Chapter 27
Kanji Perception and Brain Function

Ichiro Shimoyama
Chiba University, Japan

Hitoshi Shimada
National Institute of Radiological Sciences, Japan

Toshiaki Ninchoji
Suzukake Hospital, Japan

ABSTRACT

The semantic processing involved in the visual perception of Chinese characters (Kanji) was studied using electroencephalograms. Thirty concrete Kanji, 30 absolute Kanji and a closed circle were used in a tachistoscopic presentation, wherein one character or a circle was displayed at random for 35 ms, and visual evoked potentials were recorded. The test subjects were11 native Japanese speakers. The concrete Kanji were familiar objects and highly imaginable characters such as a dog, a cat, a cow, etc. The absolute Kanji were familiar Kanji but represented concepts that are difficult to imagine, such as nothing, what, existing, et cetera. P100, N160, P230, and N320 were noted on the evoked potentials. The bilateral posterior temporal lobes and the bilateral occipital lobes were activated for the concrete Kanji at approximately 320ms after the onset of the visual stimuli (P<0.001 by multiple analysis of variance).

INTRODUCTION

Language is a highly developed ability for *Homo sapiens*, so utilizing human subjects is optimal for the study of language cognition. Non-invasive methods are preferred for human studies, so electroencephalography or magnetoencephalography are best for temporal resolution. Electroencephalograms and magnetoencephalograms have been reported for language perception, e.g., frequency analyses of the alpha band (Willems, 2008), of the slow band (Hald, 2006; Hanslmayr, 2008; Klimesch, 2001; Pulvermüller, 2000), and of the fast band (Dalal, 2009; Gaona, 2011; Hald, 2006; Tanji, 2005; Willems, 2008). Evoked potentials have been reported as well, including N400 (Kutas, 1984;Olichney,2008; Zhou, 2004), P200 (Liu, 2010), P300 (Azizian, 2006; Liu, 2010; Mingshi,

DOI: 10.4018/978-1-4666-2113-8.ch027

2005; Osaka, 1992; Shirahama, 2004), and P600 (Balconi, 2005;Klaver, 2005; Kuperberg, 2011; Lück, 2006; Olichney, 2008; Rossi, 2005;Service, 2007; Zhou, 2004).

Functional magnetic resonance imaging (f-MRI) is another non-invasive method. f-MRI is good in spatial resolution but poor in temporal resolution, so f-MRI has been shown to be good for the localization of word perception (Bellemann,1995; Koeda,2006; Marinković, 2004; Rossion, 2000; Stoeckel, 2009; Thuy, 2004; Vigneau, 2006). Positron emission tomography (PET) is another non-invasive method involving little irradiation, and PET studies have been important for healthy subjects (Bright, 2004; Emmorey, 2007; Klein, 2006; Krause, 1999; Marinković, 2004; Mechelli, 2000; Thuy, 2004; Yasuno, 2000).

Written Japanese is different from written English, as Japanese is primarily morphographic, and English is phonographic. Sentence structure is also different, especially in negative sentences. In Japanese, negation is often indicated by the addition of a negator at the end of the sentence. A morphogramcan represent an object with one character; e.g., “木”represents a tree. Therefore, word perception should be analyzed for the respective languages. We studied Kanji perception with high-imaginable Kanji (HIK) and low-imaginable Kanji (LIK) electrophysiologically.

METHODS AND SUBJECTS

Eleven healthy native Japanese speakers, males aged 32.4+/-7.2 years, participated in this study. All subjects were right handed (100%) with the Edinburg inventory (Oldfield 1976). They had no history of central nervous system conditions. HIKs were “犬” (dog), “猫” (cat), “牛” (cow), “馬” (horse), “猿” (monkey), etc. LIKs were “無” (nothing or null), “何” (what), “在” (existence), “以” “然”(hard to translate into English), etc. Thirty HIKs, 30 LIKs, and a closed circle (CC) as a control were displayed as black characters over a grey background on a TV monitor at random, 2m apart in front of the subjects. The size of the Kanji and CC were adjusted to 1.6 degrees of the visual angle. The stimuli were displayed for 35 ms, and the inter-stimuli-interval was 3 to 5s at random. The subjects were asked to look at a fixed point on the monitor and were on a reclining chair with a headrest in a dimly illuminated sound attenuated shielded room. Twenty-one electroencephalograms (Biotop, 6R12, NEC San-ei, Japan) were recorded with a band-pass-filter between 0.05 and 60 Hz, using the balanced non-cephalic reference (Stephenson, 1951). The signals were sampled at 500 Hz and digitalized into 14 bits for averaging. The time windows was 1 s from -100 to +900 ms after the stimuli. After artifact rejection, the respective averaged time was 90 +/- 27ms. Amplitudes at the 4 peaks of interest were tested with multivariate analysis of variance.

RESULTS

Figure 1 shows the total averaged visual evoked potentials for HIKs (thick traces), LIKs (thin traces), and CC (dotted traces). Peaks were noted at 100ms positively (P100), at 160 ms negatively (N160), at 230ms positively (P230) and at 320ms negatively (N320).

Figure 2 shows topographies for the potentials at the 4 peaks. At 100 ms, no difference was noted between topographies for HIKs and LIKs, but more positive area was noted for the CC over the right occipital parietal lobes. At 160 ms, no difference was noted between the topographies of HIKs and LIKs, a deep negative area was noted over the bilateral occipital and posterior temporal lobes, and a more positive area was noted for the CC over the bilateral posterior temporal lobes. At 230 ms, little difference was noted between the peaks for HIKs and LIKs, a less negative spotty area was noted over the left parietal area for LIKs, and a more positive broad area was noted for the CC over the posterior half

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