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Table 1. Subjective ratings of vividness of imagery and intensity of emotion during imagery^a

| Imagery Condition | TAS-20 Group | Vividness of imagery | | p ^d | Intensity of emotion during imagery | | p ^d |
|-------------------|------------------|----------------------|------|----------------|-------------------------------------|-----|----------------|
| | | Mean | SD | | Mean | SD | |
| Past Happy | HDA ^b | 6.1 | 2.2 | 0.007 | 6.0 | 1.8 | 0.068 |
| | LDA ^c | 8.3 | 0.75 | | 7.5 | 1.7 | |
| Past Sad | HDA ^b | 4.6 | 2.7 | 0.031 | 4.1 | 2.7 | 0.009 |
| | LDA ^c | 7.4 | 2.6 | | 7.6 | 2.6 | |
| Past Neutral | HDA ^b | 4.2 | 2.2 | 0.052 | 2.3 | 1.9 | 0.188 |
| | LDA ^c | 6.3 | 2.3 | | 3.8 | 2.8 | |
| Future Happy | HDA ^b | 6.5 | 2.7 | 0.133 | 5.9 | 2.7 | 0.086 |
| | LDA ^c | 8.1 | 1.9 | | 7.8 | 1.8 | |
| Future Sad | HDA ^b | 3.9 | 3.1 | 0.003 | 3.7 | 2.8 | 0.010 |
| | LDA ^c | 7.7 | 1.8 | | 7.0 | 2.4 | |
| Future Neutral | HDA ^b | 4.5 | 2.2 | 0.325 | 2.3 | 1.6 | 0.321 |
| | LDA ^c | 5.7 | 2.8 | | 3.5 | 3.1 | |

^aTwo nongraduated visual analogue scales were used, the vividness of imagery, □ imaging nothing to imaging extremely vividly□, and the intensity of emotion during imagery □from feeling nothing to feeling extremely intense□.

^bHigh degrees of alexithymia group: the subjects with a total TAS-20 score of □, 56

^cLow degrees of alexithymia group: the subjects with a total TAS-20 score of □, 44

^dP value of t-test

Table 2. Brain regions showing significant activation during imagery task

| | k ^c | BA ^d | T ^c | Talairach Coordinates ^f | | |
|--|------------------|-----------------|----------------|------------------------------------|-----|-----|
| | | | | x | y | z |
| <i>Low degrees of alexithymia group</i> | | | | | | |
| Past Happy > REST | | | | | | |
| Left posterior cingulate gyrus | 325 ^a | 30 | 6.93 | -4 | -54 | 8 |
| Past Sad > REST | | | | | | |
| Left superior frontal gyrus | 229 ^a | 8 | 9.22 | -4 | 22 | 48 |
| Past Neutral > REST | | | | | | |
| Left anterior cingulate gyrus | 128 ^b | 24 | 6.85 | -3 | 4 | 47 |
| Future Happy > REST | | | | | | |
| Left posterior cingulate gyrus | 528 ^a | 30 | 9.85 | -6 | -54 | 9 |
| Right posterior cingulate gyrus | | 30 | 6.25 | 6 | -50 | 17 |
| Right posterior cingulate gyrus | | 23 | 5.56 | 4 | -58 | 14 |
| Future Happy > Future Neutral | | | | | | |
| Right precuneus | 97 ^b | 31 | 8.35 | 6 | -62 | 25 |
| <i>High degrees of alexithymia group</i> | | | | | | |
| Past Happy > REST | | | | | | |
| Left cerebellum anterior lobe | 369 ^a | | 10.54 | -32 | -48 | -22 |
| Left fusiform gyrus | | 37 | 7.81 | -36 | -60 | -19 |
| Left cerebellum posterior lobe | | | 6.63 | -31 | -63 | -25 |
| Past Neutral > REST | | | | | | |
| Right cerebellum posterior lobe | 398 ^a | | 10.48 | 38 | -73 | -20 |

| | | | | | | |
|--|------------------|----|------|-----|-----|-----|
| Right fusiform gyrus | | 18 | 6.40 | 24 | -85 | -19 |
| Right cerebellum posterior lobe | | | 5.75 | 19 | -75 | -22 |
| Left fusiform gyrus ^a | 179 ^a | 18 | 5.75 | -20 | -85 | -20 |
| Left cerebellum posterior lobe | | | 4.76 | -36 | -73 | -23 |
| Future Happy > REST | | | | | | |
| Left cerebellum anterior lobe ^a | 566 ^a | | 9.25 | -36 | -40 | -30 |
| Left cerebellum posterior lobe | | | 6.78 | -29 | -75 | -24 |
| Left fusiform gyrus | | 19 | 5.81 | -41 | -75 | -11 |

^aDifferences were significant at $p \leq 0.001$, uncorrected for voxel level and $p \leq 0.05$ corrected for cluster extent.

^bDifferences were significant at $p \leq 0.001$, uncorrected for voxel level and $p \leq 0.05$ uncorrected for cluster extent.

^cNumber of voxels in cluster

^dBrodmann's Area

^eT score

^fCoordinates of the local points of maximal activation included in the cluster

Table 3. Brain regions showing significant activation in low degree of alexithymia group compared to high degree of alexithymia group during imagery task

| Area | k ^c | BA ^d | T ^e | Talairach Coordinates ^f | | |
|---------------------------------|-------------------|-----------------|----------------|------------------------------------|-----|----|
| | | | | x | y | z |
| Past Happy > REST | | | | | | |
| Left posterior cingulate gyrus | 220 ^b | 30 | 4.53 | -4 | -56 | 7 |
| Left posterior cingulate gyrus | | 31 | 4.23 | -1 | -60 | 25 |
| Left posterior cingulate gyrus | | 23 | 3.93 | -8 | -58 | 18 |
| Future Happy > REST | | | | | | |
| Left posterior cingulate gyrus | 1150 ^a | 30 | 6.97 | -4 | 22 | 48 |
| Right posterior cingulate gyrus | | 31 | 5.61 | 8 | -54 | 25 |
| Future Happy > Future Neutral | | | | | | |
| Right posterior cingulate gyrus | 277 ^b | 31 | 5.58 | 6 | -59 | 23 |

^aDifferences were significant at $p \leq 0.001$, uncorrected for voxel level and $p \leq 0.05$ corrected for cluster extent.

^bDifferences were significant at $p \leq 0.001$, uncorrected for voxel level and $p \leq 0.05$ uncorrected for cluster extent.

^cNumber of voxels in cluster

^dBrodmann's Area

^eT score

^fCoordinates of the local points of maximal activation included in the cluster

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Visual emotional stimuli modulation of auditory sensory gating studied by magnetic P50 suppression

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Abstract The auditory sensory gating system modulates its sensitivity to incoming stimuli and prevents higher brain functions from sensory overload in the primary auditory cortex. We investigated whether visually evoked emotional stimuli affect auditory sensory gating. Magnetic P50 (P50m) suppression was evaluated by magnetoencephalography in fifteen healthy subjects while they viewed slides varying in emotional valence and arousal. The ratio of strength of dipole moments of the 2nd to the 1st P50m and the anatomical location of their sources were calculated. Negatively valenced slides significantly attenuated P50m suppression, as compared to neutral ones, while the effects of positive slides were insignificant. No effects on latencies or the location of P50m sources were observed. Thus, negative emotional stimuli may modulate sensory gating.

Key words emotion · auditory sensory gating · magnetoencephalography (MEG) · P50 suppression

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Introduction

Sensory gating is defined as the pre-attentive ability of the brain to modulate its sensitivity to an incoming stimulus, and is hypothesized to be a protective mechanism that prevents sensory overload of higher brain functions by filtering out the irrelevant sensory input (Braff and Geyer 1990). Deficit in sensory gating could result in an overload of irrelevant stimuli, which in turn may lead to perceptual and attentional impairments associated with psychiatric disorders such as schizophrenia (McGhie and Chapman 1961).

A paired click paradigm is used to evaluate the auditory sensory gating. In this paradigm, two identical stimuli (1st: conditioning stimulus and 2nd: test stimulus) are presented with a short inter-stimulus interval (ISI) of 500 ms and a longer inter-pair interval. The P50 appears as a positive peak in electroencephalography (EEG), at about 50 ms after the stimulus onset. Under normal conditions the amplitude of the P50 for test stimuli is smaller than that for conditioning stimuli, and this suppression of P50 is typically quantified as a ratio (S2/S1). This phenomenon is referred to as P50 suppression (Adler et al. 1982).

Magnetoencephalography (MEG) offers a non-invasive method for functional brain studies with high temporal resolution equal to that of EEG, but it enables more accurate source localization. MEG measures selectively the activity from tangential sources and is well suited for the measurement and localization of primary auditory cortical activity (Hämäläinen et al. 1993). MEG studies indicate that the magnetic P50 (P50m) counterpart is generated in the superior aspects of temporal lobes, near the primary auditory cortex (Hari et al. 1980; Reite et al. 1988; Mäkelä et al. 1994).

Cognitive and affective processing are two basic interacting modes of information processing (LeDoux 1993). Several studies have shown that emotional visual stimuli can have an effect on visual evoked potentials (VEPs), especially late component P300 in healthy sub-

jects (Lang et al. 1990; Laurian et al. 1991; Kayser et al. 1997; Cuthbert et al. 2000). Only a few studies have investigated the effect of visual emotional stimuli on auditory information processing and have shown that emotional stimuli may in fact affect auditory processing (Schupp et al. 1997; Surakka et al. 1998). However, the exact role of the interaction between emotion and cognition remains to be elucidated. In this study, we examined whether visually evoked emotional stimuli could affect auditory sensory gating, as measured by P50m suppression in healthy subjects.

Methods

Subjects

Fifteen healthy, right-handed volunteers (14 males and 1 female), aged 22–38 years (mean age 29.5 ± 5.1 y), participated in the experiment consisting of three sessions in a randomized order. The subjects reported having no history of neurological or psychiatric disorders or of any drug use for 2 weeks before the study. Because acute nicotine ingestion within 0.5 h of testing may alter P50 suppression, subjects were not permitted to smoke at least 1 h before until the end of the measurement (Adler et al. 1992). Informed consent was obtained from each subject according to institutional guidelines, and the study was approved by an institutional ethical committee.

Task procedure

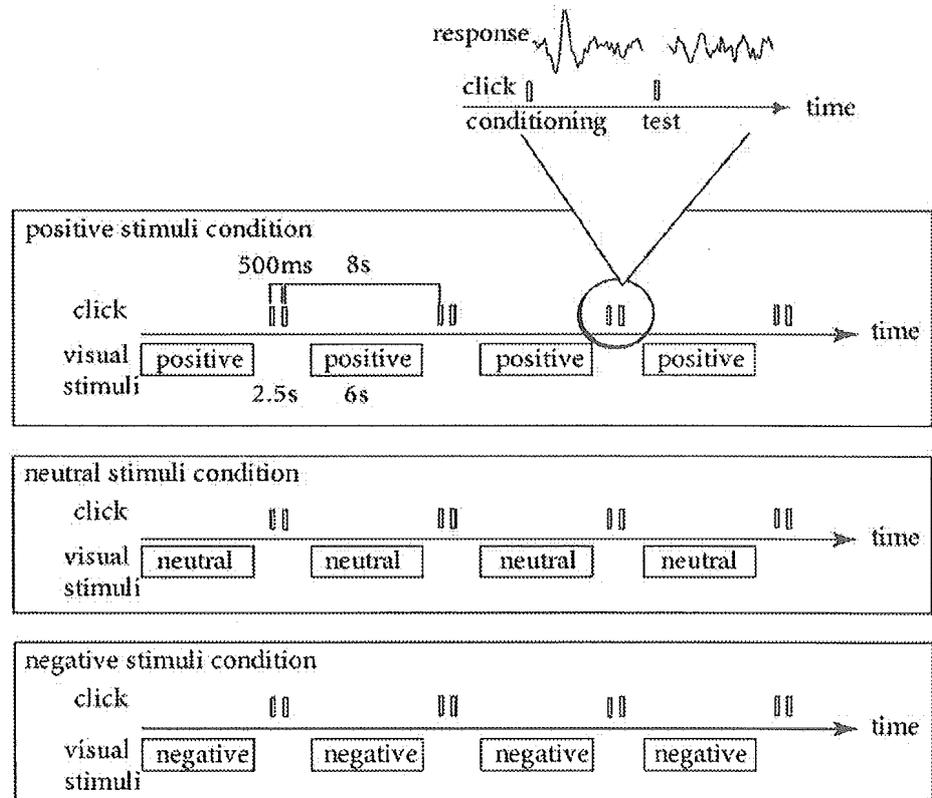
During the MEG recording, the subject sat in a comfortable chair in a magnetically shielded room. The auditory evoked magnetic fields

were recorded with a 204 channel MEG (Neuromag Ltd., Finland). The paired-click paradigm with an inter-click interval of 500 ms with click pairs (0.1 ms, 60 dB above the individually determined subjective hearing threshold) separated by 8 s inter-pair was used. The stimuli were delivered binaurally to subjects through a non-magnetic, echo-free plastic tube system, because all previous studies which investigated P50 suppression have used bilateral stimuli (Adler et al. 1982; Braff et al. 1990; Adler et al. 1992; Light et al. 1999; Patrick et al. 1999; Adler et al. 2001), and the ipsilateral P50 response to monoaural stimuli is so small that it is difficult to detect. Three hundred digitized pictures (one hundred per category) were chosen from the International Affective Picture System (IAPS) (Lang et al. 1997). The categories were negative, neutral, and positive (e.g., mutilations, buildings, and pleasant landscapes, respectively). The visual stimuli were presented by projection onto a screen during the interval of click pair presentation for 6 s, from 1 s after the second click to 1 s before the first click of the next pair (Fig. 1). The viewing distance was 3 m, and light was dimmed during the measurement. Three sessions were recorded for 15 minutes per session in a randomized order. The subjects rated their experiences evoked by stimuli, on two dimensions: valence and arousal (Lang et al. 1997). The ratings were made on a nine-point visual analog scale. The valence scale varied from unhappy to happy. The arousal scale varied from calm to highly arousing.

Neuroimaging data collection

The position of the subject's head relative to the recording instrument was determined by measuring the magnetic fields produced by marker coils in relation to cardinal points of the head (nasion, left and right pre-auricular points), which were determined before the experiment using an Isotrack 3D-digitizer (Polhemus, Colchester, VT, U.S.A.) (Ahlfors and Ilmoniemi 1989). The recording passband was 0.1–200 Hz for MEG and EOG, and the sampling rate was 600.025 Hz. Digital band-pass filtering was performed off-line at 5–50 Hz (Light et al. 1999). The first few responses and the entire epoch coinciding with EOG or MEG changes exceeding $150 \mu\text{V}$ or 3000 fT/cm, respec-

Fig. 1 Schematic diagram of the stimulus sequences in the three experimental conditions. Auditory stimuli (60 dBHL, click: depicted as bars) were presented as trains of pairs in a conditioning (1st)-testing (2nd) paradigm. The inter-pair interval was 500 ms and the intra-pair interval was 8 s. The rectangles below the sounds represent visual stimuli. The visual stimuli were presented during the interval of click pairs presentation for 6 s, from 1 s after the second click to 1 s before the first click of the next pairs. Three sessions (negative, neutral, and positive slide conditions) were recorded separately



tively, were omitted from averaging. An epoch lasted 550 ms, including a 100 ms prestimulus baseline. Electrodes were attached below the right eye and above the left eye to minimize potential electrooculogram artifacts. The electrode impedances were below 5 k Ω . Subjects were monitored visually for signs of sleep. At least, 70 responses were averaged in each condition.

MEG source localization

All analyses were conducted blind to the session condition. An individual sphere model of the head was constructed from the local radius of curvature on the basis of individual MRI images. MRI was performed using a 1.5-T apparatus (General Electric Co., Milwaukee, WI, USA). The P50m peaks were obtained from the latency ranges of 35–80 ms after the stimulus presentation. The latency, location, and strength of the P50m source were analyzed with single equivalent current dipole modeling, determined by a least-squares fit using a subset of 34 channels separately over each auditory cortex (Hämäläinen et al. 1993). Dipole fits with at most 40% residual variance and with at most 4186 mm³ confidence volume (10 mm radius sphere) were considered successful. The latency, location and dipole moments of P50m for conditioning stimuli (Qc) and test stimuli (Qt), and the t/c ratio (Qt/Qc) in the positive and negative slide conditions were compared to those in the neutral slide condition.

Data analysis

For statistical analysis, one or two-way analyses of variance (ANOVA) for repeated measures were used. Fisher's PLSD was used for post-hoc

tests. Stepwise forward multiple regression analysis was used to examine the Qc, Qt, and t/c ratio-related factors. Qc, Qt, and t/c ratio were entered into the analysis as a dependent variable. Sex, age, hemisphere, valence, and arousal during individual sessions (negative, neutral, and positive) in all subjects were entered as independent variables. In addition, the relationships between the three dependent variables and independent variables were investigated. The results are expressed as a mean \pm standard deviation.

Results

The self-ratings of experiences evoked by the positive, neutral, and negative slide sessions were, respectively, 7.3 ± 0.6 , 4.8 ± 0.5 , and 2.2 ± 0.6 for valence; and 4.4 ± 1.1 , 4.2 ± 1.0 , and 7.5 ± 0.9 for arousal. A one-way ANOVA revealed a significant main effect of slide category on valence ratings ($F[2,28] = 286.4$; $p < 0.01$). Post-hoc tests showed that all the pair-wise differences were significant ($p < 0.01$). For arousal ratings ANOVA also showed a significant main effect of slide category ($F[2,28] = 67.8$; $p < 0.01$). Post-hoc test showed that the negative slides were experienced as significantly more arousing, in comparison to neutral or positive slides ($p < 0.01$).

Fig. 2 shows the typical response waveform over the left primary auditory cortex and dipole location in one

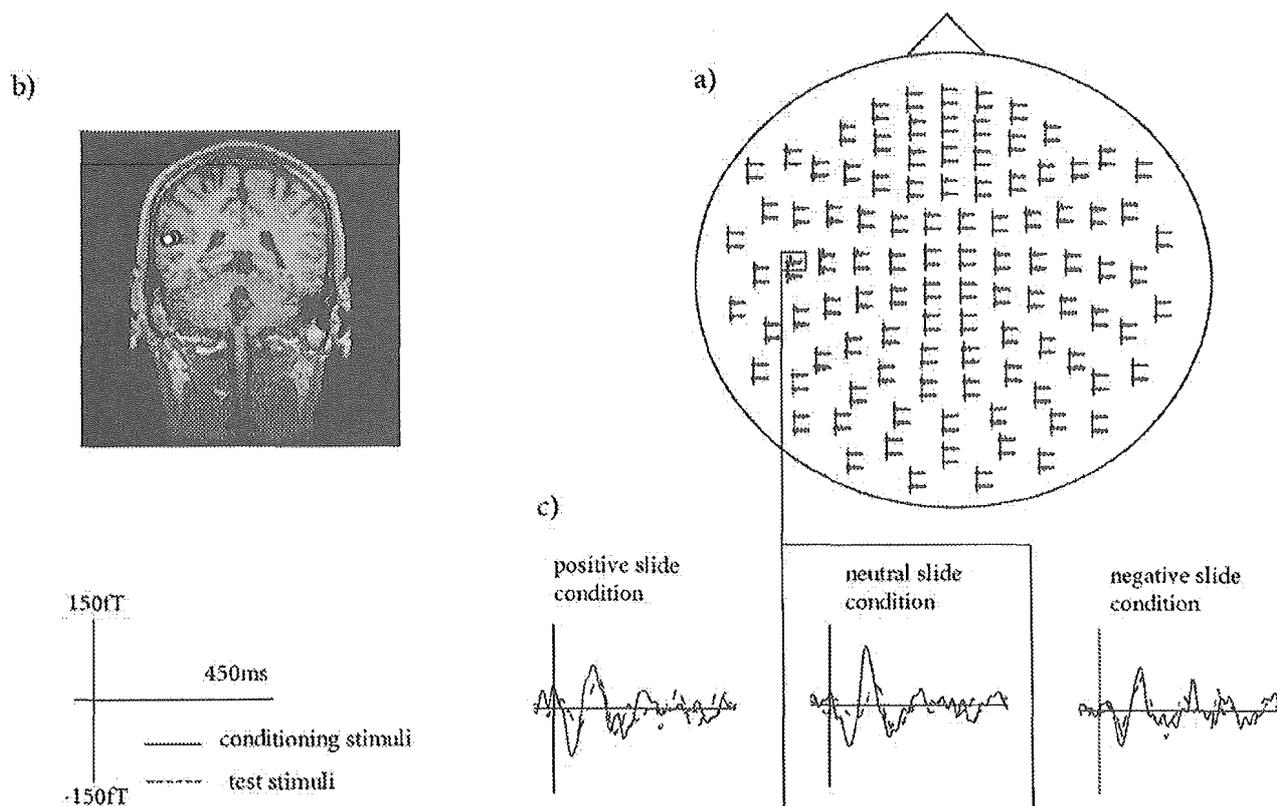


Fig. 2 a The average response waveform in the neutral slide condition of one representative subject. b Dipole locations over the left primary auditory cortex of one representative subject. The white dot represents the dipole to the conditioning click and the gray dot represents the dipole to the test click. c The response waveform at the channel showing maximal response in the left hemisphere in negative (left), neutral (middle), and positive slide conditions (right). The solid line represents the response to the conditioning click and the dashed line, the response to the test click. Note that the amplitude of response waveforms do not directly reflect the intensity of the underlying neural activation, which was estimated on the basis of magnetic field distribution at the sensors and the relative position of the head with respect to the sensors

subject. A significant difference between Qc and Qt in the neutral slide condition was observed in both hemispheres (left: $t=7.85$; $p<0.01$, right: $t=5.19$; $p<0.01$). The strength of Qc was not affected significantly by the slide category or hemisphere. A two-way ANOVA revealed a significant main effect of the slide category on Qt ($F[2,48]=4.27$; $p<0.05$), and t/c ratio ($F[2,48]=15.97$; $p<0.01$), and a significant main effect of hemisphere on t/c ratio ($F[1,24]=6.29$; $p<0.05$). Post-hoc tests showed that Qt and t/c ratio in the negative slide condition were larger than those in the positive and the neutral slide conditions, and t/c ratio in the right hemisphere was larger than that in the left hemisphere (Table 1). Slide category \times hemisphere interactions were not significant in any of the analyses. P50m latencies and the source location were not significantly influenced by emotional condition (data not shown).

Table 2 shows the predictors of Qc, Qt, and the t/c ratio.

Table 1 Source activations in different emotional conditions

| | Slide category | | |
|------------------|--------------------------------|------------------------------|------------------------------|
| | Negative | Neutral | Positive |
| Left hemisphere | | | |
| Qc (nAm) | 15.0 \pm 3.7 | 18.3 \pm 7.4 | 18.4 \pm 6.7 |
| Qt (nAm) | 8.9 \pm 3.6* | 6.0 \pm 3.4 | 6.5 \pm 4.2 |
| t/c ratio | 0.61 \pm 0.24** | 0.33 \pm 0.17 | 0.33 \pm 0.17 |
| Right hemisphere | | | |
| Qc (nAm) | 14.0 \pm 7.3 | 16.7 \pm 7.6 | 16.7 \pm 7.0 |
| Qt (nAm) | 10.7 \pm 7.9* | 8.0 \pm 3.6 | 7.2 \pm 3.9 |
| t/c ratio | 0.77 \pm 0.25** ^a | 0.48 \pm 0.21 ^a | 0.45 \pm 0.22 ^a |

* $p < 0.05$; ** $p < 0.01$, compared to Neutral and Positive slide conditions

^a $p < 0.05$, compared to left hemisphere

Qc strength of the P50m response (dipole moment) to conditioning stimuli; Qt strength of the P50m response (dipole moment) to test stimuli

Table 2 Multiple regression analysis of predictors of Qc, Qt, and t/c ratio

| Independent variables | Coefficient | Standardized coefficient | F | p |
|-----------------------|-------------|--------------------------|--------|----------|
| Qt | | | | |
| Valence of stimuli | -0.508 | -0.221 | 4.108 | 0.046 |
| t/c ratio | | | | |
| Valence of stimuli | -0.056 | -0.454 | 15.338 | < 0.0001 |
| Right hemisphere | 0.142 | 0.268 | | |

There was no significant predictor of dipole moment of Qc response

Qt Multiple R = 0.221, Multiple R² = 0.049, Adjusted R² = 0.037

t/c ratio Multiple R = 0.529, Multiple R² = 0.280, Adjusted R² = 0.261

Table 3 Correlations between P50 responses and independent variables

| | Qc | | Qt | | t/c ratio | |
|--------------------|---------|---------|---------|---------|-----------|----------|
| | r-value | p-value | r-value | p-value | r-value | p-value |
| age | -0.054 | 0.63 | -0.063 | 0.57 | -0.055 | 0.62 |
| sex | 0.084 | 0.45 | 0.028 | 0.81 | -0.072 | 0.52 |
| Arousal of stimuli | 0.006 | 0.95 | 0.205 | 0.07 | 0.301 | 0.006 |
| Valence of stimuli | 0.189 | 0.09 | -0.221 | 0.04 | -0.456 | < 0.0001 |

p-values were obtained with Pearson's correlation analysis

There was no significant predictor of the dipole moment of the Qc response. A stepwise forward multiple regression analysis revealed that the self-rating valence of the emotional slides may have been predictive of dipole moment of Qt response, and t/c ratio and right hemisphere predicted a higher t/c ratio. The relationship between the separate independent variables and the dependent variables is shown in Table 3. The self-rating valence of the emotional slides was significantly correlated with the Qt response, and the t/c ratio. In addition, the t/c ratio was positively correlated with arousal by the emotional slides.

Discussion

The present study demonstrated that P50m suppression was attenuated by negative visual stimuli, and that this modulation effect predominated in the right, rather than the left hemisphere, and was related to emotional valence. Our study suggests that negative emotions could modulate sensory gating in the auditory cortex.

A deficit in sensory gating has been identified in a number of psychiatric disorders, most notably schizophrenia (Adler et al. 1982). Furthermore, drugs affecting emotional tone such as amphetamines (Light et al. 1999), marijuana (Patrick et al. 1999), and cocaine (Adler et al. 2001) have been reported to disrupt the P50 suppression. Although emotional stress contributes to the onset and exacerbation of illness in patients with psychiatric disorders, no study has been conducted which attempted to determine the effect of emotional stress on P50 suppression.

There have been a few studies which evaluate the effect of emotional stimuli on other components of event-related potentials (ERP). Schupp et al. (1997) reported that auditory P300 amplitudes were modulated by picture arousal, with smaller auditory P300 responses elicited when viewing highly arousing pictures regardless of their valence. They speculated that attentional resources are needed for the late information processing because they are very complicated and have more cognitive factors. On the other hand, Surakka et al. demonstrated that the mismatch negativity, an ERP component elicited by sound change that peaks about 150 ms after stimulus presentation, was attenuated by positively valenced and little arousing visual emotional stimuli (1998). Our results showed that emotional modulation of sensory processing could occur even at earlier (about

50 ms) cortical stages of auditory processing and that this modulation was related to emotional valence. Together, these results suggest that auditory processing can be affected by emotional stimuli, and in earlier stages, the emotional valence of the stimuli may predominate over the arousal effect. However, due to the small sample size, the results should be confirmed by further studies with a larger number of subjects.

The amygdala is thought to play an important role in the perception of emotionally meaningful information (Morris et al. 1996), and neurons in the amygdala of rats behave similarly to the human P50 in response to repeated auditory stimuli (Bordi and LeDoux 1992). In addition, it has been reported that fear conditioning enhances auditory evoked activity in the amygdala in response to repetitive auditory stimuli (Rogan et al. 1997). The amygdala is richly interconnected with the neocortex. Some amygdalofugal projections to auditory areas have been found, in addition to projections to visual regions (Amaral et al. 1992). Thus, we speculate that the effect of emotional visual stimuli on auditory P50m suppression, at least in part, might be mediated by the amygdala.

This P50m suppression study showed that auditory sensory gating at the primary auditory cortex was affected by emotional stimuli, and that this effect may be related more to the emotional valence than to the arousing effect of the stimuli. We suggest that a pre-attentive, automatic mechanism of the brain to gate out incoming irrelevant sensory input is affected by emotional valence.

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血管性うつ病と痴呆の鑑別

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はじめに

血管性うつ病 (vascular depression ; VD)とは脳梗塞を基盤として生じるうつ病を指し、computed tomography (CT), magnetic resonance imaging (MRI)などの画像を用いた研究をもとに 1997 年に Alexopoulos, Krishnan ら¹⁾²⁾が提唱した概念である。VD は脳梗塞が臨床所見(脳卒中発作の既往、局所神経徴候)もしくは検査所見(CT, MRI)にて認められるものを示し、1) 脳卒中後にうつ病を発症した post-stroke depression(PSD)と2) うつ病患者において MRI にて脳梗塞が発見される MRI-defined VD に分類される。MRI で発見される脳梗塞の大多数は神経学的には無症候であり、潜在性脳梗塞(silent cerebral infarction; SCI)と呼ばれる。すなわち、PSD は臨床所見と検査所見の両方で脳梗塞の存在が確認されるが、MRI-defined VD は MRI にて脳梗塞が発見されるが臨床所見では脳梗塞の存在が確認できない(脳卒中発作の既往がなく、局所神経徴候も存在しない)ものである。

これまで老年期うつ病患者では脳の器質的要因の関与が大きく、痴呆に進展しやすいのではないかと漠然と考えられてきたが、VD 概念の導入により、老年期うつ病と痴呆との関連性がより注目されるようになってきている。一方で以前から老年期うつ病患者で認められる認知機能障害はうつ病の治療によって改善する可逆的なものである(仮性痴呆)との指摘もなされており、血管性うつ病と痴呆との関係を考えていく上では現在のところ、以下の2つの考え方が存在すると考えられる。

- 1) 血管性うつ病と痴呆とは別のものである。血管性うつ病に認められる認知機能障害はうつ病の症状(仮性痴呆)として考えられるため、認知機能障害を主訴とする高齢者を診察する場合にはうつ病の存在に注意を払い、治療の機会を逃さないようにしなければならない。
- 2) 血管性うつ病は痴呆(特に血管性痴呆)

の初期段階である。ほとんどの症例で痴呆に進展していくため、血管病変の進展を防ぐことで痴呆への進展を予防していく必要がある。また、現在認められる認知機能障害に対しては痴呆の治療に準じた治療をおこなうべきである。

1 と 2 は相対する考え方であるが、本稿においては最近の報告を元に血管性うつ病と痴呆との関係について明らかとなっている点を紹介したい。

うつ病患者の認知機能

うつ病患者では病相期においては思考や運動の抑制症状のために痴呆と間違われやすい症状を呈する場合がある(仮性痴呆)ため、うつ病と痴呆を鑑別し、うつ病を治療する機会を逃さないようにすることは重要であり、表1³⁾のような症状や経過の違いが鑑別のために役立つと従来の精神医学の教科書には必ず記載されている。実際にうつ病患者に抗うつ薬による治療をおこなうことで認知機能が改善することは成人患者だけでなく、高齢患者においても数多く報告されている。たとえば Kimura らは、PSD を対象として、Nortriptyline による治療を6-12週間おこない、うつ病が改善したグループではMMSEが24点から27点に改善したのに対してうつ病の改善が見られなかったグループではMMSEの改善はみられなかったと報告している⁴⁾。しかし、同年齢の健常対照者と比較するとうつ病患者では依然として認知機能や社会機能の障害は残存している場合も多く、その原因としては抗うつ薬の抗コリン作用や加齢に伴う器質的な要因などの存在が重要であると考えられている。

silent cerebral infarction(SCI)の認知機能

うつ病を呈していないSCI患者の認知機能への影響に関する報告は今までに多数ある。今までの報告をまとめると、MMSEや長

谷川式痴呆スケールなど認知機能障害に対する感度の低い検査では SCI の存在は認知機能に影響を与えないとする結果となるが、さらに詳細に認知機能障害が測定できる感度の高い検査 (Stroop test, Wisconsin card sorting test など) を使用すれば、SCI の存在により認知機能が障害されていることが明らかとなる。

また、SCI 患者においては、apathy を呈する患者が多いといわれている。apathy とは、発動性低下を主訴とする病態であるが抑うつ気分や思考制止などのうつ病に特有な症状は存在しておらず、うつ病の診断基準を満たさないものを示す。この apathy はアメリカ精神医学会による精神疾患の診断基準第 4 版(DSM-IV)などの精神疾患の診断基準には記されていないが、脳血管障害を専門とする神経内科領域では汎用されており、apathy を伴う SCI 患者においては apathy を伴わない SCI 患者より認知機能が障害されていると報告されている⁵⁾。

MRI-defined VD の認知機能

Ginsberg らは MRI-defined VD の認知機能について、MRI-defined VD 患者 (VD 群) と MRI にて脳血管障害を認めないうつ病患者 (non-VD 群)、健常高齢者の間で記憶力、遂行機能、言語機能などの比較をおこなっている。彼女らは VD 群では non-VD 群、健常群と比較して全ての領域において有意に障害されていた⁶⁾と報告している。われわれは、MRI-defined VD 患者 (VD 群) と MRI にて SCI を認めないうつ病患者 (non-VD 群) において、うつ病症状が改善後に WAIS-R (全般的な認知機能の検査) と内田クレペリンテスト (思考スピードと集中力の検査) を行い、両群の認知機能を比較検討した⁷⁾。その結果、WAIS-R においては VD 群では non-VD 群と比較して、言語性 IQ、動作性 IQ 共に低下しており、言語性 IQ の中では知識、単語、算数、類似の 4 項目で差を認め、動作性 IQ の中では 5 項目全てに差を認めた (表 2)。内田クレペリンテストにおいては VD 群では non-VD 群と比較して、誤謬率では差を認めなかったが平均作業量は約 50% に低下しており、休息効果 (休息による作業量の回復) も低下していた (表 3)。つまり、VD 群ではうつ病症状が存在している

間もうつ病症状回復後においても認知機能障害を認め、特に思考速度の低下は特徴的な症状と考えられる。われわれが VD 患者を診察した時、うつ病症状が完全に寛解しているにもかかわらず、今ひとつ理解力が悪い、今ひとつ反応が遅いと感じることが多いが、WAIS-R、内田クレペリンテストのデータは臨床場面でのそのような印象を裏付けているものと思われる。

MRI-defined VD の痴呆への進展

上述したように VD 患者ではうつ病相期だけでなく寛解後の維持療法期にも認知機能障害が認められやすいことも考えあわせると VD では non-VD より将来痴呆へ進展しやすいことが推測される。以前にわれわれは、3年間の臨床経過を MRI-defined VD 患者 (VD 群) を non-VD 患者 (non-VD 群) に分類し、痴呆への進展の有無、神経学的障害 (脳卒中、せん妄、血管性パーキンソニズム) の出現率について検討をおこなったことがある。その結果、脳卒中、せん妄、血管性パーキンソニズムの出現率については VD 群に有意に多かったが、痴呆への進展は VD 群に多いものの有意差は認められなかった⁸⁾。この結果から MRI-defined VD 患者の長期予後は non-VD 群と比べると不良であり、神経学的障害の合併率が高いことが明らかとなった。痴呆への進展については有意差が出なかったが、これは調査対象症例が少なかつたためと、経過観察期間が 3年間と短かつたためと思われ、今後はより長期間の経過観察をおこなう必要がある。老年期うつ病患者と老年期でうつ病を呈していない患者の比較では、うつ病患者の方が痴呆に移行しやすいことは以前から指摘されており、最近の大規模研究でうつ病の既往が脳血管性痴呆の有意な危険因子であると報告されているが⁹⁾、老年期うつ病患者においては VD 患者が多いこと、すなわち脳梗塞合併症例が多いことが明らかであるため、結果として痴呆へ進展しやすいものと考えられる。

これらの結果をまとめてみると血管性うつ病と痴呆との関係性としては、上述の 2つの考え方はお互いに相対するものではなく、どちらの視点も併せ持つことが臨床家

としては大事であるように思われる。つまり現時点においては、血管性うつ病と痴呆には一部で共通の病態が存在し、血管性うつ病は痴呆の危険因子のひとつである。そのため、一般人口と較べると痴呆に進展していく割合が高いと考えられる。痴呆への進展を防ぐにはまずはうつ病の治療をしっかりおこなう必要がある。また、場合によっては痴呆の治療に準じた治療をおこなうべきであると考えが必要があろう。

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A Tactile Display System in the Use of a PC for Individuals Who Are Deaf-Blind

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Abstract. A purpose of this study is to develop a sensory aid system for totally deaf-blind persons who are not Braille users. We developed a tactile display system and also designed special font style for the display. In this paper, we evaluated the font style as well as the tactile display from a viewpoint of the character identification test. It is found that the percent correct answer was more than 90% when ninety-three characters were presented onto the display. This result suggests that it is enough to enable the deaf-blind to understand the presented characters using our tactile display system instead of the Braille display.

1 Introduction

Although sign languages, finger-spelling method, a print-on-palm method, a tadoma method, and a finger Braille have been used as the deaf-blind communication tools, it is restricted and difficult for the deaf-blind without an interpreter. Furthermore, the acquired deaf-blind are likely to only choose a print-on-palm method because it is difficult for them to master the other communication skills. Therefore, it was almost impossible for these persons to access communication tools such as an Internet, an e-mail, and a printed Braille. The communication aids for these people have been expected to be designed using advanced information technologies. Though there were some preceded studies (1), (2) regarding the tactile display for the blind, there was no device for the deaf-blind PC-users respect a Braille display. We have designed a tactile display system that can present Japanese kana-characters instead of Braille. In this paper, we described the tactile display system and evaluated the font style designed for the display from a viewpoint of a character recognition test by the deaf-blind.

2 Tactile Display System

Figure 1 shows the tactile display system that we proposed. This system consists of a tactile display unit, a mobile phone type switch and a cursor key, all of which are connected to a PC as shown in Figure 2. The tactile display is constructed by ten tactile display modules (Graphic cell SC5) developed by KGS Corporation in Japan.

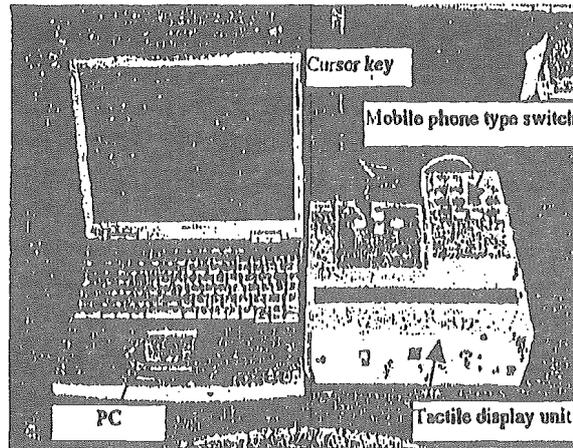


Fig. 1. The tactile display system. This system consists of a tactile display unit, a mobile phone type switch and a cursor key, all of which are connected to a PC as shown in Figure 2. The display has 8 x 80 pins arranged at 3 mm intervals in a matrix.

Each module contains 8 x 8 pins arranged at 3mm intervals so that the hole pins are arranged at 3 mm intervals in a matrix (8 x 80). Since 8 x 8 dots are used for each character presented on the display, it can simultaneously present ten characters.

The tactile display shown in Figure 2 is presenting characters "DISPLAY". An underline of "S" represents a cursor, and the end of character on the display represents a space. The details of the fonts displayed on the tactile fonts are described in the chapter 3 and 4. Although the mobile phone type switch was designed in different way of a keyboard, it is useful to write or to edit sentences. How to use this switch to input the characters is as follows. When you press a "2" key, "2" is shown on the tactile display. When you press the 2 key again, "A" is shown on it instead of "2". When you press the 2 key again, "B" is shown on it. When you press the 2 key again, "C" is shown on it. When you press the 2 key again, "2" is shown on it again. When the character that

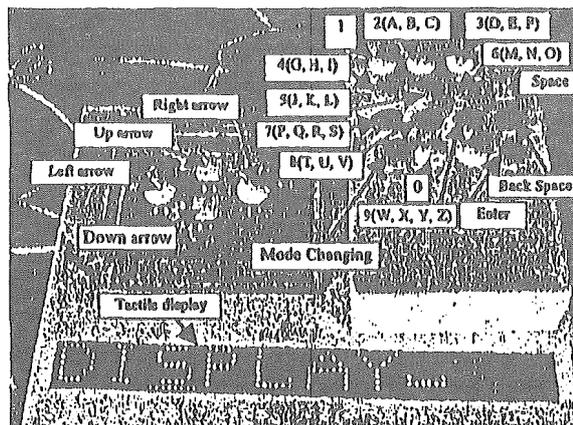


Fig. 2. The tactile display unit, the mobile phone type switch and the cursor key. The tactile display has 8 x 80 pins arranged at 3 mm intervals in a matrix. Since a character shown on the display uses 8 x 8 dots, it is able to show ten characters on it. The tactile display in this figure shows "DISPLAY". A under bar under "S" is a cursor, and the last character shown on the tactile display illustrates a space.

you would like to settle is shown on it, you have to press an Enter key to settle. Then the character is inputted on the word processing software in the PC and is shown on it. Before you press the Enter key, any letter is not settled.

How to input "DIS" is as follows. On inputting "D", you press a 3 key twice. Then "D" is shown on it. Since you press the Enter key to settle, "D" is inputted as shown on the first character of the tactile display in Figure 2. To input "I", you press a 4 key four times. Then "I" is shown on it. You press the Enter key to settle, then "I" is inputted after "D". On inputting "S", you press a 7 key four times. Then "S" is shown on it. You press the Enter key, then "S" is inputted after "I". From these operations, "DIS" is inputted on the word processing software in the PC and is shown on the tactile display. In the same way, you are able to input "PLAY" which is the rest of the characters shown on the tactile display in figure 2.

A line under "S" on it is a mark of the cursor. You can move the cursor by pressing a Right Arrow key or a Left Arrow key. When you press a Back Space key, the character before the cursor is deleted. A symbol that is the end of "DISPLAY" on it is the mark of a space. When you press a Space key, a space is inputted. The mobile phone type switch has three inputting modes that are the Japanese kana-characters, the Arabic numeric (including the alphabet) and the symbols. The Japanese kana-characters is a kind of Japanese phonogram. The symbols are ASCII-American Standard Code for Information Interchange characters which do not include the Arabic numeric and the alphabet. You can change these three modes by pressing the Mode Changing key. All keys on the PC are also available. Since one of Japanese screen reading software which name was WinVoice was improved to connect this system, the display is able to show characters on the tactile display. You can use the PC in full keyboard by using this tactile display system instead of the Braille display.

3 Designs of Fonts

We designed the fonts of ASCII code (JIS X 0201 Roman standardized in Japan). The characters in this standard consist of the Japanese kana-characters, the alphabet, Arabic numerals and the other characters for example a dot, an asterisk, round brackets, and a tilde and so on.

The tactile display was designed 8 x 80 dots in a matrix to present ten characters on it. Though a character can use 8 x 8 dots in a matrix, we designed a font in 7 x 7 dots in a matrix. The two reasons are as follows. First, since the under cursor which is shown in Figure 2 is used on the tactile display; the lowest line is occupied to present it. Second, spaces both side of a character are needed to distinguish adjacent characters.

All designed fonts are illustrated in Figure A-1 and Figure A-2 in the appendix. Figure A-1 illustrates "A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K", "L", "M", "N", "O", "P", "Q", "R", "S", "T", "U", "V", "W", "X", "Y", "Z", "0", "1", "2", "3", "4", "5", "6", "7", "8" and "9". Figure A-2 illustrates the symbols which are "!", "#", "\$", "%", "&", "(", ")", "*", "+", ":", ";", "<", ">", "?", "@", "[", "]", "^", "_", "`", "(", "|", ")", "~", ":", ":", "<", ">", "+", "=", and "\". The fonts of the Japanese kana-characters and another character standardized only in Japan are not mentioned in this paper. The small letters of the alphabet are omitted due to limitation of space.

4 Evaluations of Fonts

4.1 Subjects and Methods

Subjects are three males whose ages are from twenty-two to twenty-four years old. They have no difficulty in their tactile sense.

The tactile display system was used as an experiment device to present the font sets. The four font sets that are used in this evaluation are as follows:

- (1) The capital alphabets: twenty-six characters shown in Figure A-1
- (2) Arabic numerals: ten characters shown in Figure A-1
- (3) The symbols standardized in ASCII code: thirty-one characters shown in Figure A-2
- (4) Above three font sets and the small alphabet: ninety-three characters in total

Processes of an evaluation are as follows:

- (1) The subject put on the eye mask.
- (2) All characters of the font set were presented to subject once. The tester told the subject the correct name of the character to let the subject know all characters of the font set.
- (3) All characters of the font set were presented to subject at random. The subject answered the name of the font. The time from presenting the font until the subject replying the answer was measured. The tester let the subject know the correct answer after the subject replied the answer.
- (4) Above process was repeated five times.

All answers of the subjects were recorded and all the time required to answer was measured. Since the subjects were not instructed how to touch the tactile display, they were able to use any fingers.

4.2 Results and Discussion

Figure 3 shows the evaluation results of the font recognition in the case of capital alphabets. As shown in the figure, the percent correct answer of the both subjects is more than ninety percent. However, the average time required to answer showed about two times longer in the subject A than the subject B.

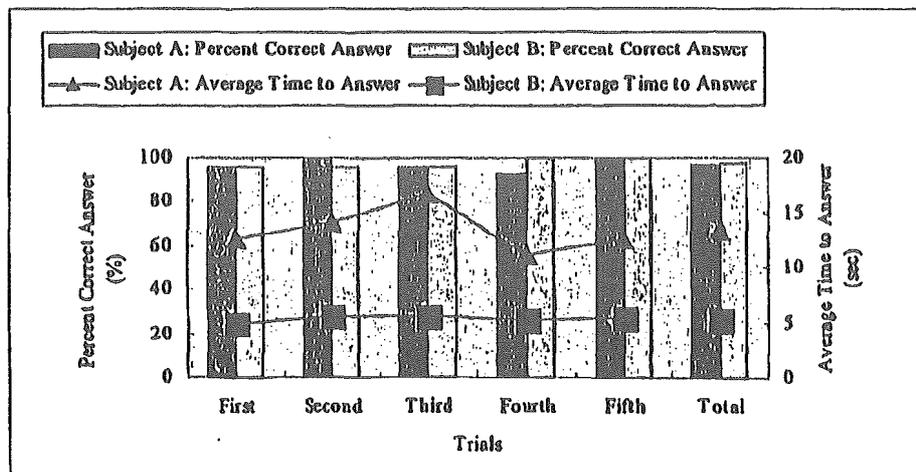


Fig. 3. Evaluation Results of the Font Recognition in the Capital Alphabet.

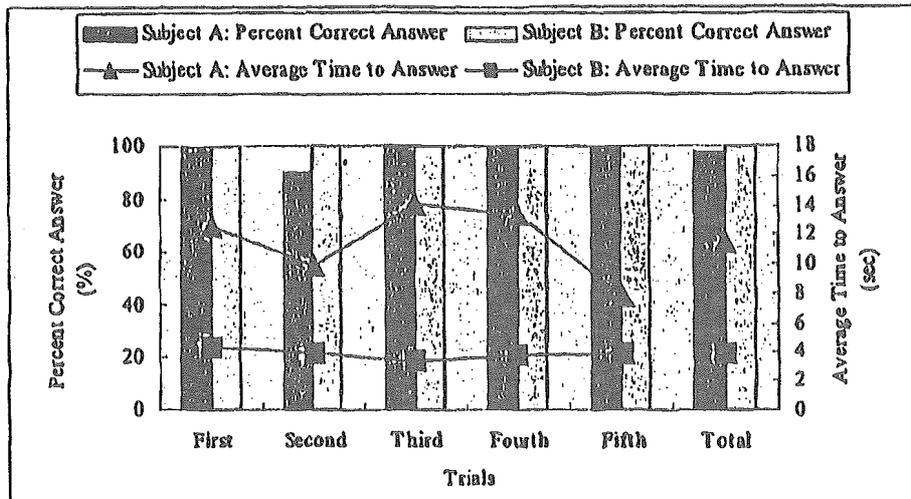


Fig. 4. Evaluation Results of the Font Recognition in Arabic Numerals.

Figure 4 shows the evaluation results of the font recognition in the case of Arabic numerals. The percent correct answer of the both subjects is almost 100%.

Figure 5 shows the evaluation results of the font recognition in the case of symbols. The percent correct answer of the subject B is close to 100%. On the other hand, that of the subject C is under 90% in average. With the regard to the contents of the mistakes, subject C tended to confuse in brackets, for example he mistook the square bracket for the round bracket twice. He also mistook the round bracket for the angle bracket. These mistakes of subject C occupy 41% of all mistakes.

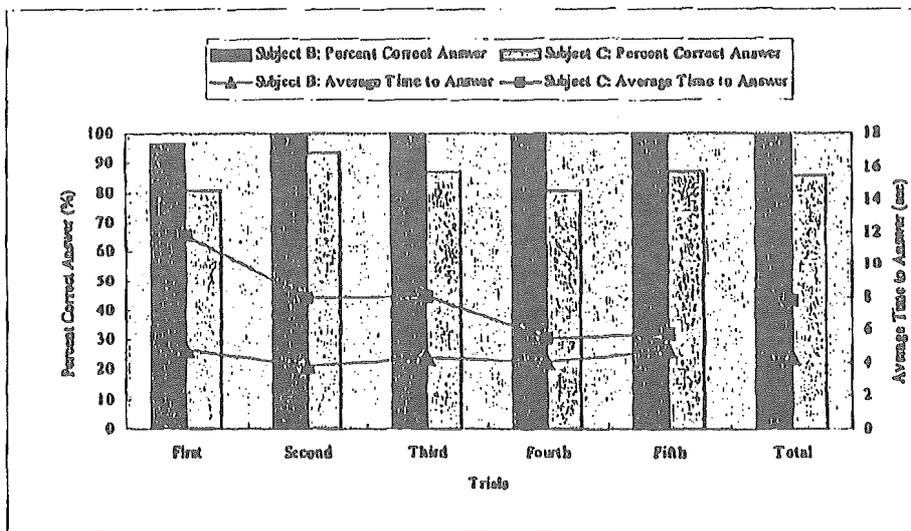


Fig. 5. Evaluation Results of the Font Recognition in Symbols.

Figure 6 shows the evaluation results of the font recognition in the case of all characters. Though the number of all characters is ninety-three, the percent correct answer in total is more than 90% for both in subject B and in subject C. This result shows that it is enough to understand the displayed characters using our tactile display system. However, some researchers reported that the function of the tactile sense deteriorates