

Kinetic visual acuity and reaction time in male college students

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The purpose of this study was to investigate the relationship between kinetic visual acuity and reaction time in college students. Eighteen male college students, mean age: 21.5±2.2 years, participated in this study. Static and kinetic visual acuity and simple and choice reaction time were measured. In addition, visual evoked potential using pattern reversal stimulus was recorded. These items were measured by the following apparatuses: KOWA AS-4F (visual functions), Takei Scientific Instruments T.K.K.1264b (reaction times), Biopac MP150, AcqKnowledge software, and Biopac ERS100 amplifier (visual evoked potential). The results indicated that there was no significant correlation between kinetic visual acuity and reaction time(KVA-SRT: $r=-0.135$ $p=0.595$, KVA-CRT: $r=0.183$ $p=0.468$, KVA/SVA×100-SRT: $r=-0.060$ $p=0.813$, KVA/SVA×100-CRT: $r=0.024$ $p=0.925$). Further, there were no significant relationships between reaction time and the latencies of visual evoked potential (SRT-N70: $r=-0.323$ $p=0.191$, SRT-P100: $r=0.453$ $p=0.059$, SRT-N140: $r=0.219$ $p=0.383$, CRT-N70: $r=0.034$ $p=0.893$, CRT-P100: $r=-0.271$ $p=0.277$, CRT-N140: $r=-0.049$ $p=0.847$). Therefore it was suggested that quick reaction time was not linked to high kinetic visual acuity. In this study, some data relative to mechanism of kinetic visual acuity were obtained.

Key words : Kinetic Visual Acuity, Simple Reaction Time, Choice Reaction Time, Visual Evoked Potential, Pattern Reversal Stimulus

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1. Introduction

Numerous studies that examine visual function in athletes make it obvious that visual function in athletes is superior to that in non-athletes. Further, athletes who demonstrate higher skill exhibit better visual function compared with athletes who demonstrate lower skill levels (Laby et al., 1996; Russo et al., 2003; Stine et al., 1982). Among the visual functions, dynamic vision has been the subject of a number of previous studies. Dynamic vision is divided into Dynamic Visual Acuity and Kinetic Visual Acuity (KVA). Of these, KVA has been studied extensively in Japan for many years.

Suzumura (1971; 1961) points out that accommodation, amphiblastrode, nerve center and congestion functions affect the factors and mechanism of KVA. Yamada

and Morita (1969) reported that KVA increased after accommodation training in both athletes and non-athletes. On the other hand, Atsumi (1993) reported an age-related decrease of KVA that was similar in both the phakic eye and non-adjustable intraocular lens, and that adjustability did not influence KVA ability. Therefore, there is disagreement over the relationship between KVA and adjustability. Our report also shows a decrease in the relationship between KVA and ability for simple reaction time that can be expected from the method of KVA measurement, which is only one part of the other experimental data (Kohmura & Yoshigi, 2004). However, few recent studies of KVA mechanism have been published, and many questions remain unanswered.

Recently, Visual Evoked Potential (VEP) was recorded in an electrophysiological clinical examination of visual

sense. VEP is an electrical change in the brain precipitated by visual stimulation. VEP measurement records electrical alteration when an electrical impulse undergoes photoelectric conversion in the retina through the visual nerves, the lateral geniculate body and visual areas of the lobus occipitalis (Emoto & Yano, 2002). In particular, the latency of peaks in VEP is used in the diagnosis of optic nerve disease. It is known that a peak latency of P100 delays fasciculitis optica and ischemic optic neuropathy (Mizota, 2006). Also, in the field of sports medicine and science, VEP research has begun targeting athletes. As a result it has been reported that the latency of peaks in N70 and P100 in athletes who react quickly from visual stimulation have a tendency to be short (Delpont et al., 1991; Taddei et al.1991; Thomas et al., 2005).

We have already reported that shortness of peak latency in VEP and KVA are related. (Yoshigi et al., 2007) However, there are no reports on the interaction of KVA, reaction time and VEP research conducted simultaneously, which can be considered as being in the same category of reaction as visual stimulation. Based on the results of earlier studies, it is believed that there may be some relationship among the speed of reaction time, KVA and VEP peak latency. In this study, therefore, I examined the relationship between simple reaction time and choice reaction time, a measurement long used in sports science, and KVA, in order to obtain one data set for the KVA mechanism. In addition, I would like to examine whether there is a relationship between both reaction times, by way of recording VEP for the same individual.

2. Methods of study

2.1. Test subjects

Test subjects were 18 male University undergraduate and graduate students enrolled in the Physical Education Department of University (average age 21.5 ± 2.2 years). In this study, test subjects were chosen randomly, and participation was not limited to involvement in specific sports. The purpose and content of this study was explained to participants and written consent was obtained from all test subjects. Approval for this study was obtained from the Research Ethics Committee of the Juntendo University Graduate School of Health and Sports Science. All measurements were performed on the right eye

under ordinary corrected conditions. Further, as a Static Visual Acuity (SVA) of 0.7 is considered the minimum requirement for participation in sports (Edagawa et al., 1995), we included test subjects with SVA greater than 0.7.

2.2. Measurement of visual function

Measurement of SVA and KVA was performed by dynamic vision analyzer, model AS-4F, produced by KOWA Co. Ltd. In the measurement of KVA, the Landolt ring is set to approach the subject from the front, moving from 50 meters to 2 meters at a rate of 30 kilometers per hour. Recognition of the Landolt ring on the dynamic vision analyzer AS-4F within 30 meters is equivalent to a visual acuity of 1.0. Test subjects responded by indicating the direction of the ring gap at the moment the direction of the gap was identified. Measurement values were recorded for correct responses only, and measurements were taken until 10 correct responses were recorded. Values were then averaged with maximum and minimum values excluded. If greater than 4 incorrect responses were given, test subjects were allowed period of rest before measurement was started again from the beginning. Also, SVA and KVA values could be obtained as decimal visual acuity. However, decimal visual acuity is the inverse of visual sense; therefore, the interval of value is not supposed to parallel ability (Kato, 1989). Moreover, in order to avoid positive, negative and zero values (a decimal visual acuity of 1.0) by a simple conversion to logarithmic parameters, statistical processing was carried out by multiplying the measurement values by a factor of ten prior to conversion to logarithmic parameters. After converting into logarithmic parameters, the KVA ratio for SVA was calculated.

Investigators commonly attempt to shorten KVA measurement time by averaging 5 measurement values. However, as in the measurement of reaction time, in order to obtain better measurement accuracy, measurements were taken 10 times and averaged after excluding maximum and minimum values.

2.3. Measurement of reaction time

Reaction time to light stimulation was measured using a T.K.K.1264b manufactured by Takei Scientific

Instruments Co. Ltd. Light stimulation for simple reaction time employed a red light only. Test subjects were directed to respond as soon as they identified the red light. In the measurement of choice reaction time, red, blue and yellow were used for light stimulation; however, test subjects were directed to respond to red only. Only correct responses were recorded, and when test subjects reacted in error more than 4 times, a rest period was taken before measurement was started again from the beginning. The order of stimulus colors was random. Test subjects were instructed to use the forefinger of their right hand to push a response button. After practice measurements were completed, 10 measurements were taken. Values, excluding maximum and minimum values, were averaged and used as the measurement values.

2.4 Recording Visual Evoked Potential (VEP)

VEP was recorded using earlier studies (Odom et al., 2004; Thomas et al., 2005) as reference. On a liquid crystal display, a black and white checker board design was reversed and used as visual stimulation. The distance from the display measured 82 cm. The size of each check and screen measured 60 minutes, and 20 degrees \times 30 degrees. Stimulation reversal frequency was 2 reversals/second. The reverse of black and white was block pulse modulation. Contrast of stimulation was 86%, and average brightness was 79cd/m². The active electrode was in Oz, the reference electrode was in Fpz and the ground electrode was in Cz. VEP was recorded using a

Biopac MP150 and AcqKnowledge software. Biopac ERS 100 was used as an amplifier with the gain set to 50,000. The sampling rate was 10 kHz (samples per second) and the Band-pass was 1-3000Hz. Test subjects were directed to hold their focus on the center of stimulation and measurements were recorded for right eyes only. On the basis of reverse stimulation, they were averaged 100 times and latencies were recorded (N70, P100 and N140) (Figure 1). Also, a Braun tube display was used in an exploratory experiment to uniformly correct the average difference of latency (45msec).

2.5 Statistical processing

The average value and standard deviation of each measurement value were calculated. In addition, the correlation among VEP, simple reaction time, choice reaction time and KVA (including KVA rate of static vision) were analyzed. Pearson's product-moment correlation coefficient was used for correlation analysis. Statistical significance was determined to be 5 % and test of significance was performed by two-sided test.

3. Results

The results for each measurement are shown in Table 1, and the correlation coefficients of measurement values are shown in Table 2. No significant correlations were seen between each component of both reaction times and KVA, and both reaction times and VEP.

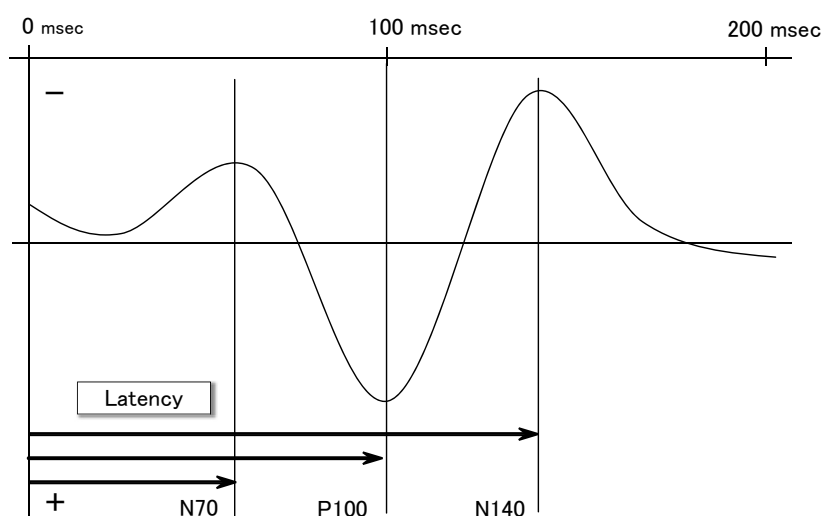


Figure 1. Parameters in visual evoked potential

4. Discussion

In this study, the relationships among KVA, simple reaction time, choice reaction time and VEP latency, which records the reaction of the cerebral visual area to visual stimulation, were examined. Regarding the relationship between KVA and VEP, results obtained in this study were consistent with results obtained in earlier studies (Yoshigi et al., 2007) and a significant correlation was found between the two, even if it was at a medium level. On the other hand, a low coefficient of correlation between KVA and both reaction times was revealed. From the results of this study, it is suggested that the relationship between KVA and reaction time is weak. That is, in the measurement at 30 kilometers per hour, KVA is high not because the reaction time is fast, nor is it low because the reaction time is slow. However, having subjects identify the direction of the Landolt ring gap, which moves towards the subject at 30 kilometers per hour, using an indicator is

believed to exert an effect on reaction time. And for cases in which the speed of target movement is quick, the effect is significant.

No significant correlation between simple reaction time, choice reaction time and VEP was revealed. Other studies show mixed results and little agreement with one reporting that change of VEP peak latency corresponding to changes in brightness exceeds the change of simple reaction time, and others claiming changes to be parallel (Jaśkowski et al., 1990; Kammer et al., 1999; Takiura, 2004). In either case, from these reports, it can be seen that the delay of latency of peaks relates to the delay of reaction time. From the results of this study, no significant correlation between reaction time and the VEP component was yielded. However, I could obtain a coefficient of correlation of a medium level in P100 latency and simple reaction time. One possible reason for the failure to obtain a significant correlation may be that the effect of the number of test subjects, variance

Table 1. Means and standard deviations of visual function, reaction time, and latencies in visual evoked potential

n = 18		M	SD
Static Visual Acuity (SVA)		1.07	0.09
Kinetic Visual Acuity (KVA)		0.79	0.17
KVA/SVAx100 %		73.3	12.0
Simple Reaction Time		177.0	18.5
Choice Reaction Time		270.2	35.3
Latency	N70	71.1	4.0
	P100	102.2	5.3
	N140	137.1	7.7

Table 2. Pearson's correlation coefficients among variables

variables		Kinetic Visual Acuity	KVA/SVA x100	Simple Reaction Time	Choice Reaction Time	
Simple Reaction Time	r	-0.135	-0.060			
	p	0.595	0.813			
Choice Reaction Time	r	0.183	0.024	-0.105		
	p	0.468	0.925	0.678		
Latency	N70	r	-0.529 *	-0.574 *	-0.323	0.034
		p	0.024	0.013	0.191	0.893
	P100	r	-0.187	-0.172	0.453	-0.271
		p	0.458	0.495	0.059	0.277
	N140	r	-0.152	-0.286	0.219	-0.049
		p	0.547	0.250	0.383	0.847

n = 18, * p<0.05

of reaction time and VEP latency of peaks were small. Another reason is that this study was not undertaken with the purpose of targeting the delay of reaction time and VEP latency of peaks when the brightness in eye tracking was changed. In addition, a study by Thomas et al. (2005) reports that top-level cricket players have shorter latency of peaks in VEP compared to ordinary people, yet there was no difference in the measurement value of reaction time. The reaction time reported by Thomas et al. differs slightly from that reported in this study; therefore, the two cannot be compared simply. However, based on the low correlation between reaction time and KVA, reaction time and VEP, and the relationship between VEP and KVA, reaction times commonly measured in the field of sports science for many years, activating the indicator quickly after identifying light and color is a comparatively simple task. And the results might affect the fact after inputting information such as speed of muscle contraction, and not before inputting the information. However, the results obtained from this study do not allow a detailed examination of this. I would like to reconsider the methods of this study and leave the issue open for the moment.

As described above, I believe that the direct relationship between KVA, simple reaction time and choice reaction time are low. In addition, there was a significant relationship between the VEP component and KVA. On the other hand, the relationship between VEP, simple reaction time and choice reaction time were at medium and low levels. In the future, additional research is needed to clarify the relationship between KVA and reaction time, both measurement items classified as reactions to visual information.

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