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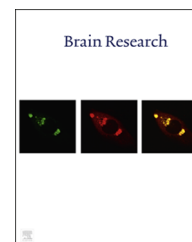
Research Report

Neuroanatomic localization of priming effects for famous faces with latency-corrected event-related potentials

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ABSTRACT

The late components of event-related brain potentials (ERPs) pose a difficult problem in source localization. One of the reasons is the smearing of these components in conventional averaging because of trial-to-trial latency-variability. The smearing problem may be addressed by reconstructing the ERPs after latency synchronization with the Residue Iteration Decomposition (RIDE) method. Here we assessed whether the benefits of RIDE at the surface level also improve source localization of RIDE-reconstructed ERPs (RERPs) measured in a face priming paradigm. Separate source models for conventionally averaged ERPs and RERPs were derived and sources were localized for both early and late components. Jackknife averaging on the data was used to reduce the residual variance during source localization compared to conventional source model fitting on individual subject data. Distances between corresponding sources of both ERP and RERP models were measured to check consistency in both source models. Sources for activity around P100, N170, early repetition effect (ERE/N250r) and late repetition effect (LRE/N400) were reported and priming effects in these sources were evaluated for six time windows. Significant improvement in priming effect of the late sources was found from the RERP source model, especially in the Medio-Temporal Lobe, Prefrontal Cortex, and Anterior Temporal Lobe. Consistent with previous studies, we found early priming effects in the right hemisphere and late priming effects in the left hemisphere. Also, the priming effects in right hemisphere outnumbered the left hemisphere, signifying dominance of right hemisphere in face recognition. In conclusion, RIDE reconstructed ERPs promise a comprehensive understanding of the time-resolved dynamics the late sources play during face recognition.

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1.   Introduction

Event-related potentials (ERPs) averaged across single trial EEG epochs are widely used measures of brain activity in humans due to their excellent temporal resolution, noninvasiveness, and validity as indicators of sensory, cognitive, and motor processes. Hence, the different ERP components help to understand the functions of the brain across different experimental situations. The brain neural systems generating the ERP components can be localized by inverse modeling based on the scalp-recorded signals. Here we present a possible approach to one of the challenges posed to the localization of the neural sources for ERP components.

Localizing ERP components in the brain may be challenging not only because of the non-uniqueness of inverse solutions (Helmholtz, 1853; Basile et al., 1997; Nunez and Srinivasan, 2006); especially late ERP components beyond about 300 ms are usually generated by multiple, functionally distinct, and distributed neural sources whose scalp manifestations overlap temporally and spatially (Dale et al., 2000). A further problem arises from the traditional averaging procedure for obtaining ERPs from single trial EEG epochs. Cognitive sub-processes and the corresponding ERP components may have strong latency variability across single trials even within the same experimental condition. Conventional stimulus-locked averaging of single trial EEG leads to smearing of the late, latency-variable components in the ERPs. These smeared components are diminished in amplitude and suffer from blurred scalp distributions (topographies) because they are mixed with other components, seriously limiting our ability to detect their sources.

Solving the smearing problem in ERPs should also improve source localization. Recently, (Ouyang et al., 2011) developed a method – Residue Iteration Decomposition (RIDE) – that may reduce the smearing present in conventional ERPs. When RIDE is applied to scalp-recorded ERPs, the amplitudes of late components often increase (Ouyang et al., 2015a, b). As explained below, RIDE can reconstruct ERPs after resynchronizing latency-variable components. In the present study, we applied source localization to RIDE-reconstructed ERPs (RERPs) from a face priming experiment in order to assess if the benefits of RIDE at the surface level generalize to the source level.

Previous works on source localization of face processing-related ERPs have revealed a number of brain systems involved. Around 100 ms after stimulus onset bilateral sources are active in the Inferior Occipital Lobe/Lingual Gyri (Mnatsakanian and Tarkka, 2004; Wong et al., 2009), yielding the occipital positive-going visual evoked P1 component, which is a response of the peristriate cortex to any kind of visual stimuli (Tobimatsu and Celesia, 2006). In contrast, the next peak at 170 ms (N170) is more prominent for faces as compared to other visual stimuli and has been localized in the Inferior Temporal Gyrus (Schweinberger et al., 2002) or the Fusiform Gyrus (e.g., Deffke et al. (2007), Mnatsakanian and Tarkka (2004) and Wong et al. (2009)). It has been suggested that the N170 component reflects the structural encoding of faces (for a review see Eimer (2011)) and is usually neither affected by familiarity of the face (Bentin and Deouell,

2000; Eimer, 2000) nor by priming (Cooper et al., 2007; Eimer, 2000).

Two other components of interest here are best seen in the so-called repetition priming paradigm as a difference between the ERPs to primed and unprimed faces. In repetition priming, faces are immediately preceded by the same face (primed condition) or by a different face (unprimed). In such paradigms, there are usually two repetition effects in difference ERPs between primed and unprimed conditions. The early repetition effect (ERE) or N250r was suggested to reflect the activation of structural face representations in memory (Schweinberger, 2011) has its maximum around 250 to 300 ms, and is positive at fronto-central and negative at occipito-temporal electrodes. Previous studies reported larger repetition-related N250r responses for familiar than unfamiliar faces (Herzmann et al., 2004; Pfütze et al., 2002). Schweinberger et al. (2002) and Bindemann et al. (2008) localized the sources of ERE/N250r in the ventral temporal area around Fusiform Gyrus. An fMRI study by Eger et al. (2005) found activation around the same area for repeated faces. In an MEG study by Schweinberger et al. (2007) the sources of M250r (thought to be equivalent to N250r in ERPs) were localized in inferior temporal/mid-Fusiform Gyrus area and in Cingulate Gyrus.

The ERE/N250r is followed by LRE or N400. In repetition priming paradigms, the long-lasting parietal positivity between about 200 to 700 or more ms is diminished by priming in its early part (ca. 300 to 500 ms). It has been suggested that this increased positivity is due to the reduction of a centro-parietal N400 component, which in the unprimed condition overlaps with and decreases the late positive component (e.g. Engst et al. (2006) and Schweinberger et al. (1995)). A similar effect has been observed in associative priming studies where a famous face is primed by a associatively related face (e.g. Michele Obama→Barak Obama) (Schweinberger, 1996; Wiese and Schweinberger, 2008); therefore, the LRE/N400 was considered to reflect the activation of semantic knowledge about persons (Schweinberger, 2011, for a review). The LRE/N400 is therefore related to those aspects of semantic processing, which are triggered by familiar faces. Neural sources of the LRE/N400 for faces have not yet been reported, although linguistic studies on the N400 in priming found sources at Superior and Inferior Temporal areas along with Prefrontal Cortex (e.g., Kutas and Federmeier (2011) and Lau et al. (2008)).

In the present study, we aimed to localize the neuroanatomical sources of ERP activities related to famous face processing. A special interest was in the ERP components affected by repetition priming, which have been rarely addressed with respect to the brain systems involved. Because such late ERP components are degraded by latency jitter, we applied RIDE in order to correct the jitter and enhance the amplitudes of these ERP components. Specifically we expected to replicate brain areas in ERP sources, which have previously been related to the face processing network, namely, the peristriate cortex for domain-general visual processes and the Fusiform Gyrus (FG), an area related to face detection and analysis. In addition, we expected to identify further sources involved in general long-term memory processes, such as the Medio-Temporal Lobe (MTL) and in