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Selective attention to a facial feature with and without facial context: an ERP-study

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Abstract

Summary. The present experiment addressed the question whether selectively attending to a facial feature (mouth shape) would benefit from the presence of a correct facial context. Subjects attended selectively to one of two possible mouth shapes belonging to photographs of a face with a happy or sad expression, respectively. These mouths were presented randomly either in isolation, embedded in the original photos, or in an exchanged facial context. The ERP effect of attending mouth shape was a lateral posterior negativity, anterior positivity with an onset latency of 160–200 ms; this effect was completely unaffected by the type of facial context. When the mouth shape and the facial context conflicted, this resulted in a medial parieto-occipital positivity with an onset latency of 180 ms, independent of the relevance of the mouth shape. Finally, there was a late (onset at approx. 400 ms) expression (happy vs. sad) effect, which was strongly lateralized to the right posterior hemisphere and was most prominent for attended stimuli in the correct facial context. For the isolated mouth stimuli, a similarly distributed expression effect was observed at an earlier latency range (180–240 ms). These data suggest the existence of separate, independent and neuroanatomically segregated processors engaged in the selective processing of facial features and the detection of contextual congruence and emotional expression of face stimuli. The data do not support that early selective attention processes benefit from top-down constraints provided by the correct facial context.

Keywords: ERP; Selective attention; Facial feature; Context effect; Top-down modulation

1. Introduction

Everyday life visual scenes consist of complex objects (e.g. a house) in which other, smaller objects are embedded (e.g. bricks, windows, doors). Each of the embedded objects is in turn, composed of complex constellations of visual features (color, shape, texture, etc.). A general theoretical question concerns how the visual system processes such complex objects. Does the processing of the parts precede the perception of the whole, or is the whole perceived first and then decomposed into its parts? With respect to this

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question, two opposing views are expressed by structuralism on the one hand and Gestalt psychology on the other hand.

Structuralism holds that the perceived whole is nothing more than the sum of its separately perceived parts. In line with this view, most models of human vision usually assume that a decomposition of a visual object into its constituent features is the first stage of information processing (e.g. Treisman and Gelade, 1980). Also, principles of brain organization seem to dictate a structuralistic account of vision. A dominant principle of brain organization, namely, is the functional specialization of separate visual areas of the brain for processing different visual attributes (e.g. color, shape, motion; Desimone and Ungerleider, 1989; Zeki, 1993). The general view is that the brain recognizes objects by first decomposing the visual scene into parallel representations of different elementary stimulus features. Combining these separate feature representations into a unified object percept is supposed to occur in a later, serial, attentive stage of processing (Treisman and Gelade, 1980).

In contrast, the major view of Gestalt psychology is that the whole is more than the sum of its parts. This school stressed the importance of perceptual organization, suggesting that basic organizational principles such as proximity and similarity determine whether the wholes or parts are recognized first. Research using compound stimuli, for instance small ('local') letters nested within a larger ('global') letter, has provided some evidence in favor of the latter view. Navon (1977) found that subjects reacted faster to the global letters than to the local ones. Furthermore, when the identities of the global and local letters were different, this interfered more when subjects responded to the local letters than when they responded to the global letters, i.e. there was more interference from the information at the global level to the local level than vice versa. On the basis of such data, Navon formulated the 'global precedence hypothesis', which holds that visual pattern processing proceeds from a more global level to a more local level. He claimed that 'we see the forest before the trees'. However, subsequent research has shown that the performance advantage for global stimuli is not a general phenomenon at all and depends on various perceptual factors. In addition, the results of several studies suggested that selective attention may play an important role in the differential processing of global and local levels of compound stimuli (e.g. Van Velzen et al., 2000). For instance, Kinchla et al. (1983) has shown that the performance for a particular level of the compound stimulus is influenced by the probability of targets appearing at that level. Thus, subject's expectancy determines the efficiency of processing at local versus global levels.

Another line of investigation relevant to this issue is research on the 'word superiority effect'. Reicher (1969) found that subjects detected letters presented in the context of a meaningful word more accurately than letters presented in isolation or in the context of a non-word. This effect is assumed to reflect top-down feedback from higher level information (e.g. lexical information at the word level) 'boosting' the perception of the information at the lower letter level. Recent electrophysiological data also suggest the importance of reafferent feedback in the processing of objects. Roelfsema et al. (1998) found that the activity of neurons in the primary visual area (V1) of the monkey is enhanced when its receptive field is aligned with the shape of an object to which the monkey attends. Lange et al. (1999) suggested on the basis of topographical brain potential mapping that visual search for letters involves a reafferent recheck of information in brain areas involved in early levels of visual processing.

In this kind of research, there is a general problem with behavioral studies. Since behavior is the end-product of several stages of processing, it is difficult to be sure at which stage of processing a particular performance effect is produced. For instance, the general interpretation of the word superiority effect is that it involves perceptual processes, but it is hard to exclude that other factors (e.g. decisional, memory-related) might be involved as well. By recording event-related potentials of the brain (ERPs) it is better possible to circumvent this problem. Since ERPs are an online reflection of information processing in the