11. STUDIES ON THE VISUAL FIXATION POINT OF JUDOISTS

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From ancient times the aspect of the eyes during Judo has been considered important and was termed "Metsuke". However, scientific studies regarding it have not been made. By using a headpiece television eye-camera the "look" of the judoist and the non-trainee were investigated by making the experimental subjects regard a fixed point during basic postures (basic natural posture and basic defensive posture) and while standing erect.

METHODS OF INVESITGATION

1) Two university student Judoists, 20 and 21 years of age, respectively, and both III-dan holders, and 2 non-trainee university students, 19 and 20 years of age, respectively, were selected as expermental subjects.

2) The experiments were conducted in the laboratory of the NHK Scientific Research Institute from 24th March, 1966 to 18th July, 1966.

3) The head-piece television eye-camera was used. The general make-up of the appratus is illustrated in Fig. 1 and a photographic view of the apparatus in use is shown in Fig. 2. It consists of a device to detect the visual fixation point by utilizing the light reflected from the cornea (light from a miniature electric bulb is applied to the cornea and by catching the reflection thereof by means of a concave lens the real image of the lamp filament may be obtained as a single bright point, because the cornea acts as a convex mirror. The bright point moves with the movement of the eyeball) and a television camera. Also, by using an optical fiber and a small-size optical system, the apparatus may be fitted to a helmet and allows convenient use without fixing the head. The weight imposed on the head is 1.3 kg. and does not interfere with the experiment. Two sets of optical systems are attached to the front part of the helmet: one set photographs the scene which the subject is looking at in front and focuses the image at one end of the optical fiber. The image which appears at the other end after passing through the optical fiber is photographed on a Vidicon photoelectric surface by means of a lens system and then monitored. The other set of optical system is devised to catch the visual fixation point as a bright point by applying the light from a miniature bulb to the left eye and the reflection thereof is reflected upward by means of a half mirror and after passing through a lens is focussed at one end of the optical fiber. The output is reproduced by another Vidicon camera as a point on the screen.

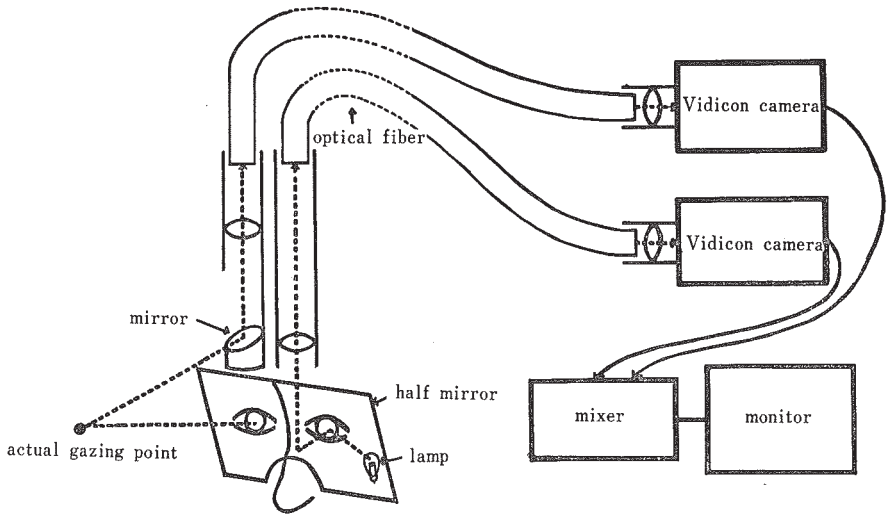

Fig. 1 Scheme of Television eye-camera

By reproducing the output of these two Vidicon cameras into one picture the point of visual fixation may be directly detected[1].

4) The experimental subjects were made to fix their eyes for 3 minutes in their respective postures on an exciting point (light from a mercury lamp was projected by a lens to form a spot on the screen in a dimly lit room) on the screen situated 3 meters in front. The movements of visual fixation point and the exciting point (posture) were observed by monitoring and also were simultaneously filmed by a 16 mm. cinecamera (24 frames per second).

5) The data obtained during the 3 minutes of recording were classified into the following time groups and studied: 0 second–30 seconds (first half), 1 minute 15 seconds–1 minute 45 seconds (middle

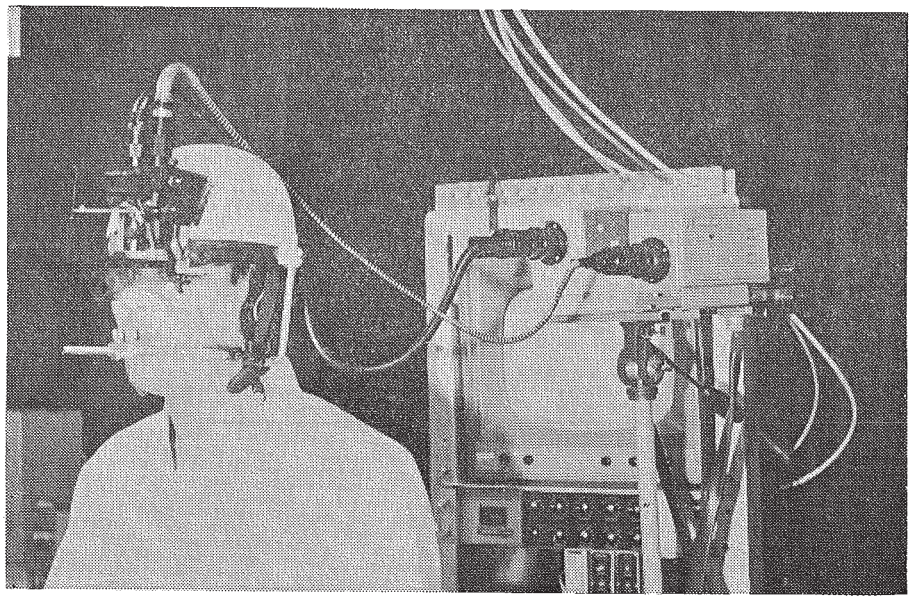

Fig. 2 A photograph of the experimental apparatus

half), and 2 minutes 30 seconds –3 minutes (latter half). By means of a motion analyzer the serial changes of the visual fixation point and exciting points were studied on every 4 frames (0.17 seconds), and were plotted on the X axis (vertical direction) and Y axis (horizontal direction). The reason for investigating every 4 frames is because the movement of the eye following a moving object, i.e., pursuit movement and the impulsive movement of changing the point of visual fixation occur in a cycle of approximately 0.2 seconds and only very rarely in less than 0.2 seconds[2].

Since the movement of the visual fixation point on the screen is brought about by the movement of the eyeball itself and also by the movement of the body, the real movement of the visual fixation point (movement due to the movement of the eyeball) may be determined by subtracting the movement of the exciting point (movement due to posture) from movement of the visual fixation point on the screen (solid lines in Figs. 3,4, and 5 indicate movement of visual fixation point, and the dotted lines the movement of posture).

RESULTS AND DISCUSSION

1) The main action of the eyeball movement is to project the image of the object of vision on the fovea centralis of the retina (visual fixation=central vision, i.e., forming the image of the object of vision on the fovea centralis)[3].

2) The diameter of the fovea centralis wherein the best vision is obtained is approximately 1°[4].

3) A very minute involuntary physiological movement exists and is approximately ±10′[5]. In other words, when considering the visual fixation point a very minute deviation may be neglected, and if the deviation is within 1° of the visual angle it may be considered as visually fixed. From this viewpoint, a 1° zone (±30′) was marked on the diagram.

In order to investigate the fundamental aspect when fixing the eyes the pattern during the first half of the erect posture is illustrated in Fig. 3. It will be seen that in spite of the fact that the eyes are fixed on a certain point the eyes are moving in various directions, however, the cycle with which the eyes move was not ascertained. Blinking interrupts visual fixation, and while the visual fixation point moves suddenly a drop in visual acuity occurs. The upward movement which occurs before and after blinking corresponds to this state of lowered visual acuity. Since visual acuity is zero during blinking, from the viewpoint of fixing the eyes blinking is a disadvantageous activity. The visual fixation point moves upward when blinking, and there is no influence on the horizontal direction. This is understandable from the fact that during sleep the eyeballs are rotated upward. When the judoist was compared with the non-trainee, it was found that the non-trainee blinked more, thus interrupting visual fixation more than the Judoist, and also that the posture of the non-trainee was more unstable than that of the Judoist, presumably due to the influence of more blinking in the non-trainee.

Fig. 4 shows the pattern during the latter half when the feet were placed one foot length apart constituting the natural basic posture of the basic posture of Judo. It will be seen that in the Judoist, visual fixation is often interrupted by blinking, and instability is also observed in the posture of the non-trainee. No difference in the condition of visual fixation was observed in the erect posture and in the natural basic posture.

Fig. 5 shows the pattern during the latter half of the posture in which the hip is lowered by further separating the feet and constituting the defensive posture. This is a position which involves a considerable amount of isometric contraction, and compared to other postures more agitation of the visual fixation point was observed. Also, minor disturbances of posture were increased when compared to other postures and sometimes major disturbances were seen. When the Judoist and the non-trainee were compared, more stability was observed in both the visual fixation point and posture in the former than in the latter.

The upper section of Table 1 shows deviation from the range of visual fixation, i.e., area outside the visual fixation zone, and the lower section shows the frequency of blinking and the average time

required for blinking. The area outside the visual fixation zone was smaller in the Judoist than in the non-trainee indicating that the duration of visual fixation was longer in the former than in the latter. The frequency of blinking was less in the non-trainee, E.T. than in the Judoist, T.M., however, considering the area outside the visual fixation zone, it is thought that visual fixation was less stable in E.T. than in T.M. Generally, the frequency of blinking is said to be approximately 10–20 times per minute. In the present experiment there were 3 subjects with a low frequency of blinking and one with a high frequency. Judoist Y.S. blinked very little. It is said that the time required to blink in a voluntary blink is 0.2 second and in an involutary blink 0.3–0.4 second[6]. In the present experiment it is presumed that blinking was mostly involuntary. The blinking time of the non-trainee was 0.32–0.34 second and that of the Judoist was 0.21–0.25 second indicating a blinking time very near that of the voluntary blinking time.

CONCLUSION

In order to investigate the movement of the eyes during Judo, a television eye-camera was used and a comparative study of the eye movement of Judoists and non-trainees during visual fixation was made.

Basically, the visual fixation point fluctuates very minutely even when fixing the eyes, and blinking creates a large fluctuation. Since visual acuity is lowered when the visual fixation point shifts before, during and after blinking, this activity is disadvantageous when fixing the eyes at a certain point. The time required for a blink was approximately 0.2–0.3 seconds. Blinking is presumed to influence

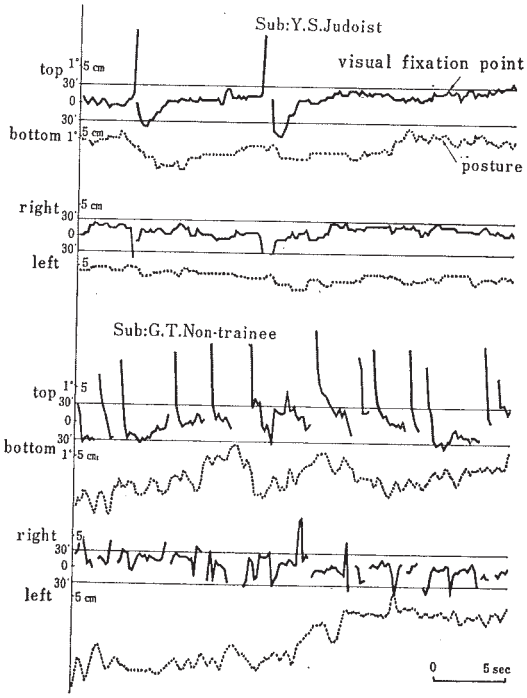

Fig. 3 Standing posture, first half

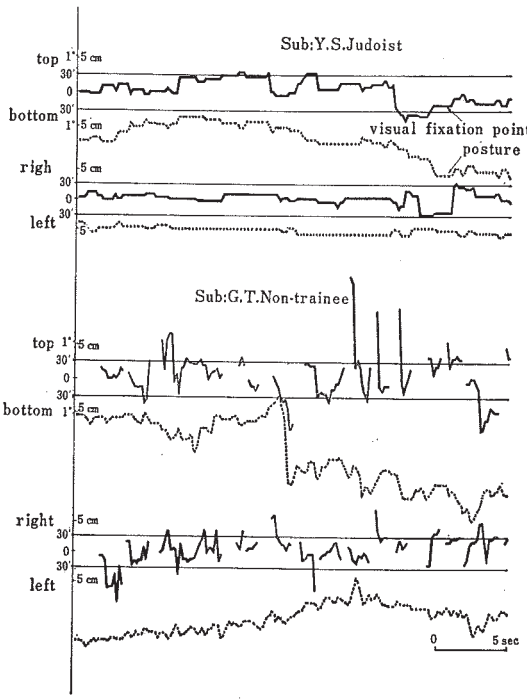

Fig. 4 Basic natural posture (Shizen-hontai) latter half

posture by disturbing its stability. A comparison of visual fixation during varying postures of Judoist and non-trainees revealed a higher stability in the former than in the latter. No significant difference in the visual fixation and disturbance of posture were noted in the erect posture and natural basic posture, however, in the natural defensive posture the fluctuation of the visual fixation point and disturbance of posture were quite pronounced, and are presumed to be due to the influence of posture.

The frequency of blinking was less in the Judoists than in the non-trainees, and the average blinking time was also less in the former than in the latter.

The aforementioned result sindicate that there is a significant difference between Judoists and non-trainees with regard to fixing the eyes at a certain point, and that Judo training is advantageous to the eye movement regulating mechanism of the eyes.

The above investigation is first of a series of studies on the eye movement in Judo, and further studies will be made on how the eyes respond to a moving stimulus or other complicated stimuli.

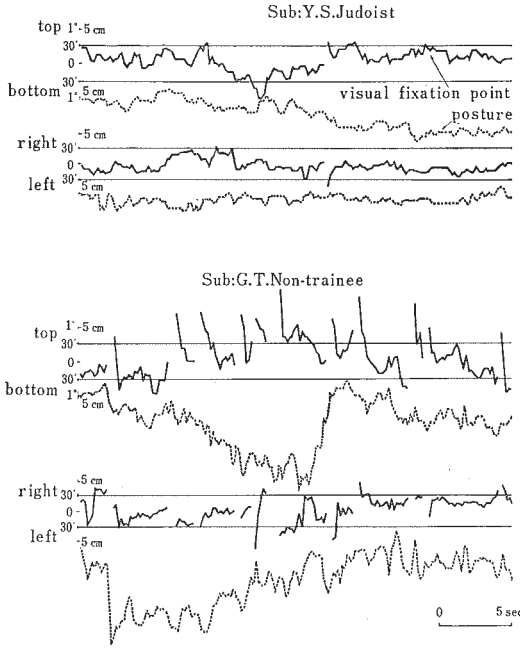

Fig. 5 Basic defensive posture (Jigo-hontai), after half

Table 1

Juboist		Standing posture			Basic natural posture			Basic defensive posture		
		first half	middle half	latter half	first half	middle half	latter half	first half	middle half	latter half
Sub Y.S.	top bottom	2400	99	198	0	78	118	131	118	113
	left right	4	125	26	0	31	3	38	25	4
Sub: T.M.	top bottom	397	373	91	389	1081	560	299	586	209
	left right	780	69	145	100	121	32	43	72	365
Non-trainee										
Sub: G.T.	top bottom	1013	763	790	2174	1500	892	900	1089	814
	left right	227	445	252	548	876	388	312	66	166
Sub: E.T.	top bottom	1046	532	3205	1520	1324		1192	776	1757
	left right	201	91	538	13	0		80	56	113

Judoist	frequency and duration of blinking									
Sub: Y.S.	1	1	0	1	1	0	3	0	1	total 8 times(4'30") average 0.25 sec.
Sub: T.M.	6	7	4	3	4	6	8	3	5	total 48 times(4'30") average 0.21 sec.
Non-trainee										
Sub: G.T.	13	14	12	12	14	17	11	18	12	total 123 times(4'30") average 0.34 sec.
Sub: E.T.	2	4	6	3	6		1	3	2	total 27 times (4') average 0.32 sec.

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