

Eye Movement Study on the Information Processing Within the Sight Range of Football Players

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Abstract: For athletes, the fixation account on the central information is less than that on peripheral information; the fixation account of the expert group is more than that of the novice group. For the expert group, the saccade distance of peripheral information is smaller than that of central information. The fixation account of the expert group is significantly larger than that of the novice group; the differences of indexes between the central and peripheral information is not significant. This shows that the expert group adopts strategies of concentrated fixation and search of central information while adopts strategies of rapid and large-scope scanning of peripheral information. The expert group has a stronger information processing capability, the duration time of secondary fixation point is shorter, the fixation account is more and the duration time of fixation is short. There is significant difference between the expert group and the novice group. There is significant difference between the expert group and the common group in saccade distance. Different materials affect the duration time of secondary fixation point, fixation account, the duration time of fixation and saccade distance. For the athletes in different levels, from expert to novice, the cognitive difficulty of the same task is increasing.

Keywords: Eye Movement; Information Processing; Football Players

1. Introduction

A large number of exercise practice shows that the high-level athletes have obvious advantages in the processing speed when dealing with the sports information of related projects. The novice may not have a good ability to analyze sports information and lack the ability to possess special information. Their reaction speed is slow and the judgment lacks accuracy. Seen from the previous studies, experts can carefully process the sports situation information more effectively and their fixation duration lasts longer and the fixation count is less. While the novice and control group adopt the processing strategy of rapid scanning; they further clarify information processing tasks, and increase the reaction index of cognitive behaviors. There exist differences between experts and novices in terms of the extraction of picture information, indexes of eye movement and behavioral characteristic, as well as different sports events ^[1].

Therefore, using eye movement to study the visual search and fixation of athletes in the competition is a rather scientific method and of certain theoretical and practical significance. In recent years, eye movement recording method is widely used in all kinds of sports researches, and provides the guidance basis to the scientific train-

ing. ^[2] Eye movement in sports psychology usually investigates athletes' eye movement characteristics and laws from visual search, visual perception, selective attention, sports situation and other aspects and synthesizes the various kinds of eye movement and behavior indexes to explore the visual eye movement laws in moving. In football and other ball games, athletes need to make rapid decisions, actively and quickly capture the important information and timely take measures and adjust tactics and strategies due to the complex and changing competition situations. ^[3] Therefore, the capture of visual information is very important for football players. In terms of how to actively look for, filter, selectively process, reorganize and create information, the cognitive process of different-level athletes have different performance in sports, which provides empirical basis for better sports training, psychological material selection and training monitoring.

2. Macro Mechanism of the Information Processing within the Sight Range of Football Players

Visual sense is one of the most important human sense organs. The desire to "look" is one of the most original

instincts. Human eyes, like other organs, hide the desire to capture the pleasure. Today, visual sense takes an overwhelmingly dominant position and the daily life becomes universally visualized. Visual sense has become the place generating significance and competition. Visual becomes consumptive and consumers seek information, significance and pleasure from visual events by visual technology. Images, instead of material objects, become the center of consumption. Therefore, landscaping generates. The opening ceremony of 19th World Cup was held in Soccer City Stadium of Johannesburg, South Africa attracted the world sight. There were more than 1,500 entertainers from all over the world and key statesmen from over 50 countries joined it.

CCTV spared no efforts to report the World Cup. For prominently better visual effects, CCTV firstly broadcasted total 64 matches during World Cup with fully high-definition open circuit. Through the movie wide screen, it showed the living high-definition 3D matches of World Cup to the audience. It firstly adopts the advanced technologies such as studio big screen possessed by rendering server, virtual technology, touch screen, 3DReplay and MVP in 'Grand Dinner', which is the thematic section for World Cup. In 1/8 finals of 2010 World Cup in South Africa, Messi cried like a child when Argentina completely defeated Germany, Maxi Rodriguez had red eyes,^[4] Heinze choked with sobs and Argentina fans on the stands had tears on faces and the people showed inconsolable expressions. All those were enlarged through TV close-up shot. Compared with the joy of Germany, the scene was rendered with court wonder of both sadness and joy. The fans who were watching at the scene had also been an important part of the sight. They waited with splendid dress and made various exaggerated facial expressions and movements in front of the camera for joy. The World Cup court can be said as a large stage rather than a competition terrain.

The determining factor of images is naturally consumption. World Cup is one typical case of visual consumption. Take CCTV as an example, in terms of funding, the expenditure on 2002 and 2006 World Cup broadcasting right is 25 million dollars while that on 2010 and 2014 should be up to 100 million dollars. Of course, huge expenditures also bring great rewards. TV station transfers the huge audience to advertising agencies. Through the broadcasting of 2010 World Cup in South Africa, CCTV income was over 1 billion RMB. The urban data of CSM 25 Central survey meter shows that the average audience rating of the opening ceremony of 2010 World Cup in South Africa was 57% and the market share was 14.34%, which was 9 times of the audience rating of the same time period at ordinary times. Therefore, the media actually calls people's senses and instincts as the resources to win audience ratings, hits and business interests, and further deepens business logic operation into human instinct and desires and realize appreciation through the

satisfaction of pleasure. The image of Maradona in suit brought direct business interests after violently transferring and rendering in various ways. The valuable wardrobe has been sold to out of stock^[5].

Under the attraction of wonder effects, people's visual participation and information participation in sports are more than physical participation. Stadium, as a public body-building place has less functions and gradually become one ritualized performance stage. Visual appreciation is more than personal participation. The sports which emphasize participation become performance events with most people watching and few being watched. Therefore, the first point of cutting wonder effect lies in the promotion of personal participation in sports and changes people's interests from watching to practice. In sports reports, the focus should be on how to attract audience to participate in the sports activities, enhance the national physical quality, and also provide plenty of reserve talents who truly love sports for higher-level sports. On the other hand, interactive programs which lead the audience to do sports should be held more frequently, which aims at making people experience the warmth and friendliness from sports and strengthen exchanges, rather than attracting the audience' eyeballs. Sports should not belong to star sports only. The USA with the most obvious commercialization proposed query on the commercialization of sports and athletes and began to self-examine whether it is necessary to produce so many sports stars and fervently boost.

3. Research Subjects and Methods

3.1. Research Subjects

Choose 3 testing groups, 25 persons in expert group, 26 persons in common group and 25 persons in novice group. The gender ratio is equivalent. All the testees are of average 18 to 22 years old. The visual acuity or corrected visual acuity is ordinary. The testees will get a reward after the experiment.

3.2. Research Design

This experiment adopts the mixed design of 2 x 3. The experiment independent variables are the information focusing position and different-level athletes. The former are within-group variables with central 1 level and peripheral level; the later are between-group variables which are divided into expert athletes, common athletes and novice according to sport expertise. Dependent variables are the indexes such as fixation point, fixation time, fixation count, pupil diameter, saccade distance. In the experiment, the testees sit in front of eye movement equipment, with their heads on U-shape support frame and fixed. The testees are informed of no head moving during the experiment. The tester adjusts the eye movement equipment. Nine o'clock is adopted to correct sight tracking system and the practical experiments and formal ex-

periments are carried out when reaching the required accuracy. When eye correction is over, the testees carry out practical experiments under the guidance of the tester. When the testees have understood guidance language and requirements, the formal experiments starts. The testees are required to judge whether the following presented description information is right or not, once the action images of football match on the computer screen. The eye movement equipment will automatically record the eye movement data in the fixation process.

3.3. Experimental Materials

The experimental materials adopted in this research are the video record of high-level football matches, deriving from Women Volleyball Team matches of 10th National Games, held in Nanjing in October, 2005. Photoshop is used to edit rather clear cut-scenes, including 2 pieces of exercise materials, 10 pieces of official materials, 5 pieces of central information pictures and 5 pieces of peripheral information pictures.

3.4. Experimental Instrument

Eye Link II is adopted to record the testees' eye movement process. One computer presents stimulating materials to the testees and another one monitors and records experimental data by tester. The eye position of the testee is of equal altitude with screen center and the distance between eyes and the screen is 60cm and the head is fixed on the frame. The experimental procedure adopts VC++ formation, the experimental display is of 19 inches, its resolution ratio is 1024x768 and refresh rate is 85Hz. The instrument will record automatically the indexes such as the fixation point, fixation time, fixation count, saccade and pupil diameter.

4. Experimental Results

4.1. Fixation Count and Time

Make variance analysis of repeated measurement on fixation count indexes. The results shows that the main effect of material types is significant ($F = 14.621, P < 0.01$). The differences of material properties have an obvious effect on the fixation count. The fixation count of central information pictures is less than that of peripheral information pictures. The major reason for this is about the central information concentration. The main effect between groups is not significant ($F(1, 43) = 2.459, P > 0.05$). Furthermore, through comparing LSD there are significant differences between the fixation counts of the expert group, common group and novice group while there is no significant difference in other aspects. The interaction between material properties and groups is not significant ($F(2, 43) = 0.043, P > 0.05$).

4.2. Analysis on the Duration Time of Fixation Point

Make variance analysis of repeated measurement on first fixation point. The results shows that the main effect of material types is not significant ($F(1, 43) = 1.075, P > 0.05$); the main effect between groups is not significant ($F(2, 43) = .588, P > 0.05$); the interaction between material properties and groups is not significant ($F(1, 43) = 1.018, P > 0.05$); the differences of material properties has no significant effect on the duration time of the first fixation point. There is no significant difference between three groups in the duration time of the first fixation point.

Table 1. Three Groups of Participants to the first Fixation Duration Comparison (ms)

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	316	55	315	60
General group	342	82	324	58
The novice group	317	90	321	89

Table 2. Three Group Subjects first Fixation Duration Comparison (ms)

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	190	46	195	38
General group	231	70	202	45
The novice group	276	152	219	80

Make variance analysis of repeated measurement on secondary fixation point. The results shows that the main effect of material types is significant ($F(1, 43) = 4.686, P < 0.05$); the effect of different materials has significantly effects on the duration time of secondary fixation point; the main effect between groups is not significant ($F(2, 43) = 2.113, P > 0.05$); furthermore, through comparing LSD, it is found that the expert group is faster than the novice group and there is no significant difference in other aspects. The interaction between material properties and groups is not significant ($F(2, 43) = 2.024, P > 0.05$).

4.3. Pupil Diameter Analysis

The length of pupil diameter is one quantitative index which reflects the mental load in the process of pattern recognition. The higher tension degree of cognitive processing is, the greater the pupil diameter is. Make variance analysis of repeated measurement on pupil diameter index (statistical results see table 5). The results shows that the main effect between groups is significant ($F(1, 43) = 23.161, P < 0.01$); the pupil diameter of the expert group is greatest while that of common group and novice group is smaller; the main effect of material types is not significant ($F(2, 43) = 0.840, P > 0.05$);

there is no significant effect of material types on pupil diameter. The interaction between material properties and groups is not significant ($F(2, 43) = 1.115, P > 0.05$).

Table 3. 3 Comparison Group Subjects at Times (ms)

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	26.02	2.61	27.31	2.43
General group	24.77	2.79	25.93	3.13
The novice group	23.52	4.27	23.75	4.62

Table 4. 3 Groups of Participants to Gaze Durations are Compared (ms)

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	258	22	251	21
General group	276	26	273	30
The novice group	281	45	278	40

Table 5. 3 Comparison of Pupil Diameter was Trying Times (MS)

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	1441	615	1521	609
General group	1129	579	1182	583
The novice group	1326	918	1327	914

Table 6. 3 Comparison Subjects first Saccade Distance

Test group	Central information		Peripheral information	
	M	SD	M	SD
Expert group	2.71	0.43	3.07	0.49
General group	2.21	0.69	2.42	0.31
The novice group	2.43	0.91	2.65	10.1

4.4. Saccade Distance Analysis

Saccade distance reflects the scope and information of once fixation content (statistical results see table 6). Make variance analysis of repeated measurement on saccade distance index (statistical results see table 5). The results shows that the main effect between groups is significant ($F(1, 43) = 6.381, P = 0.015$); there is significant effect of material types on saccade distance and the average saccade distance of peripheral information pictures is larger than that of central information pictures. The main effect between groups is significant ($F(2, 43) = 3.286, P < 0.05$); further LSD test shows that there is significant difference between the expert group and the common group. The expert group has the largest saccade

distance while the common group has the smallest saccade distance. There is no significant difference between the common group and novice group. The interaction between material properties and groups is not significant ($F(1, 43) = 0.286, P > 0.05$). The results declares that the fixation scope of the expert group is larger than that of the common group and novice group and the saccade distance during peripheral information processing is larger than that during central information processing.

5. Conclusion

For athletes, the fixation account on the central information is less than that on peripheral information; the fixation account of the expert group is more than that of the novice group; for the expert group, the saccade distance of peripheral information is smaller than that of central information.; the fixation account of the expert group is significantly larger than that of the novice group; the differences of indexes between the central and peripheral information is not significant. This shows that the expert group adopts strategies of concentrated fixation and search of central information while adopts strategies of rapid and large-scope scanning of peripheral information. The expert group has a stronger information processing capability, the duration time of secondary fixation point is shorter, the fixation account is more and the duration time of fixation is short. There is significant difference between the expert group and the novice group. There is significant difference between the expert group and the common group in saccade distance. Different materials affect the duration time of secondary fixation point, fixation account, the duration time of fixation and saccade distance. For the athletes in different levels, from expert to novice, the cognitive difficulty of the same task is increasing. The eye movement index of the testees has obvious changes. The initial processing time increases, the duration time of fixation is longer, fixation frequency is lower, the pupil diameter is shorter, the saccade distance is smaller and the attention to sphere obviously decreases.

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