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Short Communication

The Premotion Silent Period Observed in Children with Down's Syndrome

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Motor development of children with Down's syndrome was examined with respect to PSP occurrence in comparison to MR subjects. Both DS and MR subjects with MA higher than 4 years exhibited PSP in jumping reaction movement. PSP was sometimes accompanied by sluggish agonist contraction in DS differing from MR. The correlation between PSP occurrence and motor time was lower in DS than in MR. Dissociation between PSP occurrence and abruptness of movement in DS was discussed in relation to motor coordination.

INTRODUCTION

Down's syndrome (DS) is an autosomal chromosome disorder that typically results in mental retardation and motor incoordination. Within mentally retarded population, children with DS show poorer motor performance both in fine and gross motor task than retarded children without DS of the same mental age (Berkson, 1960, Henderson, Morris & Ray, 1981, Shumway-Cook & Woollacott, 1985). DS individuals do not only react slower but also move slower (Frith & Frith, 1974) than do non-DS retarded persons.

Electromyographic (EMG) activities before and during movement reflect how the nervous system controls movement. The first overt change on agonist EMG is sometimes not phasic discharge but cessation of activity (called the premotion silent period, PSP) when a rapid muscle contraction is voluntarily executed. PSP is not observed before slow movements. This premovement phenomenon is considered to be gained through developmental course of motor coordination (Gatev, 1972). In this study, motor development of children with Down's syndrome is examined with respect to PSP occurrence. Also we pay attention on relation between slow movement and PSP occurrence in DS children.

Methods

Subjects were thirteen children with Down's syndrome (DS) and eighteen mentally retarded children (MR) from a special school. MR subjects were selected as a age-matched control for each DS child. Criteria were following: (1) the chronological age of the control was within 12 months of the DS subject, (2) the mental age of the control was within 6 months of the DS child. DS subjects were ranging in chronological age (CA) from 8.4 to 17.2 years and in mental age (MA) from 2.1 to 7.1 years. MR subjects were ranging in CA from 7.4 to 16.7 years and in MA from 2.1 to 7.2 years.

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A vertical jump responding to visual stimulation was chosen as a gross reaction task. The 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. A series of seven trials was run with each subject.

EMG signals of the vastus medialis (VM) and the hamstring muscles were recorded from the right thigh by means of a pair of surface 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.). Mechanical responses of vertical jump were detected by means of a strain gauge transducer attached to the foot plate. After amplification, EMG signals and mechanical responses were recorded on magnetic tape for offline data analysis. EMG and mechanical records were digitized with a sampling frequency of 1 kHz.

Occurrence of PSP was detected on digitized VM EMG records by inspection. Frequency of PSP occurrence was calculated on each subject. The latency of PSP was measured as time taken for the initiation of cessation of activity, and EMG-RTs of the agonist muscle as time taken for the initiation of phasic discharge after flashing light. A transient EMG silence which is preceded by small phasic discharges (Yabe et al., 1985) or accompanied with the hamstrings bursts was not regarded as PSP. The motor time was measured as time between the initiation of vertical pressure and toeoff on the mechanogram. The intraindividual mean was calculated for each measurement of EMGs and mechanogram.

Results

PSP in VM was observed on 10 DS subjects and 10 MR subjects. Mean frequency of PSP occurrence in VM was 52±37.3 % (n=13) for DS subjects, and 32±37.0 % (n=18) for MR subjects. Any significant difference was not found between frequency of PSP occurrence of DS and that of MR.

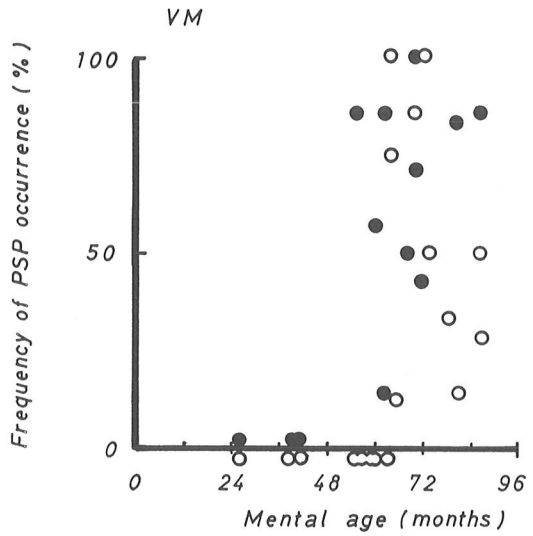

Fig. 1. Frequency of PSP occurrence in the vastus medialis by the mental age. Closed circles indicate DS subjects, and open circles MR subjects.

Fig. 1 shows changes in frequency of PSP occurrence with increasing MA. PSP was not observed in the subjects with MA lower than 4 years regardless of DS or MR. For the subjects with MA higher than 4 years, all of ten DS subjects and ten of fifteen MR subjects exhibited PSP at least in one trial. It seems that the developmental course of PSP acquisition of DS subjects does not differ from that of MR subjects.

For the subjects with MA lower than 4, difference in agonist bursts pattern during jumping was small between DS and MR. The subjects with MA lower than 4, regardless DS or MR, showed

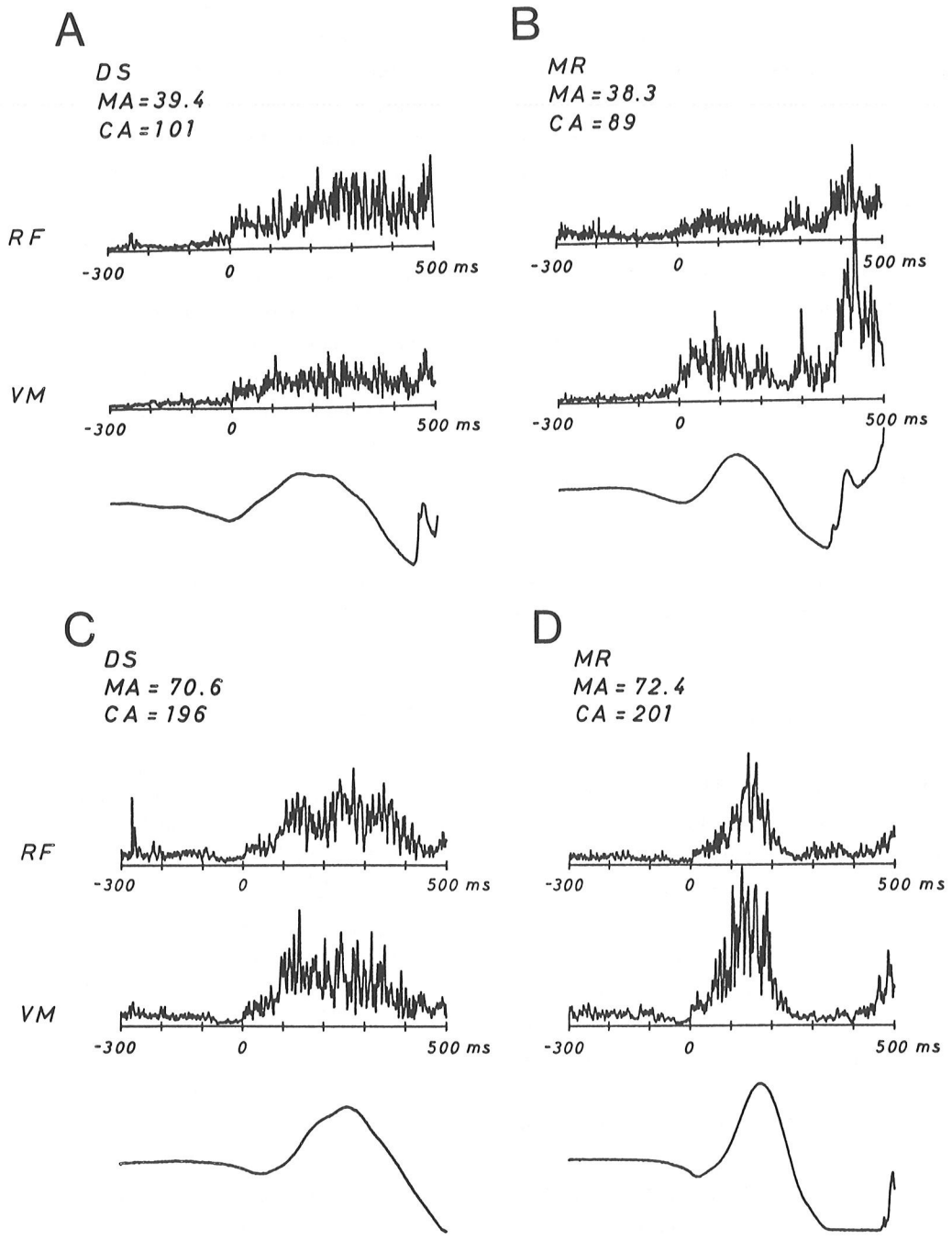

Fig. 2. Averaged EMGs of the rectus femoris and the vastus medialis, and mechanogram. Traces are synchronized on the onset (time 0 ms) of the vastus medialis response.

sluggish agonist bursts not preceded by PSP as shown in Fig. 2-A (DS subject) and 2-B (MR subject). Among subjects with MA higher than 4, difference agonist bursts after PSP was found between DS and MR subjects. In DS subjects with MA higher than 4 years, PSP sometimes preceded slowly built-up bursts of the agonists. Fig. 2-C shows an example of characteristic response pattern of DS subjects. In contrast to the DS subjects, the MR subject in Fig. 2-D exhibited PSP which was followed by short and intensive bursts of the agonists.

Any tendency that PSP occurred more frequently in subjects with shorter motor time was not observed within DS subjects. The correlation coefficient between frequency of PSP occurrence and motor time was -0.016 for DS subjects. On the other hand, the frequency of PSP occurrence significantly correlated to the motor time within MR subjects ($r=-0.576$, $df=16$, $p<0.05$).

Discussion

PSP was observed in both DS and MR subjects. The frequency of PSP occurrence was lower than that of normal adults in jumping reaction movement (Yabe, 1976). Its onset during motor development is between 2.5 and 3 years in age, and it is not frequently exhibited in 3 years old children (Gatev, 1972). The relationship between occurrence of PSP and MA in this study seems comparable to developmental course of PSP reported by Gatev (1972). It is suggested that cognitive development is involved in PSP acquisition in both DS and MR subjects.

The difference between DS and MR is found in the relationship between PSP occurrence and abruptness of motor response. In MR subjects, the ability to produce PSP is associated with that to make high instantaneous force execution. Dissociation between PSP occurrence and movement abruptness, i.e. PSP occurrence in sluggish movements, is observed in DS subjects. Did the DS subjects exhibit PSP in spite of intention of slow movement rather than rapid movement? The morphological study in the motor cortex pyramidal neurons of DS suggests possibility that output of cortical neurons lacks synchronism despite of intention of rapid movement due to anomaly in input channels at dendrites of the pyramidal cells. The results do not necessarily mean failure to develop motor program combinig PSP and rapid movement in DS children.

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