THE CHARACTERISTICS OF THE INFORMATION PROCESSING MECHANISM OF THE DOWN'S SYNDROME PATIENTS

—— Why are they good at mimicking?* ——

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INTRODUCTION

It is well known that persons with Down's syndrome have the peculiar personality traits. Benda (1960) has made the following observations. (1) "Mongoloid children, if treated well, are often lovable little being, full of affection and tenderness." (2) "An astounding gift of mimicry has been considered one of the most conspicuous psychological traits of mongoloids." (3) "A word should be said about a very characteristic behavior pattern of mongoloid patients: their stubbornness."...... "Stubbornness can be observed in very young mongoloids and seems to depend upon their inability to shift quickly from one object to another and to react to new situations."

These peculiar personality traits help us to understand how they adapt themselves to their living environments. Above all, the ability to mimic is the core trait through which we analyze how they input and process the external information and how they react it properly. In the Down's syndrome subjects, we consider mimicry that the sensory input undergoes no modification in their nervous system. The Down's syndrome subjects can make a response but they haven't their capacity to store the information to the memory and to associate and integrate it with other contents of memory.

Now, we speak of the averaged evoked responses (AER). When sensory stimulus is presented to a human subject, a transient response of the brain occurrs as the oscillation of voltages in the electroencephalography (EEG) records. We call this phasic response to the stimulus the AER. The AERs have many characteristics with which we can investigate the brain mechanisms of the human being. 1) The AER changes with age, so it is the indices of development and maturation (Dustman & Beck, 1969). 2) The AER can be used to evaluate sensory acuity of patients who can not make verbal responses properly. 3) Many investigators have reported that the AER is the indices of perceptual and cognitive functions, for example, the morphology of the AER changes with color and pattern of the sensory stimuli (Harter & White, 1970, John, 1974). To confirm these hypotheses about information processing mechanism of the Down's syndrome subjects, We use the AER as the indices of this experiment and make the following experiment. We present two sorts of tones. The probability of occurrence of them are 0.2 and 0.8. In this condition, (1) we attempt to determine

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whether the morphology of the AERs for the Down's syndrome subjects resembles that of the AERs for the children with the same chronological age (C.A.) or mental age (M.A.) and (2) whether the waveform of the AER to the rare tone is different from that of the AER to the frequent tone. In the Down's syndrome subjects, even if they can mimic, the processing of a prior stimulus can't avail them to process a stimulus. So, the AER to the frequent tone has the same morphology as the AER to the rare tone.

METHOD

Subjects

The first group of subjects were 10 youngsters with the Down's syndrome (age 12–16, IQ 24–50, 7 boys and 3 girls) who were pupils of the Sapporo Yogo School, a day school for trainable mentally handicapped children. The second group of subjects were 4 normal boys with the similar C.A. The third group of subjects were 2 boys and 2 girls with the same M.A. from the Experimental Nursery Room of Hokkaido University.

Procedures

Subject was comfortably seated in a reclining chair in a sound proof room (−60 db) and instructed to shut his eyes, to relax and to keep body movements to a minimum. He was asked to listen to a series of 250 msec. duration, 250 Hz or 700 Hz frequency tone burst at a rate of one in every two seconds. Subject was asked to do no task except listening. The probabilities of occurrence of two tones were 0.8 for high frequency tone and 0.2 for low frequency tone. The sound pressure level of the tones was 60 db above subjective threshold. The tones were delivered from a loud speaker which was placed 1 meter in front of the subject. The stimulus duration, inter-stimulus-interval (ISI) and the order of random sequence of the two kind of tone bursts were controlled by TK-80 (NEC) microcomputer system. There were 3 sessions, each session consisted of 250 tone bursts. The EEG was recorded with Ag-AgCl disk electrodes from F3, F4, C3, C4 and Cz (International 10/20 system for EEG electrode placement), referenced to linked ear lobes. All electrode impedances were below 10,000 ohm. The EEG was amplified by a SAN-EI BIO-DC amplifier. Band pass was 0.3-25 Hz (−3 db). The amplified EEG was recorded to an analog data FM recorder (TEAC R-270) with the timing and calibration pulses for later off-line computer analysis. From 40 EEG samples which were not affected by artifacts, the AERs to the frequent and rare tones were averaged separately at each electrode for individual subjects. The minicomputer (YHP-2100A) or a small special-purpose average response computer (ATAC-201, NIHON-KODEN) was triggered at the onset of the tone burst and averaged the EEG. Analysis time was 1000 msec. The AERs were plotted by an XY recorder (RIKEN).

RESULTS

In Fig. 1, the AERs to the rare tone (solid line) and the frequent tone (dotted line) recorded from the Cz electrode are shown for each group of the subjects. The AERs consisted of complex sequences of positive and negative peaks. Only 4 components were identified as designated in Fig. 1, namely P1, N1, P2 and N2. The latencies of components of the AER were measured in msec. from the stimulus onset to the peaks or troughs of the AERs.

In Table 1, the means and standard deviations (S.D.) of the peak latencies of the

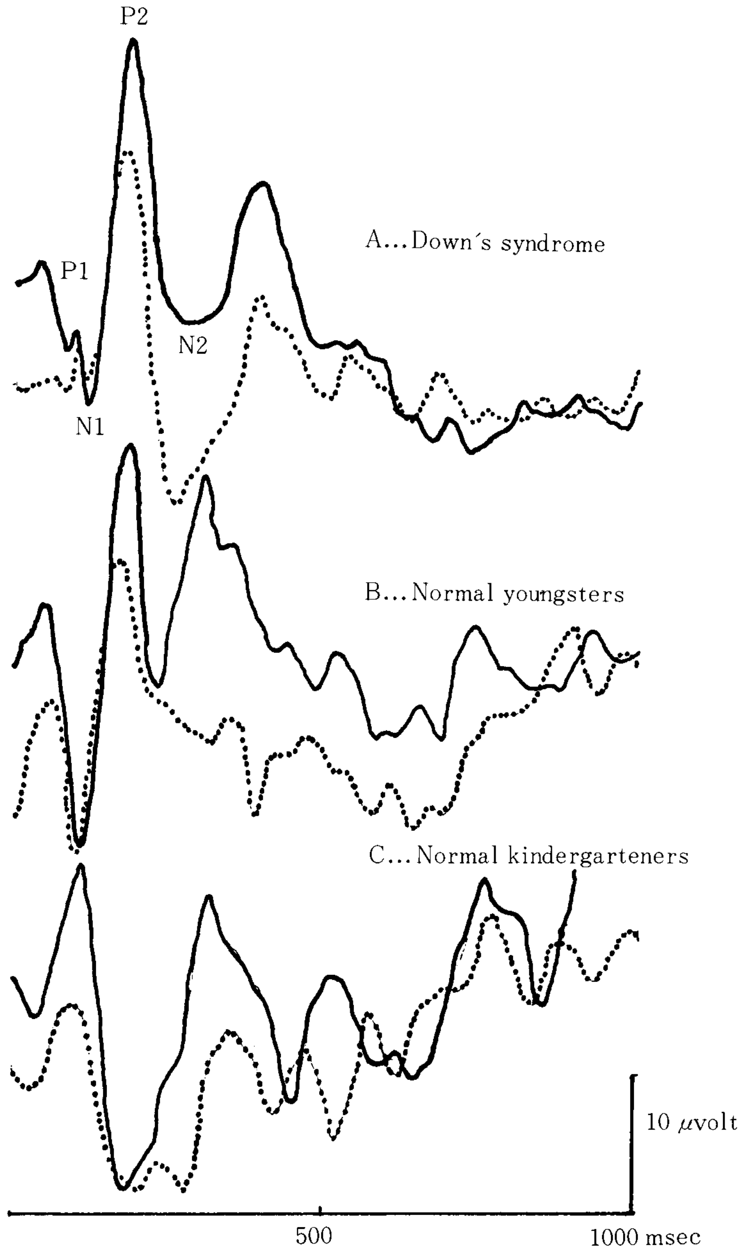

Fig. 1 Averaged Evoked Responses Recorded from Cz.

A. AERs for the Down's syndrome subjects.

B. AERs for the Normal youngsters.

C. AERs for the Normal Kindergarteners.

Solid line is the AER to the rare tone. Dotted line is the AER to the frequent tone. The AERs to the rare tone are larger than the AERs to the frequent tone.

components of the AER to two tones were shown in msec.

TABLE 1
The mean and standard deviation of the peak latencies of AER. (msec)

		P=0.2				P=0.8			
		P1	N1	P2	N2	P1	N1	P2	N2
Down	Mean	89	122	184	250	85	118	176	259
Syndrome	S.D.	8	15	11	16	12	9	11	27
Normal	Mean	57	115	184	239	58	106	176	243
Age 16	S.D.	11	8	9	13	6	8	10	18
Normal	Mean	91	192	358	448				
Age 6	S.D.	16	16	26	9				

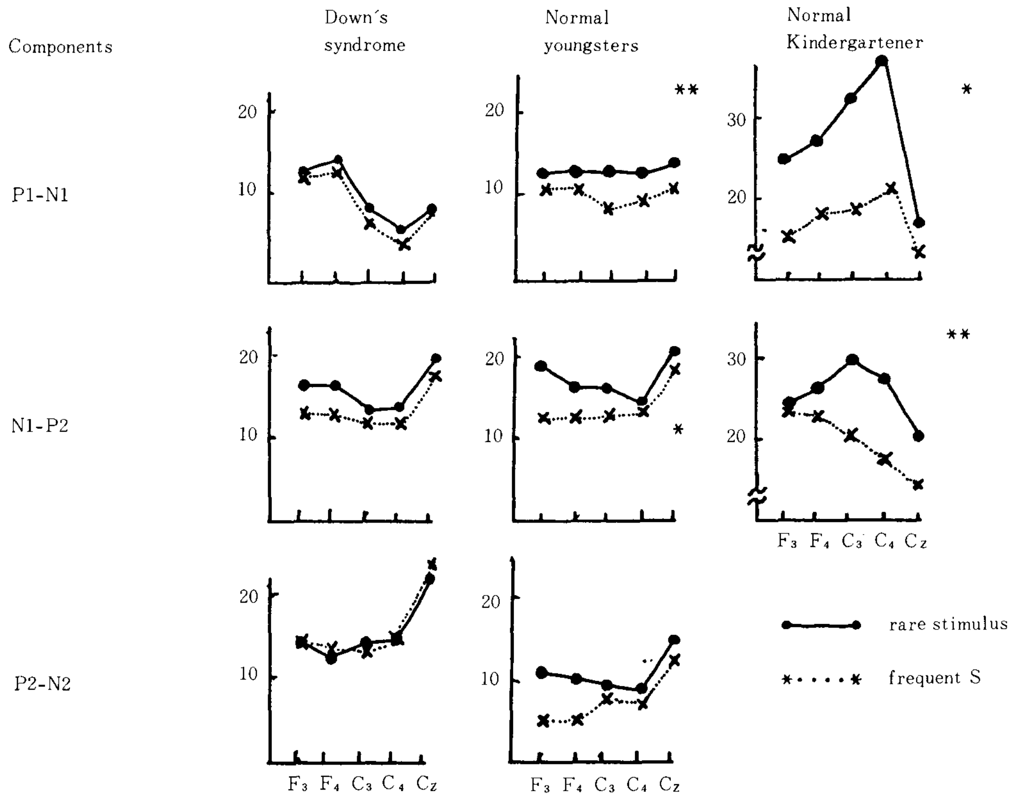

Fig. 2 Mean amplitudes of the components of the AERs to the frequent stimulus (dotted line) and to the rare stimulus (solid line). The significant difference between two stimuli were signed by the **(p=0.01) and the *(p=0.05).
In the group of normal boys, the P1-N1 and N1-P2 components were significant. And in the group of the kindergarteners P1-N1 and N1-P2 were also significant. But in the people of the Down syndrome, no components was significant.

It is noteworthy that the latencies and morphology of the AERs were not different between the Down's syndrome subjects and the normal youngsters, especially at the latencies of P2 component. However, the latencies were different between the Down's syndrome subjects and the normal kindergarteners. The amplitudes of the different components of the AER were determined by measuring the vertical distance in micro-volts between adjacent components. In Fig. 2, the mean amplitudes of P1-N1, N1-P2 and P2-N2 averaged over all subjects of each group recorded from each electrode locations were shown. The mean amplitudes of the AERs to the rare tones were represented by a solid line, those to the frequent tones by a dotted line.

For the normal youngsters, the P1-N1 and N1-P2 amplitudes were significantly larger for the rare tone than for the frequent tone (for P1-N1, $F(1, 38) = 7.91$, $p<0.01$; for N1-P2, $F(1, 38) = 5.46$, $p<0.025$). For the normal kindergarteners, the P1-N1 and N1-P2 amplitudes were significantly different between the AER to the frequent tone and the AER to the rare tone (for P1-N1, $F(1, 30) = 5.32$, $p<0.05$; for N1-P2, $F(1, 30) = 9.14$, $p<0.01$). However, for the Down's syndrome subjects, there were no significant difference in any components.

DISCUSSION

(1)The morphology of the AERs.

The brain of the Down's syndrome persons are characterized by immaturity (Benda 1960). This has been confirmed by the following facts. The AERs of normal children have longer latencies and larger amplitudes of the components than those of normal adults(Dustman & Beck 1969). The AERs of the Down's syndrome children have longer latencies and larger amplitudes of components than those of normal children matched with C.A. (Begum et al., 1970). But the result of our experiment is that the morphology, especially in the latency of P2 component, of the AER of the Down's syndrome subjects was similar to the AER of the normal subjects matched with C.A. This result means that the Down's syndrome subjects may operate their cerebral functions at a level equivalent to their chronological age. At least, we can understand that the brains of the Down's syndrome subjects have developed with increasing age.

Now, we wish to talk over mimicry. Normal children (age 1-4) can use the faculty of mimicry for their mental development. We want to confirm whether the Down's syndrome subjects mimic as the normal children do. If they mimic as normal children do, we can utilize their mimicry as a training method of their mental development. But the result of our experiment demonstrated that the intracerebral mechanism of mimicry was different between the Down's syndrome subjects and the normal children.

(2) The responses of the probability of occurrence of stimuli.

It is well known that the probability of occurrence of stimuli affects the amplitude of the AER. Especially, a late positive-going component (P300) of the AER is larger for stimuli with low probability of occurrence than for stimuli with a high probability of occurrence (Sutton, Braren, Zubin & John 1965, Sutton 1969). In their experiment, subjects were asked to do some task, for example, to guess whether the rare or the frequent stimulus would be presented or to count the ocurrence of the rare stimulus. On the other hand, in our experiment, the subjects were not asked to do any task. The hypotheses about the interrelations between the probability of occurrence of the stimuli and the amplitudes of the AER may loose their validity to some extent (Tueting et al. 1971, Duncun-Johnson & Donchin 1977). So, we must analyze our experimental data in another context.

The result of this experiment was that, for the normal subjects, the amplitude of the AER to the frequent tone was significantly smaller than that of the AER to the rare tone. But the Down's syndrome subjects did not respond as the normal subjects did. We decide to analyze this result in the following context. In the condition where the same stimulus presents repeatedly, for the normal subjects, the stimuli except the first one become irrelevant. The irrelevant afferent input is easily inhibited. We call this phenomena "habituation". When different stimulus is presented to them at that time, "dishabituation" occurs. As it were, they don't inhibit this different stimulus.

According to this interpretation, the prior experience makes it easy to access the next experience for the normal children. The normal children have the ability to habituate to the frequent stimuli and dishabituate to the rare stimuli. In another word, the neural interaction between the processing of a stimulus and the processing of the next stimulus occurs in the nervous system of the normal subjects. But in the nervous system of the Down's syndrome subjects, the neural interaction may not occur, namely, each of the sensory experiences exists independently for them. This is one of the reason why the Down's syndrome subjects are good at mimicking and why the ability to mimic does not contribute to acquiring and integrating of the experiences.

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