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CHARACTERISTICS OF PROCESSING FOR TRAIT ADJECTIVES IN DEPRESSIVE PERSONS: AN EVENT-RELATED POTENTIAL STUDY

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ABSTRACT

Event-related potentials (ERP) following emotive words were investigated in 22 healthy subjects with high (HD) or low (LD) depressive scores. The ERP was recorded following a visual presentation of emotive adjectives. The adjectives presented included words that subjects felt to be fit or unfit to their own character or traits, and that they perceived as positive or negative. The latency of P300 (P1) for negative words was significantly longer than that for positive words at Pz in HD subjects. The N400 (N1) in HD subjects showed a longer latency than that in LD subjects ($p<0.01$) at Cz and Pz. However, there was no difference in amplitude between the fit and unfit category, nor in the positive or negative category of words between the LD and HD groups. The present study suggests that an excessive level of cognitive processing in response to passive stimulation by non-specific emotive words occurs in normal subjects with a depressive condition.

Key Words: ERP, Depression, P300, N400, Personality

INTRODUCTION

Persons with a depressive condition display moods of pessimism, self-reproach, and low spirits as well as oppressive feelings, and sometimes lack concentration. Cognitive disturbance in patients with depression has been described in a previous report, in which the author pointed out that their negative feelings toward present, past, and future events were components of their mental background that could disturb their cognitive activity.[1)] The author also considered that negative thoughts or feelings occurred subconsciously in persons suffering sub-clinical depression who were at high risk for depression, and that increased levels of negative feelings caused clinical depression.

Habitual negative feelings in patients with depression are obscure, and may be difficult for them to describe in their own words, but their hypersensitivity to words with negative connotations has been observed in such patients.[2,3)] However, it is unclear whether this cognitive characteristic is merely one of the symptoms of depression or its origin. In the field of clinical

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neurophysiology, the cognitive function for semantic processing has been studied using techniques of event-related evoked potentials (ERP) in patients with depression or at risk for depression[4,5]. Blackburn *et al.*[4] reported that depressed patients showed a lower amplitude of P300 in response to negative words than to positive words, while normal controls showed the opposite pattern, and that those who have recovered from depression still showed a pattern of P300 similar to that of depressed patients. These results suggest that such cognitive dysfunction is not simply a symptom of depression but a background cognitive characteristic in those at risk for depression. On the other hand, Ohira[5] reported opposite pattern of ERP for emotive words in depressive healthy subjects to the pattern observed by Blackburn *et al.*[4] Thus, the precise ERP changes involved in the word processing of persons in a depressive state remain controversial.

In the present study, to clarify the relationship between depressive tendencies and ERP changes, we investigated P300 to emotive words in healthy subjects, including those with both low and high depression scores on the Beck Depression Inventory (BDI).[6]

METHODS

Thirty young volunteers who were students at Nagoya University and Graduate School participated in the study. They consented to participate after being fully informed about the study, which was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the School of Health Sciences, Nagoya University, Nagoya, Japan. After the BDI questionnaires were filled out, subjects in the following categories were selected to participate in the main experiments: a low-depression (LD) group with a BDI score of 1 or less (n=13, 1 male and 12 females, age 20.9 ± 0.8 years, mean ± SD), and a high-depression (HD) group with a BDI score of 6 or more (n=9, 1 male and 8 females, age 22.0 ± 2.1 years, mean ± SD).

We recorded electroencephalograms (EEG) following visual stimulation by emotive adjectives, and averaged the EEG signals according to the subject's self-assessment of the adjectives presented. During the experiments, sixty words comprised of 20 words with a positive meaning (e.g., kind, bright), 20 with a negative meaning (e.g., dark, evil), and 20 with a neutral meaning (e.g., ordinary, plain) were presented randomly on a monitor screen. Each adjective had five mora in Japanese and was written using two ideographic characters (kanji) with a suffix (kana), and whose meaning was easily understood. The stimulus words were presented in a square format (about 2.0 × 6.5 cm, within a visual field of 2.4° × 6.7°) in white on a black background on a 17-inch diagonal computer screen located 1 m in front of the subjects. During a stimulation episode, a fixation point in the center of the screen was presented for 1 s followed by 1 s of a blank screen, following which a stimulus word was displayed for 0.1 s. The inter stimulus interval was 8 s. A recording session consisted of 60 stimulus episodes of 20 each with positive, negative, and neutral words. The session was repeated twice in pseudo random order, thus exposing each subject to a total of 120 episodes of 40 each with positive, negative, and neutral words. The presentation of words was fully controlled by PC software (Super-Lab Pro, Cedrus Co., U.S.A.).

Prior to the study, subjects were instructed to memorize the presented words and to recall them after the experiment. Subjects seated in a chair in a quiet electrically shielded room were asked to gaze at the center of a screen on which words were presented. They were then asked to recall any of the words they remembered. Then, shown all the words just presented, they were asked to judge whether each word was either fit (Fit) or unfit (Unfit) for their own personality or mental condition, and to report whether they felt each word to be positive (Pos) or negative (Neg). All subjects were instructed to respond to the above questions on a scale from 1 to 6.

The ERP was recorded with exploring electrodes (Ag/AgCl, 8 mm in diameter) located at Fz, Cz and, Pz on the International 10-20 System, and referential electrode was a linked earlobe. Electroculogram (EOG) was monitored on the right side, placing the electrodes 1.5 cm lateral to the canthus and 1.0 cm above the supraorbital ridge. The EEG signals were triggered by the onset of word presentation, and epochs of the signal 900 ms in length, including a 100-ms pre-stimulus period, were digitally collected at a sampling rate of 250 Hz with a bandpass filter between 0.1-50 Hz. Each adjective presented was coded, and the code and the stimulus timing were recorded with the EEG signals. Epochs containing EEG signals larger than 1 mV or EOG signals larger than 10 mV were rejected.

The EEG signals were averaged based on the subject's judgement. In the first ERP series, they were averaged according to the Fit or Unfit words, i.e., epochs for which subject's judgment ranged from 4 to 6 points for fit and from 1 to 3 point for unfit were separately averaged. In the second series, the epochs were averaged accordingly to a Pos or Neg judgement, i.e., epochs for which their judgements ranged from 4 to 6 points for positive feeling, and from 1 to 3 points for negative feeling were separately averaged. In the third series, epochs of words recalled correctly (Recall), and of those that subjects were unable to recall (Un-recall) were also separately averaged. Thus, six ERP waveforms were finally obtained for each HD and LD group.

RESULTS

In the selection of emotive words for categorization into Fit/Unfit or Pos/Neg, there was no significant difference in the stimulated response patterns between the HD and LD groups. The ERP waveforms after stimulation showed a major positive peak at approximately 300 ms (P1) followed by a negative peak at 400–500 ms (N1), with maximum amplitudes at Cz or Pz (Fig. 1).

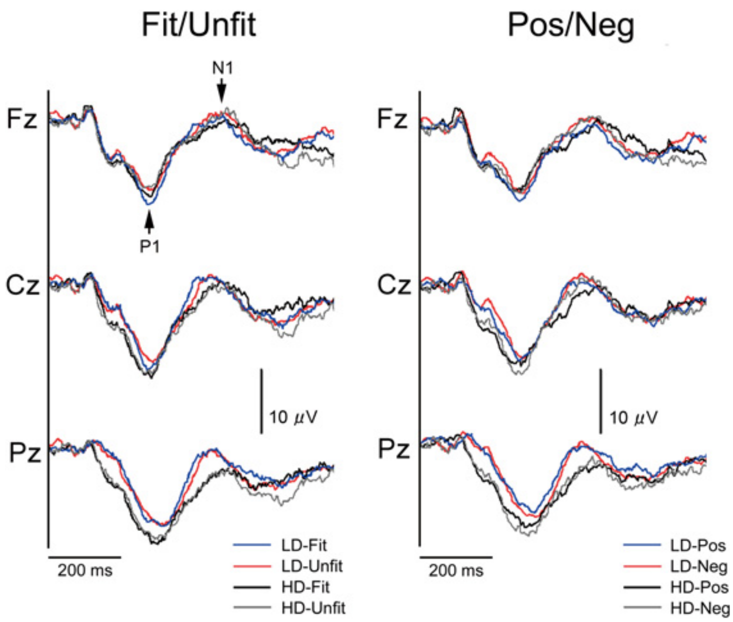

Fig. 1 ERP waveforms for each category of words, i.e., Fit/Unfit and Pos/Neg, in HD and LD groups. Arrows indicate P1 and N1 components that correspond to P300 and N400, respectively.

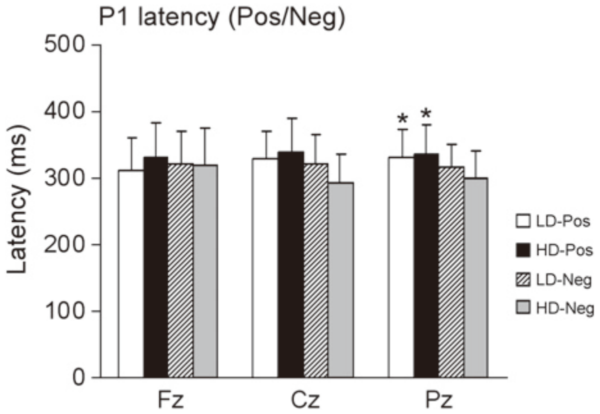

Fig. 2 Mean peak latency of P1 components. Latency for Pos words was significantly longer than for Neg words at Pz (*$p<0.05$, ANOVA) in HD and LD subjects. Vertical lines indicate standard deviations.

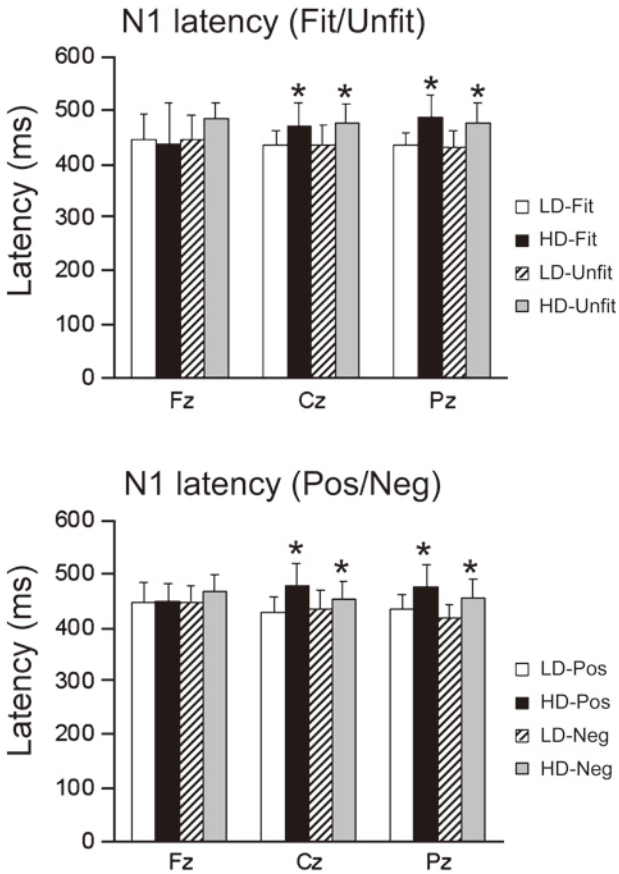

Fig. 3 Peak latency of N1 components. Latency of HD group was significantly longer (*) than that of the LD group both in Fit and Unfit words (Cz, $p<0.001$; Pz, $p<0.001$) and Pos and Neg words (Cz, $p<0.005$; Pz, $p<0.001$). Vertical lines indicate standard deviations.

Table 1 Peak amplitude of P1 and N1 components (μV, mean ± SD)

P1 Amplitude

		Pos	Neg	Fit	Unfit
LD	Fz	10.9 ± 9.1	10.8 ± 8.7	9.9 ± 8.7	10.6 ± 9.2
	Cz	11.3 ± 11.5	9.3 ± 6.3	11.1 ± 10.7	12.5 ± 10.8
	Pz	12.4 ± 11.3	10.7 ± 6.9	12.2 ± 8.3	11.0 ± 9.5
HD	Fz	8.1 ± 5.0	11.0 ± 7.6	12.5 ± 9.7	10.1 ± 6.1
	Cz	13.2 ± 7.2	16.2 ± 8.9	16.2 ± 9.5	15.0 ± 9.1
	Pz	13.7 ± 6.3	17.9 ± 8.0	14.8 ± 6.9	14.7 ± 9.2

N1 Amplitude

		Pos	Neg	Fit	Unfit
LD	Fz	15.2 ± 11.5	15.7 ± 12.2	15.1 ± 11.0	16.4 ± 13.3
	Cz	16.4 ± 13.2	16.1 ± 11.9	16.3 ± 12.5	16.9 ± 12.2
	Pz	16.6 ± 13.7	14.4 ± 11.0	16.3 ± 11.4	15.2 ± 12.2
HD	Fz	12.8 ± 9.8	15.7 ± 10.4	14.5 ± 11.4	15.6 ± 11.3
	Cz	15.6 ± 10.5	20.1 ± 10.4	18.6 ± 13.0	17.9 ± 11.4
	Pz	14.6 ± 7.7	18.5 ± 10.4	16.7 ± 9.4	16.2 ± 10.0

The peak latency for each deflection and the amplitude from onset to peak for P1, and each peak to the previous positive peak were assessed in our analysis. The latency of P1 components in the Pos categories among HD and LD subjects was significantly longer than that in the Neg categories at Pz ($p<0.05$, two-way analysis of variance (ANOVA), Fig. 2). The latency of N1 components in the HD group increased significantly over that in the LD group in the Fit or Unfit (Cz, $p<0.001$; Pz, $p<0.01$) category and the Pos or Neg (Cz, $p<0.01$; Pz, $p<0.01$) category (two-way ANOVA, Fig. 3) of words. Among words used for ERP recording in the Pos and Neg categories, the amplitude tended to be higher in the Pz area, while there was no difference in the amplitude of P1 and N1 components between word categories and subject groups (Table 1). The rate of correct recall out of 60 words in two sessions was almost the same between the HD (38.1 ± 11.1%) and LD (40.6 ± 14.1%) groups.

DISCUSSION

The experiments in the present study were designed to investigate the ERP following emotive words as categorized by the subjects' self-assessment. We concluded that the P1 and N1 components essentially corresponded to the P300 and N400 components, respectively, since each word stimulus offered a target to be memorized. As for the amplitude and latency of P300, we found no difference between the word categories, i.e., Fit/Unfit and Pos/Neg in the HD and LD groups, except for the latency of P300 in the Pos/Neg category at Pz. This suggests that P300 does not reflect the cognitive process for the words in the normal subjects with mild depressive condition. During the ERP recording, subjects were instructed to pay no attention to the specific meaning of words but simply to memorize them, and thus they ignored the meaning of words that correlated with their mental condition. In previous studies, patients with depression have showed ERP responses specific to the emotive-words, which related to their depressed mental condition.[4,5] However, there was no difference in responses between the self-assessed emotive-word categories such as Pos or Neg and Fit or Unfit. This result suggests that the sensitivity to emotive words in depressed subjects was not always linked to the self-assessed subjective mental feeling, but to the meanings of the words themselves.

An alternative interpretation of the present results is that depressive subjects modulate the cognitive function to emotive words related to their mental condition when they pay active attention to themselves. Therefore, we consider that depression-related emotive word processing may not automatically occur in depressed persons, but that it is reinforced by active attention to the meaning of specific words, thus associating such words with their own emotional state.

With regard to the latency of N400, which relates to semantic processing,[7] the results of previous studies of patients with depression or depressed persons are inconsistent. Chung *et al.*[8] has reported an increased latency of N400 for words that were incongruent with a depressive mood in healthy subjects. On the other hand, some reports have concluded that depression or a depressive condition has no relation to N400 latency.[9-11] Although our results were similar to those of Chung *et al.*,[8] they showed no difference in the N400 latency between word categories, whereas the opposite was observed between the subject groups. The assigned task was simply to memorize the words presented, but to accomplish it subjects in the HD group might need to exert more mental effort. In doing so, they might cause a delay in the semantic processing of all presented words. Since the longer latency of N400 in the HD group was evident in the Cz and Pz areas, the degree of posterior activities in the brain responsible for visual processing might have contributed to a long latency. Since the latency is considered to reflect the number of processing steps in the brain must deal with, excessive neural activity or processing steps in the early stage of the cognitive process might occur in depressive subjects. Memory performance did not differ between the HD and LD subjects. This result suggests that the delay in N400 latency among HD subjects did not aid in the improvement of memory. Therefore, we consider that the word processing in HD subjects takes a longer time processing than that in LD subjects, since the depressive subjects subconsciously persisted in a superficial semantic processing of the words.

Although we could not clarify the reason for the delay in N400 latency, since we studied only normal subjects, our present results do not reflect the pathological mechanism in depressed patients. However, those results do indicate that there are depression-related cognitive processes which occurs under depressive conditions even in normal subjects, who tend toward excessive subconscious cognitive processing of non-specific words.

REFERENCES

1) Beck, A.T.: Depression; clinical, experimental, theoretical aspects. (1967), Harper and Row, New York.
2) Derry, P.A. and Kuiper, N.A.: Schematic processing and self-reference in clinical depression. *J. Abnorm. Psychol.*, 90, 286–297 (1985).
3) Kuiper, N.A. and Derry, P.A.: Depressed and nondepressed content self-reference in mild depressives. *J. Pers.*, 50, 67–79 (1982).
4) Blackburn, I.M., Roxborough, H.M., Muir, W.J., Grabus, M. and Blackwood, D.H.R.: Perceptual and physiological dysfunction in depression. *Psychol. Med.*, 20, 95–103 (1990).
5) Ohira, H.: Accessibility of negative constructs in depression: An event related brain potential and reaction time analysis. *Jpn. J. Psychol.*, 35, 304–316 (1996).
6) Beck, A.T., Ward, C.H., Mendelson, M., Mock, J. and Erbaugh, J.: An Inventory for measuring depression. *Arch. Gen. Psychiatry*, 4, 561–571 (1961).
7) Kutas, M. and Hillyard, S.A.: Brain potentials during reading reflect word expectancy and semantic association. *Nature*, 307 (5947), 161–3, (1984).
8) Chung, G. Tucker, D.M., West, P., Potts, G.F., Liotti, M., Luu, P. and Hartry, A.L.: Emotional expectancy: brain electrical activity associated with an emotional bias in interpreting life events. *Psychophysiology*, 33(3) May, 218–233 (1996).

9) Welser, R.D.: Predicting depressive symptoms, verbal associations and personality traits from EEG and ERPs to word stimuli. Dissertation abstracts international: Section B: The sciences & engineering. Vol 56(1-B), 0106. (1995), US: Univ Microfilms International.

10) Ortiz, T., Perez-Serrano, J.M., Zaglul, C., Coullaut, R., Coullaut, J Jr., Criado J. and Fernandez A.: Deficit of cognitive event-related potentials during a working task in patients with major depression. *Actas. Esp. Psiquiatr.*, 31(4), 177–81 (2003).

11) Urretavizcaya, M., Moreno, I., Benlloch, L., Cardoner, N., Serrallonga, J., Menchon, J. M. and Vallejo, J.: Auditory event-related potentials in 50 melancholic patients: increased N100, N200 and P300 latencies and diminished P300 amplitude. *J. Affect. Disord.*, 74(3), 293–7 (2003).