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Short Communication

Effects of PSP Appearance on Development of Motor Time in Mentally Retarded Children

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Developmental changes in motor time of mentally retarded children were studied in connection with PSP appearance in agonist muscle. Forty one out of 55 subjects exhibited PSP during jumping reaction movements, and 14 subjects did not exhibit PSP. Among subjects exhibiting PSP, motor time shortened with increasing MA. Subjects exhibiting no PSP did not show any MA-related changes in motor time. It is suggested that acquistition of PSP and cognitive development contribute to shortening of motor time.

INTRODUCTION

Reaction time (RT) of jumping movement is an index assessing gross motor agility, and is affected not only by information processing speed but also by postural adjustment and muscle contraction efficiency. The premotor time and agonist EMG-RT are supposed to reflect information processing speed. Both of these measurements in jumping reaction shorten with increasing chronological age (CA) and mental age (MA) in mentally retarded (MR) children (Ando et al., 1978, Yabe et al., 1985). It is suggested that postural adjustment for jumping is improved with increasing MA, and it contributes to MA-related shortening of jumping RT (Tsukahara et al., 1985). The motor time reflects efficiency of muscle contraction during jumping, and shortens with increasing CA in non-retarded children. But the previous studies (Ando et al., 1978, Yabe et al., 1983) failed to demonstrate any developmental changes in the motor time of MR children.

In this study, developmental change in motor time of retarded children is examined in connection with PSP appearance. Effects of PSP on force exertion have been reported (Walter, 1988, Aoki et la., 1989). PSP is supposed to be learned to meet requirement of maximum power effort (Mortimer et al., 1987). It is expected that acquistition of motor pattern involved in PSP affects developmental course of motor time.

Methods

Subjects were 55 mentally retarded boys without any significant physical disabilities. They were ranging in chronological age (CA) from 6.5 to 18.6 years (13.5 ± 3.13 years, mean ± SD), in mental age (MA) from 2.2 to 11.1 years (6.3 ± 2.01 years), and in IQ from 20 to 71 (47.5 ± 15.22). Subjects were divided into three groups on MA; under 4 years (n = 8), from 4 to 7 years (n = 27), and over 7 years (n = 28). Division between 3 and 4 years was due to salient increase in PSP appearance around 4 years in MA. A "cut-off" point at 7 years in MA has been reported in reaction movement in MR children (Yabe et al., 1985, Tsukahara et al., 1985).

A vertical jump responding to visual stimulation was chosen as a ballistic movement. The

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subject was asked to stand on a wooden foot plate facing a light stilmulator (xenon lamp) placed 1 meter away at eye level. Three to five seconds before the stimulus, a warning signal (oral) was given by the experimenter. During the preparatory phase, the subject was standing with his knees slightly flexed so that an initial EMG background level was provided. A series of 7 trials was run with each subject.

EMG signals of the rectus femoris (RF), the vastus medialis (VM) and the hamstring (HM) muscles were recorded from the right thigh by means of a pair of electrodes placed on the long axis of muscle about 3 cm apart. In order to avoid disturbance of reaction movement, EMG signals were telemetered (San-ei Instrument Co., Ltd.), and after amplification, were recorded on magnetic tape for off-line measuring. EMG records were digitized at a sampling frequency of 1 kHz. PSP occurrence in VM was determined in digitized EMG record under assistance of a computer. A transient EMG silence which is preceded by small phasic discharges (Yabe et al., 1985) or accompanied with the hamstring phasic discharge was excluded from PSP. Mechanical responses of vertical jump were detected by means of a strain gauge transducer attached to the foot plate. The motor time and the flight time were measured from the mechanogram. Intraindividual mean and SD were calculated for each measurement.

Results

PSP was observed in 41 out of 55 subjects. Five subjects in the group of MA under 4 did not exhibit any PSP, and three subjects exhibited PSP (mean frequency of PSP occurrence: 27.5±0.92%). In The group of MA from 4 to 7, six subjects did not exhibit PSP, and twenty one exhibited PSP with mean frequency of 35.0±22.43%. In the group of MA over 7, three subjects did not exhibit PSP, and 17 subjects exhibited PSP with mean frequency of 39.3±23.70%.

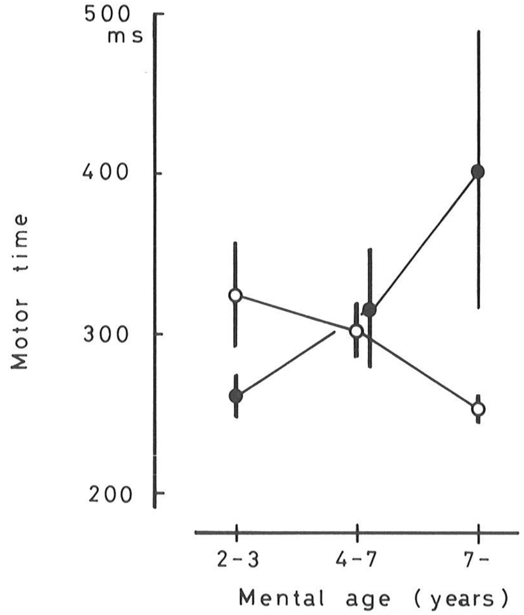

Fig. 1. Mean motor time and its SE in each MA group. ○: subjects exhibiting PSP. ●: subjects exhibiting no PSP.

Fig. 1 shows mean motor time of subjects who showed PSP and of those who did not show PSP in each MA group. Among subjects who showed PSP, significant difference of motor time was observed between MA groups ($F=3.776$, $df=2, 38$, $p<0.05$). Motor time was 323.5±56.89 ms in PSP subjects with MA under 4 years, 304.4±73.33 ms in those with MA from 4 to 7 years, and 253.4±39.83 ms in those with MA over 7 years. Motor time of PSP subjects shortened with increasing MA. On the other hand, difference between MA groups was not significant with respect to no-PSP subjects ($F=2.119$, $df=2, 11$, ns). Mean motor time of no-PSP subjects in each MA group was 262.5±29.90 ms, 315.9±94.12 ms, and 401.1±151.03 ms for MA under 4, from 4 to 7, and over 7 respectively.

Difference in motor time between PSP and no-PSP subjects was examined in each MA group. For the group of MA under 4 years, motor time of PSP subjects was slightly longer than that of no-PSP subjects ($t=2.041$, $df=6$, $p<0.10$). No difference in motor time was found between PSP and no-PSP subjects ($t=-0.374$, $df=25$, ns) in subjects with MA from 4 to 7 years. For the group of MA over 7 years, motor time of PSP subjects was significantly shorter than that of no-PSP subjects ($t=-3.755$, $df=18$, $p<0.01$).

Mean flight time of PSP subjects was 160 ± 77.35 ms, 195.6 ± 74.04 ms, and 256 ± 81.86 ms for MA under 4, from 4 to 7, and over 7 respectively. It lengthened with increasing MA ($F=3.751$, $df=2, 37$, $p<0.05$). Mean flight time of no-PSP subjects was 114.3 ± 54.60 ms, 198.7 ± 62.87 ms, and 178.4 ± 43.03 ms for MA under 4, from 4 to 7, and over 7 respectively. Mean flight time in MA under 4 was shorter than in other two MA groups ($F=3.139$, $df=2, 11$, $p<0.10$). No difference was observed on flight time between PSP subjects and no-PSP subjects at each MA group.

Discussion

In this study, MA-related shortening of the motor time was observed in MR children who exhibited PSP. On the other hand, the motor time lengthened with increasing MA among subjects with no PSP. Any significant difference of flight time was not observed between PSP and no-PSP subjects.

Ando et al. (1976) and Yabe et al. (1983) reported that motor time of MR subjects did not shortened with increasing CA. Lack of shortening of motor time was supposed to indicate discrepancy between body growth and motor function in MR children (Ando et al., 1976). But it is suggested that acquisition of PSP and cognitive development rather than CA contribute to shortening of motor time. And PSP acquisition may depend on cognitive development. Possibility of discrepancy between body growth and motor function in no-PSP subjects may be remained.

As the flight time increased with increasing MA in no-PSP subjects as well as in PSP subjects, they both seem to develop the motor program for a more forcible jump with their cognitive development. The flight time is determined by impulse (force×time), and is lengthened by increasing force and motor time. Subjects exhibiting PSP may have adopted the strategy of increasing force while no-PSP subjects may have tried to increase the motor time. Acquisition of PSP may be related to a demand for high instantaneous force. The effects of PSP on the motor time may reinforce the motor pattern with PSP through motor learning.

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