ALZHEIMER DISEASE DETECTION AND ANALYSIS USING P3 COMPONENET OF ERP IN ALZHEIMER TYPE DEMENTIA

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Abstract- **This study is to develop the Alzheimer's disease (AD) detection and analysis system using event-related potential (ERP) of AD patients. We recorded ERP in an auditory oddball task in mild AD (n=25), severe AD (n=12), age-matched normal aged controls (n=17), and young controls (n=7). The amplitude and latency of target P3 components were compared among 4 groups. The relationship between P3 measures and neuro psychological test scores were evaluated by correlations. The latency of the target P3a and P3b was prolonged in AD and the effects were correlated with the severity of dementia. The P3 amplitude was not affected significantly in AD. There's no difference between normal aged group and young group. These results suggest that the P3 component is specifically affected by Alzheimer type dementia.**

Keywords – **Alzheimer disease, event-related potential, P3**

I. INTRODUCTION

The event-related potential (ERP) has been used for objective monitoring to assess age-related change in cognitive brain function. Since reference [1] first demonstrated the slowing of event related potential (ERP) P3 with aging, many researchers have studies the effects of dementia on ERP components but to be still a matter of debate and the diagnostics roles of ERP remain to be confirmed. In particular, the P3 component of ERP has been widely applied in the study of attention and memory processes [2].

The ERP to standard tones subtracted from that of target tones elicited a negative peak called mismatch negativity (MMN). MMN is sensitive to probability and magnitude of deviation of target stimulus [3]. It is considered as a sign of an automatic neural mismatch processing triggered by sensory input from a deviant stimulus.

The aim of this study was to evaluate whether P3 component of ERP may be used to stage of severity of AD as well as to identify patients from normal matched controls.

II. METHODOLOGY

1) *Subject*

Twenty-five subjects just meeting the criteria of probable AD according to the definition of the K-DRS and MRI scan compose the mild AD group (average age: 69.3). Twelve patients suffering with AD for more 2 years are in the severe AD group (average age: 69.6). Seventeen volunteer age-matched control group (average age: 68.0) were recruited. They were carefully screened to eliminate individuals with medical or neuropsychiatric disorders. And seven normal young group (average age: 27.2) were participated in this study.

2) *Procedure*

The experiments were conducted with the subject comfortably seated in a sound attenuated room. Before EEG recording, all subject were taken the K-DRS (Korean–dementia rating scale) neuropsychological test.

For the auditory oddball paradigm, the stimuli consisted of a series of computer-generated tone with 85dB, 300msec duration. Tones of 1kHz and 1.5kHz were presented in a random sequence occurring in 75% and 25% of the 100 trials, respectively. Subjects were asked to count the number of the target tone and to report it after the session.

The EEG was recorded from Ag-AgCl electrodes place at 5 scalp locations (F3, F4, Cz, P3, P4) based on the 10-20 system and below the left eye, all referenced to both earlobes. The impedance of electrodes was kept below 5 kΩ . The EEG was amplified, filtered (bandpass 1-35 Hz), digitized (250Hz/channel), and stored in a personal computer for off-line analysis. Individual trials with excessive muscle activity or blinking were excluded.

3) *Data analysis*

We measured N2, P3a and P3b components in ERP to standard and target stimuli. The P3a and P3b components were defined as the largest positive peak in the interval 200-280, and 284-500msec post-stimulus. The N2 component is the largest negative peak in the 109-196msec post-stimulus. The peak amplitude of each ERP component was measured relative to her prestimulus baseline.

III. RESULTS

1) *Behavior*

The correct response rates to target tones showed a significant difference among groups. While normal aged group (88 %) and young group (100%) showed high accuracy, mild AD group (20%) and severe AD group (0%) had problems to count target stimuli.

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Abstract

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2) Neuropsychological test

The K-DRS consists of 5 categories of sub-test, i.e. attention, initiation & preservations, construction, conceptualization, and memory test. The total score of K-DRS of old groups are presented in Fig. 1. There are significant difference among groups (F(2,47)=11.92, p<.000).
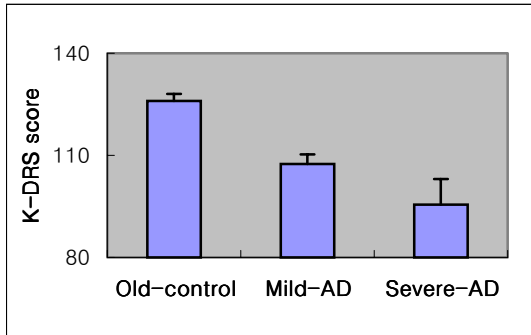

Fig. 1. The average score of K-DRS. The error bar is standard error.

3) Electrophysiology

Prominent N2, P3a, and P3b components characterized ERP elicited by standard and target tones (Fig. 2). The amplitude of N2, P3a, P3b and latency of N2 were not different among 4 groups at any site in both standard and target stimuli (Table 1). There was a significant group effect for the latency of P3a and P3b in standard tone (F(3,52)=7`.26, p<.000; F(3,50)=18.43, p<.000) and target tone (F(3,52)=8.18, p<.000; F(3,50)=18.42, p<.000). Post-hoc analyses revealed that latency in severe AD group is longer than those of mild AD group and normal groups (Fig. 3).

We analyzed the difference between P3b amplitude to standard tone and those of target tone using paired–T test. The amount of mismatch was significant in normal old group and young group, but not in mild and severe AD groups. The P3b latency correlated significantly with the score of K-DRS (Fig 4).

TABLE 1

AMPLITUDE (AMP) AND LATENCY (LAT) of N1,P3a, P3b to TARGET STIMULI at P4 SITE

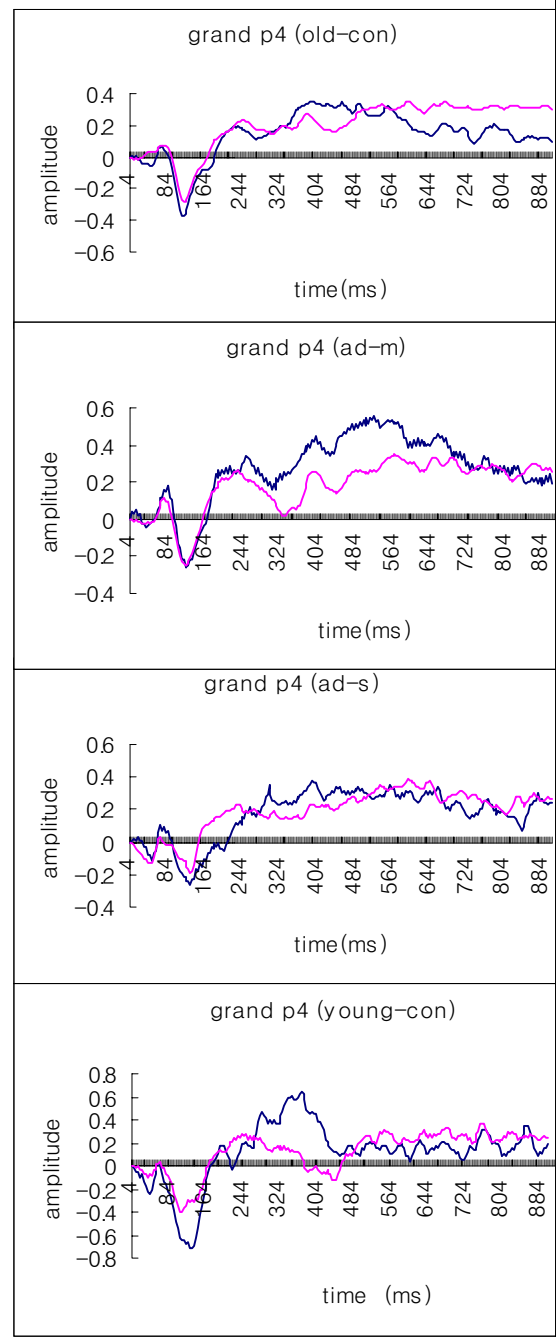|		Old-Control	Mild-AD	Severe-AD	Young-Con
N2	Amp	-.371± .059	-.474± .063	-.340± .16	-.885± .032
	Lat	119.7± 2.2	125.21± 2.6	128.72± 4.1	129.0± 6.1
P3a	Amp	.283±.072	.322±.068	.442± .18	.370± .21
	Lat	235.0± 6.3	246.1± 15.2	354.5 ±32.0	226.0±18.0
P3b	Amp	.432±.091	.459±.094	.676± .16	.767 ±.31
	Lat	381.5± 6.0	493.7± 20.9	640.0± 45.8	357.0±11.9

Fig.2. The ERP grand average waveform at P4
to standard (light line) and target (dark line) stimuli
for normal aged, mild-AD, severe-AD, young control group, in turn.

IV. DISCUSSION

The major finding of this study was the latency of P3 component was prolonged in AD patients, whereas the amplitude of P3 was not different with normal controls. The prolonged effects of P3 latency were correlated with the severity of dementia. The MMN was not detectable significantly in both mild and severe AD groups.
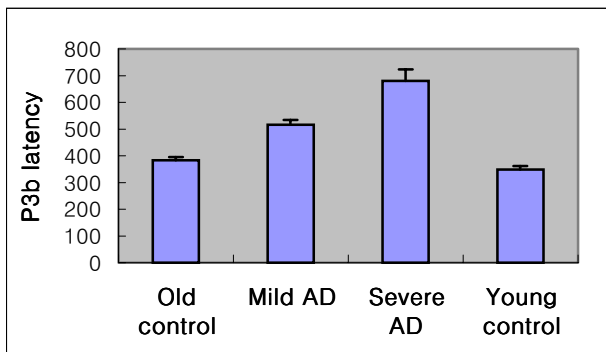
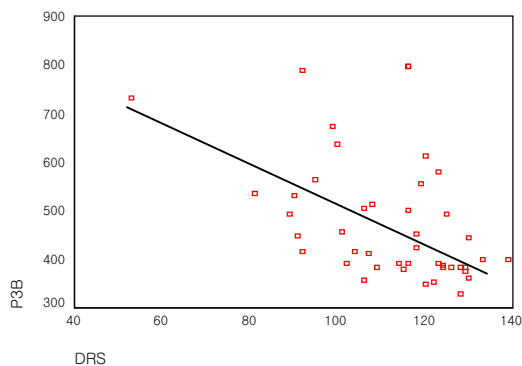Fig. 3. The P3b latency at P4 site. The error bar is standard error.

Fig. 4. Correlations between of the P3b latency and the score of neuropsychological test.

P3 latency is considered as an index of the processing time required before response generation. It reflects the neural activity underlying the process of attention allocation and immediate memory. In our study, P3b latency was correlated with the scores of neuropsychological test.

These results suggest that the P3 components of ERP could be useful indices in detection of AD. These indices could be used to predict and diagnose AD as well as to score the severity of the disease.

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