# Brain Automatic Process of Auditory Pathway of Students Majored in Basketball

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**ABSTRACT**

Mismatch negativity (MMN), as the component of the event-related potential (ERP) was introduced as an index in this study. With between-subject and within-subject design, 8 college students majored in basketball were intervened under classic and optimization experimental paradigms. The waveform caused by different voice frequencies is analyzed to explore the automatic brain processing of basketball players' auditory pathways. After comparison, the results show that under the classical paradigm, the average area of MMN in basketball group is generally small. It shows that basketball group cannot process the difference between sound stimuli at the early stage, indicating that the early preprocessing of auditory information of the cerebral cortex is relatively inactive. The average area under the MMN wave induced by the classic paradigm is larger than that under the classic paradigm.

**Key Words:** Basketball Players, Brain Automation Processing, Event Related Points

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## Introduction

Modern competitive sports have developed to the high level at present. The athletes of closed projects like archery, shooting present complicated and difficult technical movements perfectly and freely in the competition, which needs regular repetitive training to develop dynamic stereotype with technical and high automation. The open projects like playing basketball, playing football demand the athletes to properly deal with various changeable information on the court. Meanwhile, the prerequisite is that some sports skills are highly and skillfully automatic. We usually call the above performance behavior automation and learn the relationship between behavior automation (Schranz *et al.*, 2018) and brain's automatic processing. In addition, we still learn whether the athletes of closed and open projects will have respective characteristics and differences of brain's automatic process due to selecting materials or long-term specialized training, which will make sports psychology be of theoretical and applied significance.

Brain capacity and condition (Yang *et al.*, 2017) have been the important components of the athletes' competitive abilities and states. In China and foreign countries, there are more and more researches on the athletes' brain capacities and the researches in this field are implemented in physiology and psychology. Most of the research methods on EEG (Bidelman *et al.*, 2014) are descriptions for the athletes in the crucial period in the operation of closed projects.

ERP (Event-Related Potential) (Chang *et al.*, 2017) is the analysis technology of evoked EEG, which is considered as the most hopeful technology in exploring brain's cognitive activities and researching information processing. As there are much higher demands in ERP experimental. equipment and technology, presently, there are fewer application in sports

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psychology. In evoked elements of ERP, MMN has been considered as the present valuable objective indicator in reflecting brain's automatic processing but there is no report of document research in the present sports field

According to some results and related issues on the athletes' brain capacity in the present competitive sports field, the research adopts analysis method to research whether archery and basketball athletes have different characteristics in brain's automatic processing. Meanwhile, it explores the relevant feasible experiment paradigm.

The demands of modern competitive sports haven't be limited to physical state and sports skills and tactics. In addition, the role of psychological elements seems to be more apparent. The brain is material carrier of mind and the mind is the expression of brain. In addition, the athletes' brain capacity and state have been the important components in judging their competitive abilities and states. Therefore, the research on the relationship between the athletes' automation of movement skills or behaviors and brain capacity has been an important field for sports psychological psychology from home and abroad (Jin and So, 2014).

The automatic processing of brain information can be divided into:

(1) Behavioral automation (Venkata and Shahidehpour, 2017). Behavior is controlled by the brain and is a manifestation of brain function. Therefore, behavioral automation is the embodiment of the automatic processing of brain information.

(2) The automation of the sensory information processing of the brain (Lohr *et al.*, 2013), that is, the brain has the ability to automatically process information from various sensory pathways. The automatic processing of the innate brain to sensory information belongs to orienting response (Cheung and Bruce, 2015).

According to Broadbent, compared with the large amount of information from outside, the processing ability of the central system of people is limited. Therefore, the information needs to be sorted by the filter. Some information may then go into the advanced analysis stage and be transferred immediately, while inconspicuous information may be maintained in short-term memory system and be rapidly forgotten. New stimuli or significant ones may be easily accepted by the filter (such as your name) even if these stimuli belong to unnoticed information.

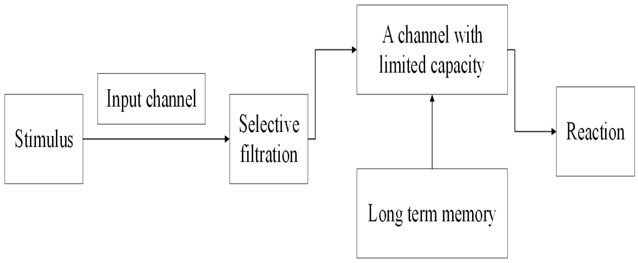


**Figure 1.** Nervi cerebrales

## Methods

Experimental hypothesis: according to Gentile's theory (R Mcalpine *et al.*, 2016), there are differences in the requirements on athletes' motor skills in open-loop and closed-loop projects. Through repeated training, technical movements or part of those movements of the athlete may have been automatically set. The automatization of such long-term behavior will in turn affects the central nervous system, changes the relevant mental processes, and even leads to alterations in brain cognitive processing (Bedajit *et al.*, 2014).

Subjects: 8 basketball players (5 males, 3 female; average age 20.2) were randomly selected to form a basketball team. All the athletes are right handed and are in healthy condition. They all have sane visions or at least corrected sane visions. Moreover, they are all second class athletes with similar training period.

Methods: the "cross-channel" experimental design, which refers to vision and audition, was adopted in the experimental design.

Procedure: see Figure 2.

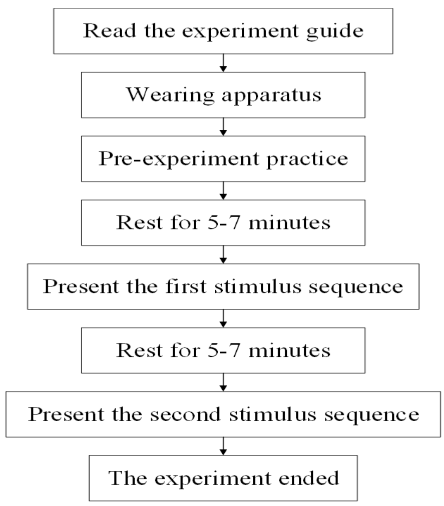


**Figure 2.** Flow Chart



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Equipment: the experiment was carried out by the event related potential workstation of Neuroscan 128 in the United States. The brain-evoked-potential devices include stimulus editing and presentation software; STIM2; brain-evoked-potential acquisition amplifier SynAmps; brain-evoked-potential offline analysis software: Scan 4.3.

## Results and Discussion

### *The study of MMN under the classic paradigm of basketball team*

In order to ensure participants can concentrate on the film, they were asked relevant questions on details. Then answers were recorded and scored. Table 1 is the correct rate of the basketball players and the archers after the experiment . It can be seen from the table that the average number of questions correctly answered is 8.5 in basketball team, and that of the archery group is 9.25. Therefore, we can ensure that the two groups of athletes focused on the film during the experiment.

**Table 1.** correct rate of basketball and archery group

| Group | Number | Average | standard deviation |
|---|---|---|---|
| Basketball | 8 | 8.50 | 1.07 |
| archery | 8 | 9.25 | 0.46 |

*Sig=0.100>0.05*

Table 2 is a comparison of the average area under MMN and the incubation period of the basketball players and the archers under classic paradigm. As shown in the table, the average area of F3 and C4is different, and there is a significant difference at C4. The incubation period of F3, C3, C4, and Cz were statistically different. Although there is no statistical difference at other points, it can seen that the incubation period of the archery group is slightly longer than that of the basketball team.

Since MMN is a subtracted waveform, which has relatively gentle negative shifts, and the average amplitude is small and is not easy for statistical processing, this experiment uses Excel to make scatter gram for the MMN of the subjects at Fz. Without missing important data, the scatter gram is easier to do analysis. The transverse axis indicates the incubation period of the MMN, that is, the time form the starting point of stimulation to the peak of the MMN. The longitudinal axis represents peak amplitude of MMN. Figure 3 is a scatter plot of the amplitude of the sound frequency MMN under the classic paradigm of the basketball and archery group. As shown in the picture, the amplitude distribution of MMN of the archery group is more concentrated while that of the basketball team is relatively scattered.

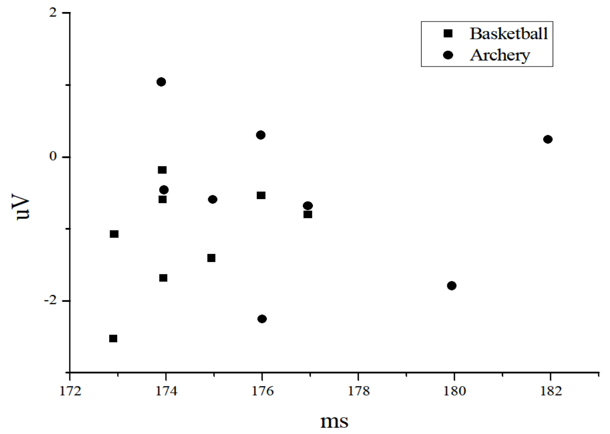


**Figure 3.** Comparison of the amplitudes of sound frequency MMN at Fz points under the classical paradigm of basketball and archery group

**Table 2.** Comparison of the average area and incubation period of MMN under the classic paradigm of basketball and archery group

| Electrode position | Statistics | Basketball | | Archery | |
|---|---|---|---|---|---|
| | | Average | Standard deviation | Average | Standard deviation |
| F3 | MMN average area under wave | -137.54* | 11.37 | -146.23* | 33.31 |
| | MMN incubation period | 140* | 5 | 165* | 3 |
| F4 | MMN average area under wave | -147.11 | 17.24 | -147.17* | 20.22 |
| | MMN incubation period | 161 | 11 | 166 | 9 |
| Fz | MMN average area under wave | -148.23 | 25.83 | -150.89 | 25.74 |
| | MMN incubation period | 174 | 4 | 168 | 2 |
| C3 | MMN average area under wave | -130.21 | 27.33 | -129.97 | 35.12 |
| | MMN incubation period | 140* | 9 | 165* | 4 |
| C4 | MMN average area under wave | -128.47** | 35.00 | 169.33** | 19.56 |
| | MMN incubation period | 144** | 13 | 170* | 13 |
| Cz | MMN average area under wave | -146.35 | 28.59 | -145.68 | 17.43 |
| | MMN incubation period | 143* | 14 | 163* | 7 |

**P<0.05,**P<0.001*



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**Table 3.** Comparison of the average area and incubation period of MMN under the optimization paradigm of basketball and archery group

| Electrode position | Statistics | Basketball | | Archery | |
|---|---|---|---|---|---|
| | | Average | Standard deviation | Average | Standard deviation |
| F3 | MMN average area under wave | -152.73* | 28.56 | -261.09** | 15.93 |
| | MMN incubation period | 155 | 11 | 160 | 4 |
| F4 | MMN average area under wave | -224.29* | 32.74 | -259.13* | 11.43 |
| | MMN incubation period | 168 | 3 | 165 | 11 |
| Fz | MMN average area under wave | -223.21* | 15.29 | -260.17* | 27.28 |
| | MMN incubation period | 170 | 11 | 165 | 4 |
| C3 | MMN average area under wave | -187.03** | 15.69 | -239.37** | 14.63 |
| | MMN incubation period | 141 | 3 | 150 | 2 |
| C4 | MMN average area under wave | -198.51** | 41.56 | -247.13** | 15.31 |
| | MMN incubation period | 163 | 7 | 155 | 11 |
| Cz | MMN average area under wave | -237.89 | 37.21 | -243.37 | 11.29 |
| | MMN incubation period | 145 | 2 | 160 | 3 |

*P<0.05,**P<0.001

### *MMN research of basketball and archery group under the optimization paradigm*

Table 3 is a comparison of the average area and incubation period of the sound frequency MMN under the optimized paradigm of the basketball and archery group. As shown in the table, there are differences in the average area of the two groups at F4 and Fz, and there are significant differences at F3, C3 and C4 points. Meanwhile, compared with the the average area of the MMN of the two groups of athletes under the classical paradigm, the difference of the average area of the MMN of the two groups was more obvious. However, the incubation periods of the two groups do not have statistically differences at all points.

Figure 4 is the scattered gram of the the amplitude comparison of the sound frequency MMN caused by the optimization paradigm of the basketball and archers group.The peak amplitude distribution of the MMN of the archery group is more concentrated, and that of the basketball group is more scattered. This is in agreement with the results under the classic paradigm.

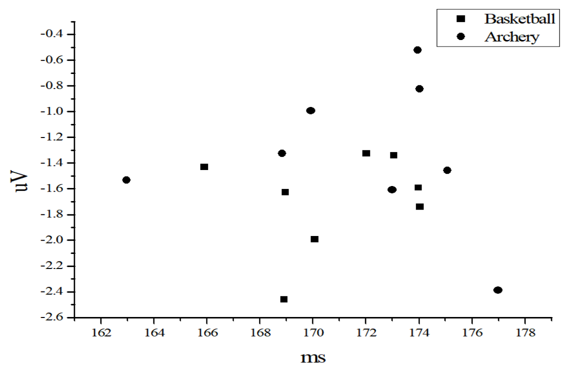


**Figure 4.** Comparison of the amplitude of sound frequency MMN at Fz point under the optimization paradigm of basketball and archery group

### *Comparison of the sound frequency MMN caused by the classic and optimal paradigm of the basketball team*

As shown in Figure 5, the scatter gram shows the peak amplitudes at Fz of the sound frequency MMN under the classic and optimal paradigm. The distribution of MMN of basketball players under the classical paradigm is more concentrated on the horizontal axis, while the MMN caused by the optimization paradigm is more concentrated on the vertical axis.

Figure 5 Comparison of the amplitudes of MMN at Fz point under the classic and optimized paradigm within the basketball group.

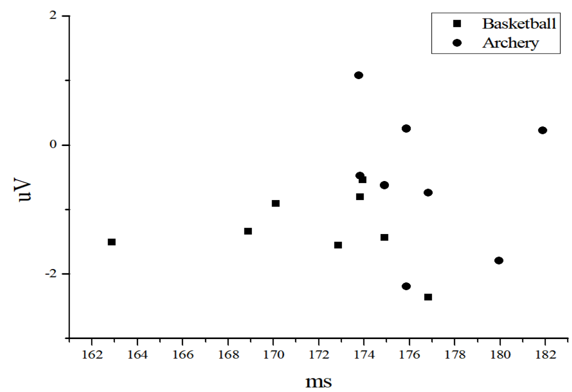


**Figure 5.** Comparison of the amplitudes of MMN at Fz point under the classic and optimized paradigm within the basketball group

According to the EEG showing the MMN evoked by the classical paradigm of the basketball group, a negative MMN appeared in the right prefrontal cortex of the basketball athletes at about 120ms, which gradually increased and reached the peak at 160ms, taking over the whole prefrontal and frontal lobe, and then diffused to the parietal lobe and continued by around 220ms.

According to the EEG showing the MMN evoked by the optimization paradigm of the basketball group, a negative MMN appeared in the right prefrontal cortex of the basketball athletes at about 120ms, which has greater degree compare that of the classical paradigm. gradually increased and reached the peak at 160ms, taking over the whole prefrontal and frontal lobe, and then diffused to the parietal lobe and continued by around 220ms.

## Conclusion and Prospect

Basketball sports are mainly dominated by open-loop sports skills, changing with the change of the external environment, and the actions are aperiodic. Moreover, feedback information is derived from various analyzers. In the course of training and competition, basketball players face more complicated situations and changes. In the game, changeable and complicated situation, the eye and body contact between teammates, the guidance of the coach outside the field, the shout of audience convey information to every athlete on the field, and influence their perception on the situation and their motor skills. However, the processing capacity of the human central system is limited. If basketball players fully process these complex information at the early stage of attention, the process will undoubtedly occupies a lot of psychological resources, thus affecting their movements. Therefore, the ability of the basketball player's brain to distinguish the difference of sound stimulation is relatively weak in the former state of attention.

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