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ERP components reflecting stimulus identification: contrasting the recognition potential and the early repetition effect (N250r)

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Abstract

The recognition potential component (RP) in the event-related brain potential (ERP) appears during rapid stream stimulation and has been related to the activation of word form or word meaning. The early repetition effect (ERE/N250r) is observed in repetition priming designs and has been linked to the access to stored representations of the structure of familiar faces and names. Because of the apparent similarities in latency, topography and theoretical interpretation we compared the RP and ERE/N250r within the same rapid stream stimulation design and for the same type of stimulus material: names and faces of famous persons and names and pictures of common objects. Contrasting with RP, the ERE/N250r occurred later and differed in both scalp topography and amplitude patterns across stimulus conditions. Therefore, the ERE/N250r seems to reflect a separate and content-specific stage of information processing, following the RP, which appears to reflect domain-general processes of structural analyses.

Keywords: Language; Face recognition; Recognition potential; Early repetition effect; N250r; Semantic processing; Structural processing

1. Introduction

Recently, several components in the event-related brain potential (ERP) have been suggested to indicate the identification of a visual stimulus. In the focus of the present paper are two ERP components, the recognition potential (RP) and the early repetition effect (ERE) or N250r. Both components have been linked to the access of presemantic representations of words or faces, respectively, and appear to have similar peak latencies and scalp topographies. However, direct comparisons within the same experiment have never been made. Therefore, we measured both components within the same experimental design, with the same type of stimuli and in the same participants. As will be shown, the two components differ in crucial respects.

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The comparison of both components will be made here in the frame of some influential models for picture and written name recognition. According to these, when an observer sees a picture of either type or a written name, a visual analysis is performed, a kind of analysis that is common to any type of visual stimulus, resulting in pictorial codes (Marr, 1982). Subsequently, and mainly based on previous knowledge, structural representations are extracted, capturing the typical aspects of the object or face (for instance, physiognomy in the case of a face) independent of surface or situational properties such as lighting or viewpoint, or the extraction of whole words in the case of names (a word-form analysis), which again would be independent of situational properties such as the type or size of the font used. In the next step, the structural representations would be compared with stored representations of objects, faces or names, such as the so-called face recognition units (Bruce and Young, 1986) or name recognition units (Valentine et al., 1991). Thereafter, semantic information is accessed, which would be common to any domain or modality.

The RP is best seen if a rapid stream stimulation paradigm is used, a procedure in which background stimuli (i.e., nonsense stimuli superficially resembling words or pictures) are presented at a high rate and a word or a picture occasionally substitutes a background (Rudell, 1992; Hinojosa et al., 2001). RP usually peaks around 250 ms when subjects view recognizable images (Rudell, 1991; Martín-Loeches et al., 1999; Hinojosa et al., 2000) and is strongly related to conscious awareness of the stimuli, selective attention being an important factor for evoking it (Rudell and Hua, 1996). RP seems to index at least part of the processing of word meaning, since RP amplitude has been shown to consistently differ in accordance with word features that can only be achieved by means of an appropriate semantic processing, such as the semantic category of the stimuli (Martín-Loeches et al., 2001a,b). However, a presemantic, more structural level of analysis has also been conceived as the process reflected by this component (Rudell et al., 2000; Martín-Loeches et al., 2004). Recently, the RP has been shown to be affected by context effects (Martín-Loeches et al., 2004). The application of the BESA algorithm has revealed the origin of the activity reflected by RP in basal temporal areas, specifically within the lingual and/or fusiform gyrus (Hinojosa et al., 2000). The topography of RP appears relatively homogeneous across studies and materials, displaying a bilateral temporooccipital negative maximum with a slight left lateralization for verbal material (Hinojosa et al., 2001; Martín-Loeches et al., 2001b).

The ERE/250R was first observed in a prime-target paradigm with faces (Begleiter et al., 1995; Schweinberger et al., 1995). Schweinberger et al. (1995) presented portraits of celebrities and unfamiliar persons. Different kinds of primes preceded the target by 1.8 s. If a celebrity's portrait had been repeated (i.e., primed), ERPs around 250 ms after target onset were more positive at frontal and more negative at temporal electrodes as compared to when it was unprimed, a finding that is now well replicated (e.g., Herzmann et al., in press; Itier and Taylor, 2002). This priming-related diminution of the ERP was called early repetition effect (ERE) in order to distinguish it from a subsequent late repetition effect that has been related to the N400 component; in more recent articles, the ERE is also referred to as N250r (Schweinberger et al., 2002; Pickering and Schweinberger, 2003). When semantically associated persons were used as primes and targets, there was an N400 again but no ERE/250r. Whereas there was also a (smaller) ERE/250r for unfamiliar faces in the study of Schweinberger et al. (1995), the ERE/250r appeared only to familiar faces when a continuous recognition paradigm was used with other stimuli intervening between repetitions (Pfütze et al., 2002). Importantly, Pfütze et al. (2002) and Pickering and Schweinberger (2003) observed an ERE/250r also for names of celebrities but with a different scalp distribution, indicating domain specificity. Because of the sensitivity of the ERE/250r to stimulus familiarity (for both faces and names) and its domain-specific scalp topography (faces being more right-lateralized, names more left-lateralized), Pfütze et al. (2002) suggested that the ERE/250r might reflect the access to stored knowledge about the structure of faces and names, respectively. In contrast, the late repetition effect or N400 was consistent with access to other kinds of knowledge about the person. Within the context of cognitive theories about face and name recognition, the ERE/250r would therefore reflect the access to face and name recognition units, respectively (Bruce and Young, 1986; Valentine et al., 1995). This interpretation was strengthened by more recent find-