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Abstract	本研究は, 限ー頭位の協応をともなう全身反応時間を指標として用い, オープン・スキル系スポーツのトレーニング効果のメカニズムを明らかにしようとしたものである。 成人男子大学生の5つの運動種目群(水泳, パレーボーノレ, 水球, サッカー, 陸上競技短距離〉と非運動群, および5歳から12歳までの幼児・児童の各年齢群を横断的な比較検討の対象とした。また, 継続的にサッカーを行っている11人の児童を6歳から5年間, 縦断的に追跡調査した。被験者は, 左右および上下を示す矢印に従いジャンプ或いはしゃがみ込むという反応動作を行うものである。 横断的検討により得られた結果は以下のとおりである。 1) 成人において水泳を除く4つの運動種目群の中枢での決断含む反応時間(LatentTime)は, 非運動群より短かった。 2) 幼児・児童の反応時間(LatentTime)は, 加齢とともに著しく短縮する傾向を示した。 そして, 縦断的検討により得られた結果は, 以下のとおりである。 1) 各被験者の反応時間(LatentTime) の発達には個人差があるが, サッカーを継続的に行った影響が8歳以降顕著に認められる。 2) 幼児・児童の発達的変化のなかでも興味深いのは反応時間の顕著な短縮の後には必ず、遅延, 或いは停滞の現象が認められることである。
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The Development of Reaction Time Accompanied with Eye-head Coordination as an Index of Open-skill

By *Akihiko Kondoh**

INTRODUCTION

There is no doubt that one of the determining factors of "open-skill" is the promptness of body movement associated with information processing from countless environmental signals. We have conducted a series of experiments to clarify the open-skill from the view point of bodily selective reaction time accompanied with eye-head coordination by comparative investigation in groups, in terms of training effect, developmental change, effect of anticipation, etc.[1][2][3]

However, there was a limitation in this comparative method. Thus, it was considered necessary to investigate strictly the relationship between open-skill and inter- and intra-individual variations by constructing the adequate psychological scale.

For the reasons above, the following items were investigated:

1) The factor which may determine total reaction time.
2) The scale of latent time.
3) The relationship between latent time and open-skill.
4) The training effect of open-skill on developmental change.

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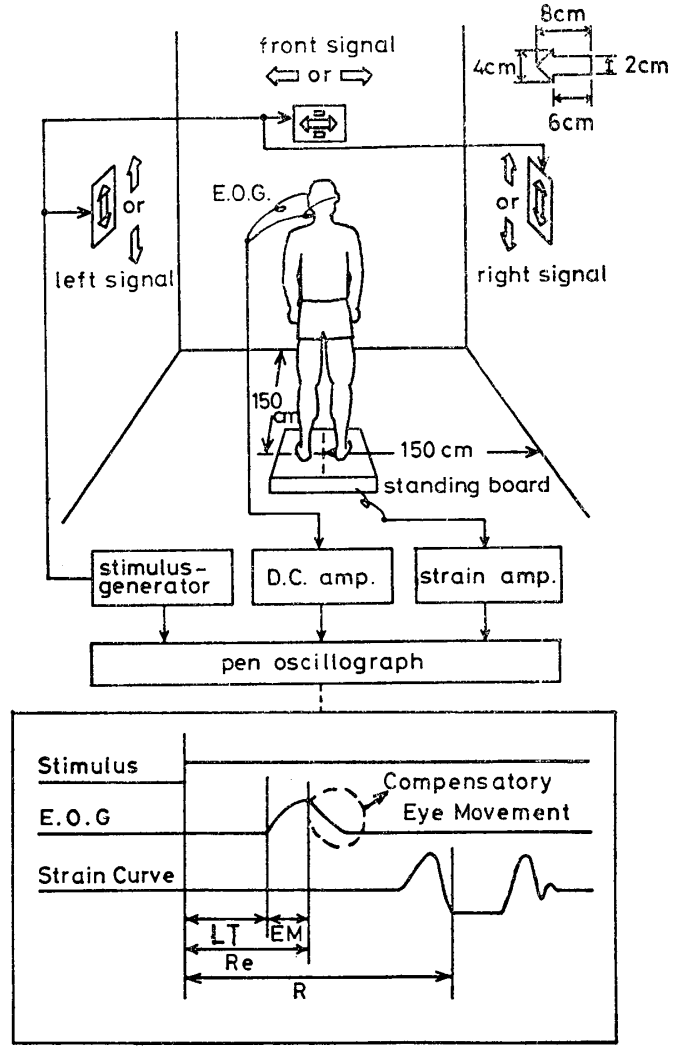
A part of this article was presented at 6th world sport psychology congress in collaboration with Prof. Atsushi Fujita (College of humanities and sciences, Nihon university), Prof. Toshiaki Yoshimoto (College of humanities and sciences, Nihon university) and Assistant prof. Kazuo Fukami (Nihon university at Mishima).

I thank Assistant prof. Kishio Nakamura (Institute of physical education, Keio university) for helping translate this article.

METHOD

Subject reacts to the signals as fast as possible, in the direction the arrow points; that is, firstly he moves his eyes and head toward the side signal as indicated by the front signal, and subsequently he reacts by either jumping or crouching, according to the direction, either upwards or downwards, the side signal points.

The signals were presented at random 20 times; the 4 variations of assorted stimulus such as upward or downward on right-side or left-side were presented



LT: Latent Time EM: Eye Movement Time

Re: Reception Time R : Total Reaction Time

Fig. 1 Experimental layout and classification of total reaction time

5 times respectively.

In order to check the eye movement, an Electrooculogram (EOG) was recorded on an oscillograph. As regards body reaction, a Strain Curve was recorded on the same oscillograph.

The total reaction time (R) measured was classified into 3 time phases as; 1) LT: Latent time. 2) EM: Eye movement time. 3) Re: Reception time. (See Fig. 1)

Five groups of athletes (swimming n=21, volleyball n=22, water polo n=14, soccer n=28, sprint n=21) and a group of non athletes (n=48) of Keio university students from 18 to 22 years of age, and children from 5 to 12 years of age (5 years. n=24, 6 years. n=92, 7 years. n=54, 8 years. n=36, 9 years. n=30, 10 years. n=32, 11 years. n=16, 12 years. n=15) were allocated to this experiment. And 11 children who have been continuing playing soccer were consecutively pursued for five years since 6 years of age.

RESULTS AND DISCUSSION

1. What is the factor which may determine total reaction time?

Reception time (Re) accompanied with eye-head coordination has been used as an index, to clarify the open-skill because Re was considered to play an important role in determining the total reaction time (R).[4]

Re is divided into two time phases as Latent time (LT) and Eye movement time (EM).

Highly significant correlation coefficient ($r=0.8201$, $p<0.001$) was found between Re and LT in adults. This result means that LT is determinant to Re.

LT is considered the important time phase which includes decision making process affected by the attentional level, arousal state, etc., in the central nervous system.

Furthermore, highly significant correlation coefficient ($r=0.619$, $p<0.001$) between LT and R was also found.

It is concluded from the results mentioned above that LT is the appropriate index of the promptness of eye-head coordination and also total reaction.

2. What is the adequate scale of Latent time (LT)

As a next step of approach, it is necessary to use adequate psychological scale in order to carry out the longitudinal analysis of LT strictly.

From theoretical viewpoint, reaction time is used to be transferred logarithmically based on Fechner's law.

$$x' = \log x \quad \text{..... formula 1}$$

Were "x'" is genotype scale and "x" is phenotype scale. Formula 1 is considered approximate.

It is assumed that LT is composed of two time phases. One is the time phase of relatively stable mechanical process which is determined by structural and functional organic system, and another is the time phase of relatively variable process of decision making which is easily affected by psychological processes such as attentional level, arousal state, etc. Based on this assumption, adapting the former time phase into the formula 1, a new transfer function is obtained as;

$$x' = \log (x-c) \quad \text{..... formula 2}$$

Where "c" is time phase of relatively stable mechanical process. And thus, theoreti-

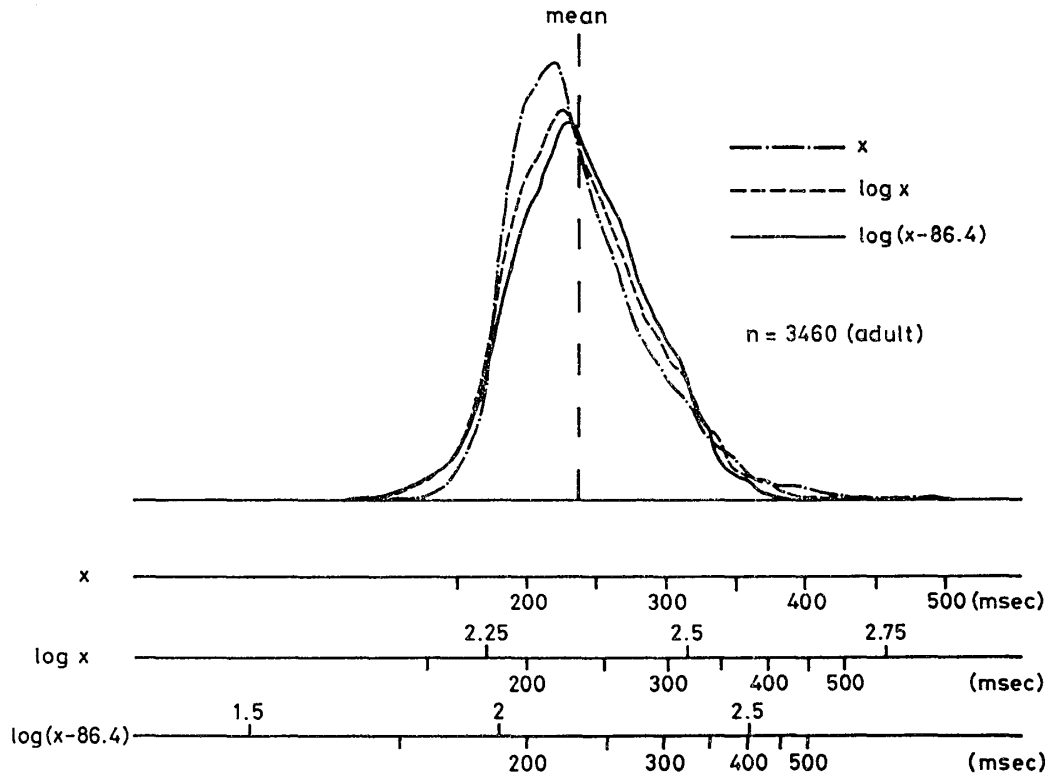


Fig. 2 Differences among three distribution curves

cally minimum value calculated was 86.4 msec.[5]

Fig. 2 shows the differences among three distribution curves in adult data; a dashed-and-dotted line was gained from pre-transferred data, a dashed line was gained from formula 1, and a solid line was gained from formula 2.

The line gained from pre-transferred data shows log-normal distribution curve. Both distribution curves gained from transfer formula are far closer to normal distribution than that gained from pre-transferred data.

Compared the distribution curve gained from $<\log x>$ with that gained from $<\log (x-86.4)>$, it is clear that the latter is somewhat closer to normal distribution curve than the former is.

However, theoretical minimum value "c" was 86.4 msec so far as observed in adult students, and it remains to be clarified in the case of children, since the data were not enough in number to calculate "c" in this study. Thus it is considered that $<\log (x-86.4)>$ can not be valid yet to use in general at this stage.

It is concluded from the reasons mentioned above that $<\log x>$ is the adequate and usable transfer function of scaling LT at this stage, even though we take into account that LT is composed of two phases in central nervous process.

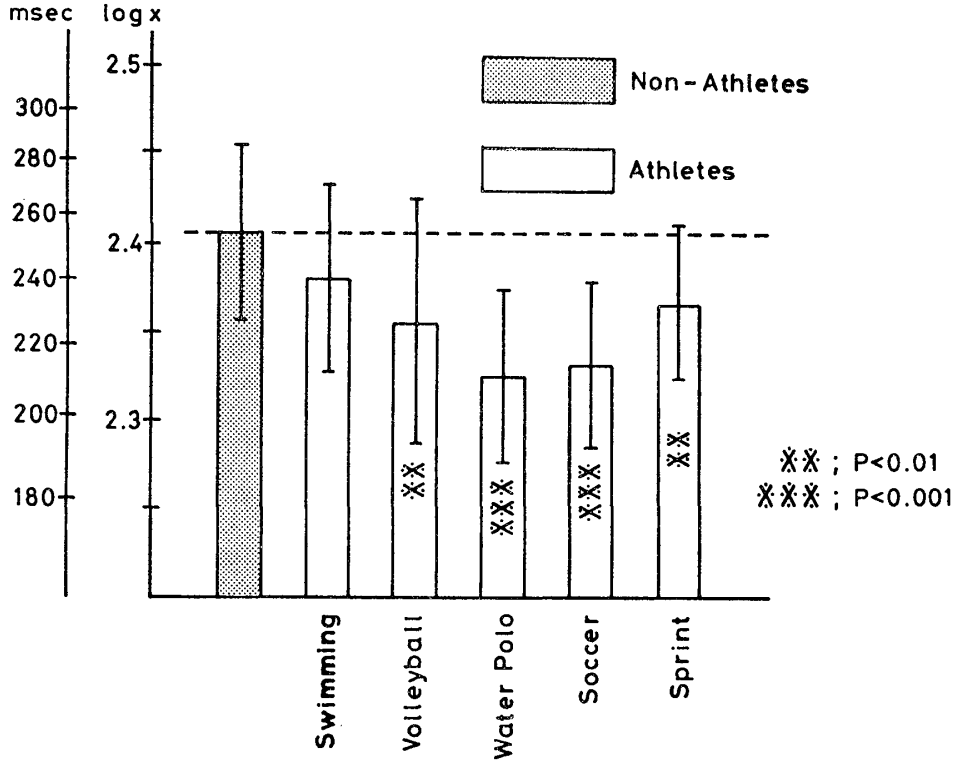


Fig. 3 Comparison between athletes and non-athletes

3. What is the relationship between Latent time (LT) and open-skill?

The Fig. 3 indicates the comparison between athletes and non-athletes.

Groups of athletes take a shorter LT than that of non-athletes. The significant differences are observed as; $p<0.01$ in sprint and volleyball, $p<0.001$ in water polo and soccer.

The distinctive point is that the athletes engaging in so-called open-skill sports represented by water polo and soccer, which require the ability to collect accurate visual information associated with eye-head coordination reaction, take shorter LT.

This result was in accordance with the previous report which had been done in children.[6]

Thus, it is concluded that it is possible to measure the training effect of open-skill by means of latent time (LT).

4. How does training of open-skill affect to developmental change?

The duplicated line in the Fig. 4 shows the average developmental change in a period from 5 to 12 years of age, analyzed cross-sectionally. Graphs "A"—"K" show chronological changes in a period from 6 to 10 years of age, observed among the children who started to play soccer at the 5 years of age and continuously have been engaging in it, analyzed longitudinally.

As is indicated by duplicated line, the average LT shortens significantly in a period from 6 to 8 and 10 to 11 years of age, and the tendency of stagnation is observed clearly in a period from 8 to 10 years of age. And LT is predicted to shorten further again after 12 years of age when compared with the adult.

The next step is to observe the training effects of soccer in 11 subjects who were consecutively pursued for five years.

As a whole, the LT of the children who have been engaging in soccer shows almost the same trend as the average of children in a period from 6 to 8 years of age. However, after the period of 8 years of age, LT of the soccer group is observed to be shorter than the average.

The developmental changes appear to be affected by individual difference and are classified as follows based on the LT.

1) A group with LT nearly same as that of average.

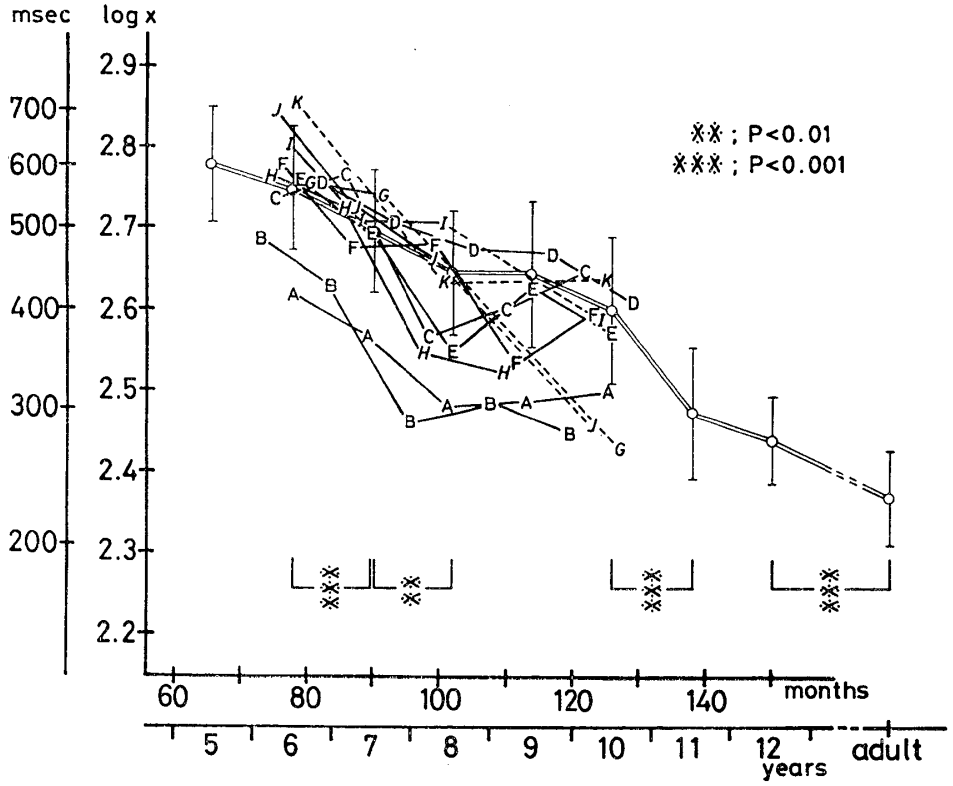


Fig. 4 The average developmental change (5–12 years of age) and the individual developmental changes (6–10 years of age) of children who have been continuing playing soccer.

2) A group with LT superior to average during 6 to 10 years of age.

3) A group with LT nearly same as that of average during 6 to 7 years of age and superior to average during 9 to 10 years of age.

It is observed in all subjects that each child demonstrates the distinctive shortening in LT around the period of 6 to 9 years of age. More remarkable point is that stagnation or delay is observed after he remarkably improved LT.

The causes of these phenomena are considered as follows; this period in question is critical for the development of open-skill, followed by an unbalance occurred in the growing process of central nervous system. Consequently, this period can be defined as considerably important period in acquiring the ability necessary to open-skill sports.

Based upon these results, it is suggested that training in this period is indispensable to acquire open-skill. Because of the individual differences in the growing process of central nervous system, it is worthy to reconsider the training program appropriate to the individual development, which should be different from

the adult program.

The data were obtained from children in a period of 6 to 10 years of age in this study. It is considered necessary to collect the data concerning the developmental changes after 10 years of age to adult.

SUMMARY

As a basic study for clarifying the mechanism of training effect of open-skill, the present study was undertaken to investigate the developmental change in motor coordination from the view point of bodily reaction time accompanied with eye-head coordination.

Five groups of athletes and one group of non-athletes of adult student, and each aged group of children (from 5 to 12 years of age) was compared with each other cross-sectionally. And 11 children who had played soccer from the time of participation to the end of this study, were consecutively pursued for five years since 6 years of age for longitudinal analysis. Subjects were requested to react to arrow shaped signal, which appeared either right or left pointing either up or down, by bodily reaction such as jumping or crouching.

Results obtained by cross-sectional analysis are;

1) Reaction time which includes decision making process (Latent time; LT) of athletes' groups except swimming group are shorter than those of non-athletes' group in adult.
2) LT shortened remarkably with the advance of age in children.

And the results of longitudinal analysis are;

1) Effect of continuing soccer on the development of LT was remarkable after 8 years of age, even though there was big individual difference among the subjects.
2) Stagnation or delay is observed after children remarkably improved LT.

References

(1) Kondoh, A.: Perceptual-Motor function and the effect of training experience, Bulletin of the Institute of physical education, Keio university, Vol. 22, No. 1, 1982.

(2) Yoshimoto, T., Fujita, A., Fukami, K., Kondoh, A.: The effect of athletic activity upon the development of motor coordination viewed from selective eye-head coordination reaction time, New paths to sport learning, ISSP 5th world sport psychology congress, 1982.

(3) Fujita, A., Yoshimoto, T., Muramatsu, H., Kasai, T.: A study on the developmental changes of selective jumping reaction time, International Journal of sport psychology, Vol. 10, No. 2, 1979.

(4) Fujita,, A., Yoshimoto, T., Fukami, K.: A proposal for utilizing selective eye-head coordination reaction time in predicting so called "open-skill", International journal of sport psychology, Vol. 13, No. 2, 1982.

(5) Kondoh, A., Fujita, A., Yoshimoto, T., Yoshimoto, T., Fukami, K., Yahagi, S., Mizuochi, F., Suzuki, T.: An attempt in Measuring the reaction time as an index of motor coordination, Japanese journal of sport psychology, Vol. 11, No. 1, 1984.

(6) Fujita, A.: The training effect on eye-head coordination, Sport psychology-international, p. 241–261, International society of sport psychology (ISSP), 1984.

オープン・スキルの指標としての眼—頭位の協応をともなった反応時間の発達

近　藤　明　彦

本研究は，眼—頭位の協応をともなう全身反応時間を指標として用い，オープン・スキル系スポーツのトレーニング効果のメカニズムを明らかにしようとしたものである。

成人男子大学生の5つの運動種目群（水泳，バレーボール，水球，サッカー，陸上競技短距離）と非運動群，および5歳から12歳までの幼児・児童の各年齢群を横断的な比較検討の対象とした。また，継続的にサッカーを行っている11人の児童を6歳から5年間，縦断的に追跡調査した。被験者は，左右および上下を示す矢印に従いジャンプ或いはしゃがみ込むという反応動作を行うものである。

横断的検討により得られた結果は以下のとおりである。

1) 成人において水泳を除く4つの運動種目群の中枢での決断含む反応時間（Latent Time）は，非運動群より短かった。

2) 幼児・児童の反応時間（Latent Time）は，加齢とともに著しく短縮する傾向を示した。

そして，縦断的検討により得られた結果は，以下のとおりである。

1) 各被験者の反応時間（Latent Time）の発達には個人差があるが，サッカーを継続的に行った影響が8歳以降顕著に認められる。

2) 幼児・児童の発達的変化のなかでも興味深いのは反応時間の顕著な短縮の後には必ず遅延，或いは停滞の現象が認められることである。