2) The athletes are informed in ahead that their performance will be recorded and announced later after the coaches read it;
- (3) Repeatedly reiterate that there will be a shot performance ranking, which will be reported to the coach.

- (4) The athletes are told that they need to run 400m around the court if they miss the shot, furthermore, it is accumulated successively;

The athletes are allowed only 3 chances of time-limited shoot warming up.

All of the athletes in the experiment complete 20 free throw line designated shots in two experimental conditions respectively. In the week before the test, the athletes are required to finish several forms, including the intended research content of the experiment. The state anxiety inventories of athletes are mutually recorded and can be test on spot in case of individual measuring error. Feeling uncomfortable in front of others is identified as a anxiety included in social anxiety, so personal self-awareness and public self-awareness can be fully analyzed.

### 3. DATA PROCESSING WITH GENETIC ALGORITHM

Genetic algorithm, firstly proposed by Professor John H. Holland, in Michigan University, USA, in the middle of the last century, is a simulated method of natural evolution of biological natural selection and crossover. The appearance of the method of simulation algorithm to generate a computer program makes it easy for the discussion and optimization of certain complex problems in actual life, as the job will be done by the computer through operation program. The optimization method is named as Genetic Algorithm (GA). Afterwards, the string-bit encoding technology was invented, through which not only mutation operation but also interlace operation can be conducted. Besides, this technology attach more importance to the effect of interlace when choosing major genetic operation.

Genetic algorithm is to simulate the evolution of biology by computer technology and to encode according to the evolutionary conditions required. Due to the character and search capability of the algorithm itself, it is gradually accepted among users.

Supposing that the practical problem is an minimum problem:  $\min f : R^n \rightarrow R$ ,  $f$  means objective function; fitness function is  $F : I \rightarrow R$ , and  $I$  means the individual space,  $I = \{a_i | i = 1, 2, \dots, n\}$ ;  $a_i$  means individual;  $x = \{x_1, x_2, \dots, x_n\}$  is objective

variable set on  $R^n$ ,  $[u_i, v_i]$  means the scope of component  $x_i$ ;  $np \geq 1$  is the group numbers of parent,  $nc \geq 1$  is the group numbers of spring, i.e. the numbers of individuals generated by the parent via crossover and mutation, that is how to produce a new generation. When the iteration happens for  $t$  times the group is  $P(t) = \{a_1(t), a_2(t), \dots, a_{np}(t)\}$ ;  $C: I^{np} \rightarrow I^{nc}$  means crossover operator, controlled by crossover probability  $P_c$ ;  $M: I^{nc} \rightarrow I^{nc}$ , means mutation operator, controlled by mutation probability  $p_m$ ;  $S: (I^{nc} \cup I^{np}) \rightarrow I^{np}$  means selection operator, to calculate the next generation parent individuals, controlled by selection probability  $P_s$ .  $C, M, S$  Are all macro operators, meaning that the operators affected on the individuals when one generation produces the next are expressed as  $C, m, S$  accordingly?

Genetic algorithm, as a class of stochastic parallel adaptive optimization method, the guiding ideology of which is "survival of the fittest", should include individuals from the group and objective function in the coding except for constraint conditions of dependent variables. These constraint conditions are referred as environment and the operation of genetic algorithm is based on the interaction between individual and the environment.

Genetic algorithm can generate different offspring data according to the algorithm environment intelligently. By adequately simulating the mechanism of natural selection and heredity, it is random, optimizing and so intelligent. And it must be adaptive, as it is a symbol of intelligent algorithm. At the same time, parallel computing is needed otherwise the computation speed would be too slow. Quickly convergence is another superiority of this algorithm that can effectively solve the optimizing issue of generous calculation.

The mathematical principle of genetic algorithm is iteration, which is to sort according to certain indicator basically in iteration, while keeping a group of approximate solution. Pick out a better solution based on another selected indicator and then conduct the math operation on the basis of .crossover operator and genetic operator, reaching a approximate solution of the new generation. Repeat the above iteration process until meeting the

requirement of convergence accuracy and the last generation is the answer.

Five elements are demanded in genetic algorithm when dealing with the optimization problem: parameter encoding, fitness function, the initial population, and evolution and control value. Basic flow diagram of standard genetic algorithm (SGA) is shown in Figure 1.

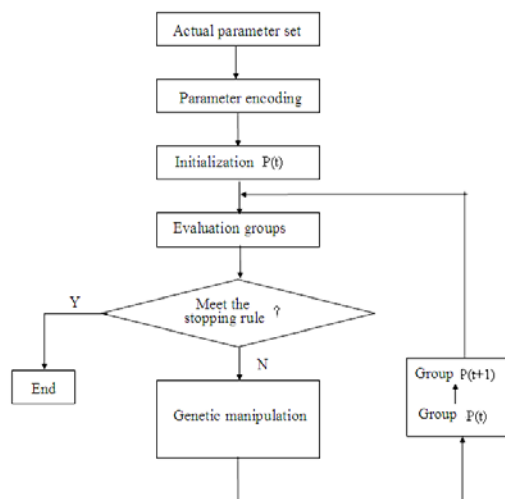


Figure 1: the basic flow diagram of standard genetic algorithm (SGA)

To explore the relationship between implicit learning of sport skills with football athlete's conditions like coping with the situation, race anxiety trait, self-will and Choking index, this article conducts the data processing with genetic algorithm. In the experiment, the difference between shot hits in natural conditions and shot hits in high pressure conditions is defined as "Choking" index. It is apparent that the index is not equal to zero when "Choking" phenomenon occurs and that the bigger the absolute value of index is, the severer is the Choking phenomenon. This article conducts t-test for differences to test whether the pressure in the experiment operates effectively taking account of athlete's training performance and anxiety status during test. The result of t-test for differences demonstrates that athletes' shot performance in natural conditions is apparently higher than that in high pressure conditions. What's more, state of anxiety in natural conditions is not obvious, but cognition state anxiety and somatic state anxiety are expressed apparently in high pressure conditions, indicating a effective high pressure operation of this experiment.

This study conducts a Pearson correlation analysis of athletes' coping with the situation, race

anxiety trait, and self-will and “Choking” index to investigate the psychological reason of “Choking” phenomenon among athletes. Analysis result shows that “Choking” index is in a significant positive correlation with public self-awareness. Athlete’s “Choking” index as a dependent variable, the relation of factors as anxiety in competition, personal awareness, awareness when facing the public, positive response and avoided response to “Choking” index is studied. The correlation coefficient of the above independent variables is substituted into the regression equation with “Choking” index and the Fitness function regression model of athlete’s “Choking” index is formed. In the prediction system, the computer is able to output the predicted value in some future time when input the parameter value of self-awareness, anxiety in competition and way of response.

$q_m$  Means the output mode at time  $t = t_m + \tau$ , so the prediction system is able to realize the following function mapping:

$$F(\mu, q_m) = d_m$$

To realize the coefficient inversion under the above circumstances, the formula of  $F$  is unknown and the observed value  $d_{ob}$  can be obtained through  $d$ . Search the most optimal approximate solution  $\mu_{op}$  in the solution set of coefficient  $K_{ad}$ , and make the difference between the output model and the corresponding observed value minimize, i.e. to meet the following requirement:

$$\|F(\mu_{op}, q) - d_{ob}\| = \inf_{\mu \in K_{ad}} \|F(\mu, q) - d_{ob}\|$$

To translate the coefficient question into a function optimization problem only needs to

identify  $\|F(\mu, q) - d_{ob}\|$  as the adaptive value function. By adopting the inversion calculation technology, this study chooses the fittest value based on the newly provided observed value of indexes for the three factors: competitive anxiety, self-awareness, and coping style, to minimize the

value of  $\|F(\mu, q) - d_{ob}\|$  and thus get the optimal solution of the index. Certainly, this solution is just an approximate solution related to evolutionary

generations. Finally, evolve the undermined index in the program designed procedure of genetic algorithm and the result is shown in Table.1.

Table 1: genetic algorithm optimization result

|           |                  |                   |                     |
|-----------|------------------|-------------------|---------------------|
| index     | Choking index    |                   |                     |
| variation | 39.5%            |                   |                     |
| index     | Public awareness | Positive response | Competitive anxiety |
| variation | 26.7%            | 8.2%              | 4.6%                |

The above results indicate that 39.5% of the total variation of “Choking” index can be effectively explained by three factors: public awareness, positive response and competitive, which lays a foundation for the case analysis in this study.

#### 4. NUMERICAL SIMULATION OF CASE ANALYSIS

Variation of a football player’s annual shot hits achievement in 14 years since 1998 is shown in Figure 2.

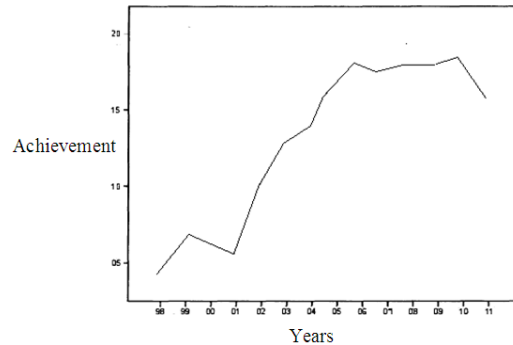


Figure 2: Variation Of A Football Player’s Annual Shot Hits Achievement

Judging from Figure 2, the player’s performance in 2010 is not satisfying and is the lowest point of the personal career in recent years. What’s more, these competition results are much worse than the usual training result. He often makes mistakes in the national important matches, even though the special techniques in his usual training has become to a high level. To explain the reason of technique abnormal performance of athletes in importance matches, the football team conducts a unlimited interview with the players to train, track and do psychological measurement. A questionnaire survey of manifest anxiety scale based on the three components as cognitive anxiety, somatic anxiety

and confidence status following the race conditions is also conducted.

The text data and qualitative analysis of the athletes can reveal the psychological causes of athletes' Choking phenomenon more clearly. A strong sense of self-oppression in psychological factors is the main reason for athletes' abnormal performance technically in competition. There are other factors like unreasonable competition, a set objective, self-efficiency, low compositeness, and change of direction of attention. Recognizing the importance of the match, the team is not able to focus on every detail of motor process during the match and achieve the best result. Therefore, it is the change of attention that breaks the automation action plan in training. As a result, "Choking" phenomenon occurs in the action executing procedure and the team loses the rhythm sense of the game. Not all athletes suffer the "Choking" problem when facing competitive stress. Conversely, strong sense of self-esteem, an unreasonable game target and competitive effect lead the athlete endeavoring to win the match. The effect of the three interactional factors as cognitive pressure, cognitive performance and life events, the competition of self-efficiency and the impact of match target and previous performance are discussed in the following text.

Usually, the emotional state of athletes is unstable when facing families, coaches, team players and audience, all of which are competitive anxiety variables. The competitive anxiety is positively related to the positive response, and so is competitive anxiety to public self-awareness. And competitive anxiety is positively related to the occurrence of Choking, even when the athletes take a positive response, probably due to the relationship of personality with competitive anxiety and coping style. The above analysis demonstrates that athletes should take a more positive response because of the high competitive trait anxiety. Avoidant coping method is not suggested because competitive anxiety is in negative correlation with avoidant response.

According to the questionnaire of the athlete, psychological intervention and technical analysis are conducted and the result is shown as Figure 3.

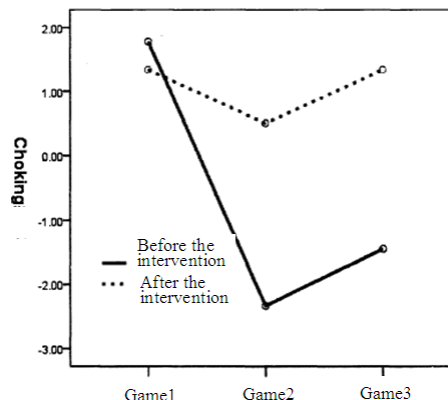


Figure 3: The Choking Index For The Same Match Before And After Intervention

The enlightenment of this research result demonstrates that: athlete with strong public self-awareness pays more attention to his public image than general athletes and the athlete can choose an effective coping style according not only to the field conditions but also the character of the match mission. Athlete with strong personal self-awareness attaches more importance to his inner feelings and felt more and stronger sense of anxiety as a result of strong pressure and response in competition. Pressure decay due to the environment particularity is a sensible response of avoidant coping. Enhancing the training of athlete's coping style and psychological intervention can be an effective way to prevent the "Choking" phenomenon for athletes in important games. Although it is revealed in the study that there are certain connections among the three factors: sports competitive anxiety, self-efficiency and coping styles, whether it is interacted or of mutual causality still reminds a question to be further confirmed utilizing the theoretical research of implicit learning. .

## 5. CONCLUSIONS

Competition in real matches is always the ultimate purpose for professional athletes and no one is willing to that the Choking phenomenon affects the team's final achievement in great matches. Now it is clear that it can be intervened by implicit learning. As a matter of fact, not only freshman athletes should have the implicit learning to prevent the "Choking", but also the coaches should too to guide and enrich their knowledge. To explain the reason of athletes making fault in matches, this study conducts the collection and analysis of athletes' psychological state during the match in experimental method and finally find the



origin of “Choking” phenomenon. To test the experimental result, this study does a case analysis of a high-ranking football athlete as well. The analysis result shows that the high-ranking athlete too much or too high goals and transfer all the attention on the game result leading to the occurrence of “Choking” phenomenon. Competition results as a major game target for athletes, as well as too much focus on bonus and honors are all root of “Choking” phenomenon. The explanation of the research results in this article reaches the statistical standard and the built model reveals the effect of the three origins on the total variation of athlete’s “Choking” index. If conditions permit, the experiment can track more athletes’ competition performance and gather abundant game data, and builds model on the relation of “Choking” index to more than three factors. It would be beneficial to fully understand how these variables affect the “Choking” index and how they are interrelated with each other, and providing more useful information eventually.

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