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Research Report

MEG correlates of bimodal encoding of faces and persons' names

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ARTICLE INFO

Article history:
Accepted 2 July 2008
Available online 9 July 2008

Keywords:
Magnetoencephalography
Learning
Memory
Language
Associative encoding
Auditory
Visual
Occipital cortex

ABSTRACT

Learning associations between people's faces and names is a universal cognitive function with important social implications. The goal of the present study was to examine brain activity patterns associated with cross-modal encoding of names and faces. Learning face-name pairs was compared to unimodal learning tasks using the same visual and auditory stimuli. Spatiotemporal brain activation profiles were obtained with magnetoencephalography using an automated source estimation method. Results showed activation foci in left (for names) and right (for faces) temporal lobe perisylvian cortices, predominantly right-hemisphere occipital and occipitotemporal regions (for faces), and right hemisphere dorsolateral prefrontal regions during the encoding phase for both types of stimuli presented in isolation. Paired (face-name) stimulus presentation elicited bilateral prefrontal and temporal lobe perisylvian activity for faces and enhanced visual cortex activation in response to names (compared to names in the unpaired condition). These findings indicate distinct patterns of brain activation during the formation of associations between meaningful visual and auditory stimuli.

1. Introduction

Many common cognitive tasks, such as relating a person's name with his face, involve the establishment of new associations between auditory and visual input. Initial, unimodal processing of either type of input shares many components with the mechanism responsible for the formation of memories based on that input. Thus, processing of a person's name (i.e. engaging in the analysis and registration of linguistic features) engages many of the same brain regions which are also involved when a name is processed for the explicit purpose of memorization and future retrieval. These regions are primarily located in the superior and middle temporal cortices in the left hemisphere (in the majority of right-handers; for a discussion of the brain substrates of encoding as part of the function and mechanism of memory see Papanicolaou et al., 2006).

Functional brain imaging studies have shown that perception of and memory for faces is mediated by a mechanism that involves neurophysiological processes that take place in several brain regions. Distinct components of this mechanism appear to be located in visual extrastriate cortex, including the inferior occipital gyri (probably involved in the early extraction of facial features; Haxby et al., 2000) and the fusiform gyrus, especially in the right hemisphere, probably involved in processing invariant aspects of faces (Clark et al., 1996; Haxby et al., 1991; Kanwisher et al., 1997). Additional structures in the medial temporal lobe (Grady et al., 1998;

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0006-8993/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.brainres.2008.07.003

Haxby et al., 1996) and the prefrontal cortices (Kelley et al., 1998) are likely involved in consolidation and retrieval of information regarding faces.

In view of the fact that initial processing (encoding) of faces and names engages different brain mechanisms, the question arises as to how these mechanisms work together to support the formation of associations between stored traces of these two types of stimuli. Most of the functional imaging studies addressing this issue have explored face-name associative memory within the visual domain. PET (Herholz et al., 2001) and fMRI (Kirwan and Stark, 2004; Sperling et al., 2001) studies have shown the engagement of medial temporal, prefrontal and ventral occipitotemporal structures in the formation of associative memories. Other regions, such as the middle frontal gyrus, the inferior frontal gyrus and the supramarginal gyrus of the inferior parietal lobe have also been shown to be involved in tasks requiring integration of face-name stimuli as compared to tasks involving within category associations such as face-face or name-name associations (Campanella et al., 2001). Surprisingly, few studies have been conducted to explore the brain activation profiles engaged during the much more common task of forming bimodal face-name associations. Along these lines, an event related potentials (ERP) study reported differences in the characteristics of the evoked electrical response to spoken names and faces which were predictive of subsequent retrieval performance (Guo et al., 2005). Further, an fMRI study that focused on hippocampal activity (Small et al., 2001) showed that the distribution of activity across the long axis of the hippocampus associated with processing of face-name pairs was not accounted by the simple summation of the activation produced by the encoding of isolated names or faces. The findings from both studies seem to indicate that lateral and mesial temporal regions show distinct patterns of activation when cross-modal memory formation is required. However, the low spatial resolution of scalp recordings of electrical potentials and the restricted scope of fMRI data to the hippocampal formation in the Small et al. (2001) study, did not allow a clear identification of the specific brain activation patterns related to associative bimodal encoding.

The present study employs Magnetoencephalography (MEG) to investigate the spatio-temporal profiles of activity elicited by brain areas engaged in the encoding of visual (faces) and auditory (names) stimuli that define a person's identity, either separately or in a task that requires bimodal integration. The study extends previous investigations of cross-modal processing (Baier et al., 2006; Johnson and Zatorre, 2005) by experimentally recreating a common phenomenon involving meaningful stimuli. In order to ensure that cognitive processes engaged during presentation of each face stimulus did not involve retrieval, each stimulus was only presented once during each phase of the experiment. The present study was designed on the premise that formation of new associations between faces and names depends on neurophysiological processes that take place in more than one brain regions. The latter may include modality-specific cortices, which are also engaged during encoding of each type of stimulus presented in isolation, as well as modality non-specific cortices.

2. Results

2.1. *In scanner performance*

Participants correctly recalled 76.4±6.9% of the person's names and correctly recognized 88.9±8.1% of the faces during Phase 1 of the experiment. During Phase 2 participants correctly recalled the name that was paired with a given face in 42.7±14.5% of the trials.

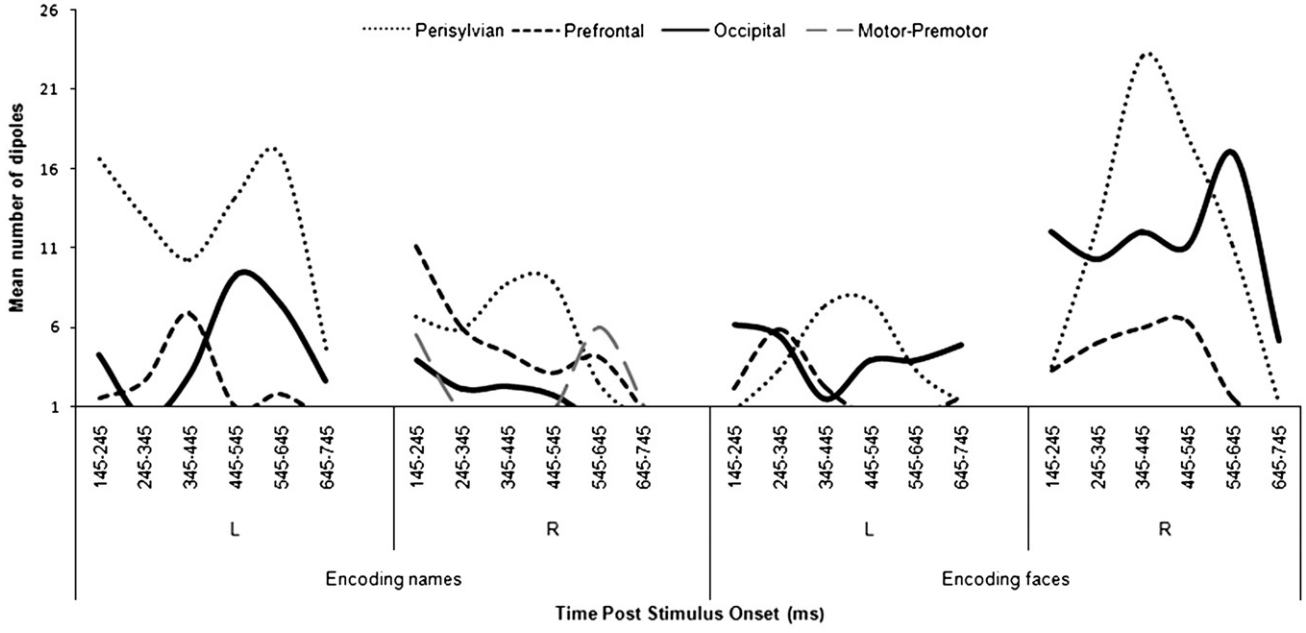

Fig. 1 – Time course of regional magnetic activity in eight ROIs which consistently showed activity sources during non-associative encoding of names and faces.