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Seeing John Malkovich: the neural substrates of person categorization

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Neuroimaging data have implicated regions of the ventral temporal cortex (e.g., fusiform gyrus) as functionally important in face recognition. Recent evidence, however, suggests that these regions are not face-specific, but rather reflect subordinate-level categorical processing underpinned by perceptual expertise. Moreover, when people possess expertise for a particular class of stimuli (e.g., faces), subordinate-level identification is thought to be an automatic process. To investigate the neural substrates of person construal, we used functional magnetic resonance imaging (fMRI) to contrast brain activity while participants judged faces at different levels of semantic specificity (i.e., identity vs. occupation). The results revealed that participants were quicker to access identity than occupational knowledge. In addition, greater activity was observed in bilateral regions of the fusiform gyrus on identity than occupation trials. Taken together, these findings support the viewpoint that person construal is characterized by the ability to access subordinate-level semantic information about people, a capacity that is underpinned by neural activity in discrete regions of the ventral temporal cortex.

Keywords: Face processing; fMRI; Fusiform gyrus; Semantic knowledge; Person perception

An extensive literature has demonstrated that regions of the ventral temporal cortex (e.g., fusiform gurus) play a critical role in person perception, notably the registration and recognition of others (Haxby et al., 2000; Hoffman and Haxby, 2000; Kanwisher et al., 1997, 1999; McCarthy et al., 1997). While it was initially suggested that this effect may reflect the domain specificity of face processing in the brain (Kanwisher et al., 1997; McCarthy et al., 1997), subsequent work has revealed that activity in ventral temporal cortex is modulated by a wide range of stimuli (Chao et al., 1999; Haxby et al., 2001; Ishai et al., 1999). This includes, but is not restricted to faces, such that activation in the fusiform gyrus has been reported when bird and car experts view exemplars from their respective areas of interest (Gauthier et al., 1999, 2000). On the basis of findings such as these, it has been suggested that it is not stimulus type that modulates activity in visual association cortex, but rather the level of categorical specificity at which objects are identified (see Haxby et al., 2000; Tarr and Gauthier, 2000).

Any object, including a person, can be identified at multiple levels of abstraction (e.g., bird vs. canary; male vs. Al Pacino—see Rosch et al., 1976). It is generally assumed, however, that objects are first identified at what is termed the *entry level* of categorical representation (Jolicoeur et al., 1984). This is the level at which a name can be generated or matched most rapidly to an object. Although such descriptions dominate the recognition process, in no sense is this the only level at which items can be identified; sometimes, people prefer subordinate or exemplar-based descriptions of stimuli. Given this observation, Gauthier and colleagues have speculated that the apparent specificity of the fusiform gyrus for faces is a byproduct of differences in the nature of face processing and object recognition (Gauthier et al., 1997, 1999, 2000). Specifically, whereas object recognition typically unfolds at the basic level of categorical abstraction (e.g., dog rather than spaniel), face recognition is automatized at the individual or exemplar-based level (e.g., Sean Connery rather than human). Supporting this viewpoint, Tanaka (2001) has demonstrated that adults identify familiar faces more often and as rapidly at the individual-level than the basic level of abstraction. Critically, however, this downward shift in the specificity of identification has also been observed when canine experts view dogs (Tanaka and Taylor, 1991) and when people respond to artificial objects (i.e., Greebles) for which they have received extensive prior training (Gauthier et al., 1999). As Tanaka (2001) contends, "face expertise, like object expertise, promotes a downward shift in recognition to more subordinate levels of abstraction" (p. 534).

But what is the functional significance of activity in regions of ventral temporal cortex during subordinate-level identification? While activity in this region is acknowledged to index fine-grained perceptual discrimination (Gauthier et al., 1997; Haxby et al., 2001; Mason and Macrae, in press), it is worth noting that portions of the fusiform gyrus, particularly in the left hemisphere, have also been associated with the generation of semantic knowledge about objects (Gorno-Tempini and Price, 2001;

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Gorno-Tempini et al., 1998; Kan et al., 2003; Thompson-Schill, 2003; Thompson-Schill et al., 1999; Zelkowicz et al., 1998). It is possible, therefore, that this cortical region may also be sensitive to the semantic specificity of person categorization (Martin, 2001). An emerging literature has demonstrated that conceptual knowledge is grounded in the neural architecture that supports perceptual processing (Kan et al., 2003; Martin, 2001; Martin et al., 1995, 2000; Thompson-Schill, 2003). As such, one might expect activity in visual association cortex to be modulated by the specificity of semantic construal, in much the same way that these regions are responsive to the specificity of perceptual identification (Gauthier et al., 1997; Haxby et al., 2001).

Generally speaking, categorization level and perceptual processing are related such that, the finer the level of identification, the more perceptual information that is required to support the judgment under consideration (e.g., pelican vs. bird, Gauthier et al., 1997; Sergent et al., 1992; Tarr and Gauthier, 2000). Unlike object processing, however, faces can be classified not only with respect to their physical properties (e.g., sex, race, emotion), but also with regard to their applicable semantic categorizations (e.g., politician, humanitarian). Moreover, because there is nothing in the physical structure of a face that specifies membership in any of these nonvisually derived categories (or indeed the possession of a particular name), semantic judgments at different levels of specificity (e.g., occupation vs. identity) are matched for perceptual difficulty. That is, the same perceptual information is required to compute the occupation or name of a person. It should also be noted that occupational judgments do not necessitate the prior establishment of a person's identity. On many occasions, people are able to provide biographical details about a person, yet be unable to name the individual in question (Young et al., 1985, 1986). Given these observations, famous faces provide a useful means to investigate the neural activity that accompanies semantic judgments at different levels of specificity.

If, therefore, regions of ventral temporal cortex are sensitive to the specificity of semantic categorization, identity judgments should be accompanied by greater neural activity than judgments of a person's occupation (see Sergent et al., 1992). To explore this possibility, we utilized a variant of the visual-identification task adopted by Gauthier et al. (1997). In a matching paradigm, participants were required to report if a face and verbal label matched at the occupational or identity level. Brain activity was measured during the performance of these tasks.

Method

Participants and design

Thirteen participants (6 males, mean age = 24 years) completed the study for course credit or $10. All participants were right-handed, reported no significant abnormal neurological history, and had normal or corrected-to-normal visual acuity. Informed written consent for all participants was obtained prior to the experiment in accordance with the guidelines established by the Committee for the Protection of Human Subjects at Dartmouth College. The experiment had a single factor (level of abstraction: occupation or identity) repeated measures design.

Stimulus materials and procedure

Color photographs of 84 celebrities were used. Each facial photograph was resized and placed on a black background that was 200 × 200 pixels (2 × 2 in.) in size. The stimulus set comprised 42 singers and 42 actors, with an equal number of male and female exemplars in each set. Each participant performed two tasks: an identity task and an occupation task. In the identity task, participants were required to report, via a button press, whether a photograph matched a simultaneously presented name (e.g., a picture of John Malkovich together with the name 'John Malkovich' or a gender-matched name from the same occupational group, e.g., Sean Connery). In the occupation task, the name was replaced by an occupation (e.g., a picture of John Malkovich together with the word 'actor' or 'singer'; see Fig. 1). The stimulus

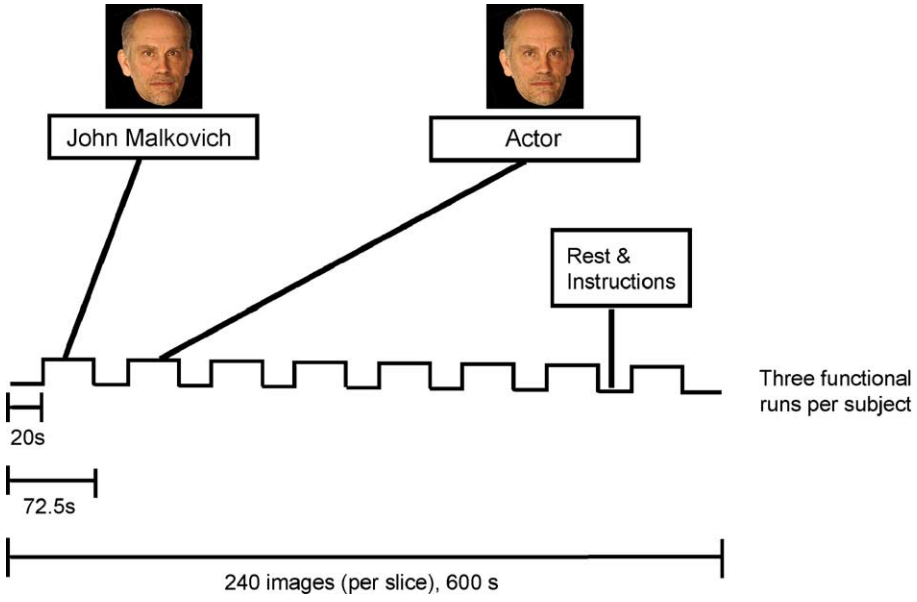

Fig. 1. Schematic representation of a single functional run.