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The involvement of the "fusiform face area" in processing facial expression

Tzvi Ganel [a,*], Kenneth F. Valyear [a], Yonatan Goshen-Gottstein [b], Melvyn A. Goodale [a]

[a] *CIHR Group on Action and Perception, Department of Psychology, University of Western Ontario, London, Ont., Canada N6A 5C2*
[b] *Department of Psychology, Tel Aviv University, Tel Aviv 69978, Israel*

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Abstract

We conducted an fMRI investigation to test the widely accepted notion that the fusiform face area (FFA) mediates the processing of facial identity but not expression. Participants attended either to the identity or to the expression of the same set of faces. If the processing of identity is neuroanatomically dissociable from that of expression, then one might expect the FFA to show higher activation when processing identity as opposed to expression. Contrary to this prediction, the FFA showed higher activation for judgments of expression. Furthermore, the FFA was sensitive to variations in expression even when attention was directed to identity. Finally, an independent observation showed higher activation in the FFA for passive viewing of faces when expression was varied as compared to when it remained constant. These findings suggest an interactive network for the processing of expression and identity, in which information about expression is computed from the unique structure of individual faces.

Keywords: Faces; Selective attention; fMRI; Facial identity; Emotion

1. Introduction

Face-recognition models have used behavioral and neuroanatomical data to argue that faces are processed in a distributed manner (Haxby, Hoffman, & Gobbini, 2000, 2002). The notion is that different attributes of the same face, such as identity, expression, or direction of gaze, are processed by separate brain regions. A crucial region for identity is thought to be the "fusiform face area" (FFA), a region within the lateral fusiform gyrus that shows robust activation for faces, mostly in the right hemisphere (Kanwisher, McDermott, & Chun, 1997). In contrast, the processing of expression is thought to be mediated by another set of brain regions, mainly in the superior temporal sulcus (STS) and the amygdala (Haxby et al., 2000).

Yet, although the role of the FFA in processing identity (Henson, Shallice, & Dolan, 2000; Henson, Goshen-Gottstein, Ganel, Otten, Quayle, & Rugg, 2003) and the role of the STS and the amygdala in processing expression (Vuilleumier, Armony, Driver, & Dolan, 2003; Winston, Henson, Fine-Goulden, & Dolan, 2004) have been well established, it is less clear how dissociable these regions are (for recent reviews, see Pessoa & Ungerleider, 2004; Posamentier & Abdi, 2003). Of particular interest is the possible involvement of the FFA in the processing of expression. Although face-recognition models have speculated that this might be possible (Haxby et al., 2000, 2002; Pessoa & Ungerleider, 2004), the nature of the involvement has never been specified or directly addressed. In the current paper, we used fMRI to test whether or not such an involvement indeed exists.

We propose, on the basis of a broad range of behavioral studies (for a review, see Ganel & Goshen-Gottstein, 2004), that facial expressions can be best characterized as dynamic variations from the invariant structure of faces, i.e. their identity. In other words, the way an individual expresses emotion is always constrained by his or her identity. Differences between individuals should lead to systematic differences in the way they express emotions. We would predict, therefore, that

* Corresponding author. Tel.: +1 519 661 2111x88240; fax: +1 519 661 3961.
E-mail address: tganel@uwo.ca (T. Ganel).

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to extract emotional expression from a specific face, it would be also necessary to process the identity of that face. Thus, the processing of facial expression should engage the same anatomical regions, such as the FFA, that have been traditionally associated with the processing of identity. Moreover, this involvement could be quite direct, and not just one of passively providing information about identity to other, more specialized "emotion-recognition" systems.

Recent imaging studies that showed stronger FFA activation to fearful as compared to neutral faces provide a preliminary support for a direct involvement of this region in processing of expressions (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002; Vuilleumier, Armony, Driver, & Dolan, 2001). These findings, however, are limited by the fact that different sets of stimuli were used for the expressive and the neutral conditions. Such differences may have resulted in low-level visual differences between the images presented in the two conditions, differences that have already been found to have robust effects on FFA activation (Vuilleumier et al., 2003). Furthermore, none of these studies controlled for differential attention to facial identity and expression, and therefore, could not isolate the effects of processing expression from those of processing identity within the FFA.

In the current study, we used a modified selective-attention task (Garner, 1974) that has been used in behavioral studies to test the functional relationship between the processing of different dimensions of objects (Felfoldy, 1974; Ganel & Goodale, 2003) and faces (Ganel & Goshen-Gottstein, 2002), including the relationship between the processing of identity and expression (Baudouin, Martin, Tiberghien, Verlut, & Franck, 2002; Ganel & Goshen-Gottstein, 2004; Schweinberger, Burton, & Kelly, 1999; Schweinberger & Soukup, 1998).

In this task, the same set of faces is presented for judgments of either identity or expression (Fig. 1), allowing us to compare the contributions of different brain regions to the

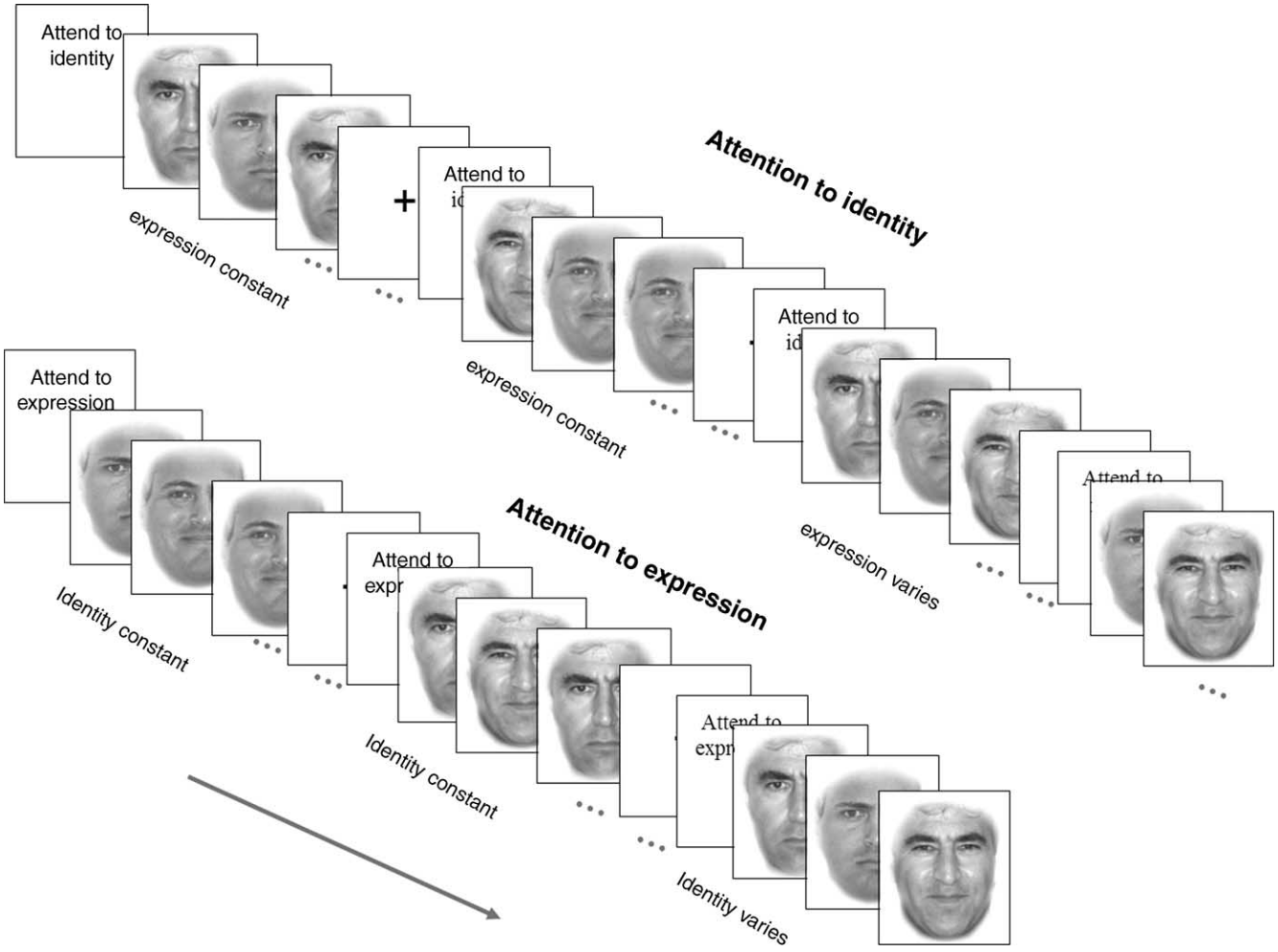

Fig. 1. Experimental design and examples of stimuli. The same set of faces was presented for speeded classification of identity (Person A/Person B) or of expression (happy/angry). Participants were asked to attend to one dimension while ignoring the other, while this irrelevant dimension either remained the same (baseline condition) or changed in value from trial to trial (filtering condition). Eight experimental runs were included, each containing all the experimental blocks. Order of experimental blocks was counterbalanced across runs.