Is Face Recognition special?

As social animals, faces represent one of, if not the, most important sources of information we can deduce within our environment. We use faces as determinants of age, sex, mood, level of interest, identity, familiarity, social status, and derive various other types of information from their gaze, expression and other cues (Young, 1998). As such, it is not unlikely to surmise that like many other essential processes, face recognition may be specialized within a certain area of the brain, and be carried out by face-specific cognitive processes. However, assessing to what extent this may be the case has proved very challenging, and it is still unwise to conclude anything definitively. As faces represent a within-category discrimination, which poses potentially infinite variations from face to face, face recognition is a remarkable feat of cognitive evolution, and our expertise in such an endeavour reflects how vital it was, and remains in society and everyday life, to possess such a skill.

Tovée (1998), lists three necessary criteria for faces to be processed differently from other complex visual stimuli Firstly, functional characteristics unique to face recognition must be exhibited. Secondly, face recognition should be mediated by anatomically separate neurons, as opposed to those which mediate general object recognition. Finally, at the neural level, faces should be represented differently to other complex visual stimuli, such as objects and words. Many conflicting findings have been found with regard the existence of functional characteristics specific to face recognition. Yin (1978) posited that face processing utilizes a different strategy to that of object processing, namely; it extracts information in a holistic manner, as opposed to extracting individual discrete features. Yin, based this hypothesis on earlier research on the inversion effect. This inversion effect is not exhibited in general object recognition, thus seems to hint at the special nature of face recognition (Moscovitch, Winocur & Behrmann, 1997). It is presumable that a discrete feature strategy is not disrupted by alterations to an object's typical orientation as it accuracy in identification is not reliant on the configural arrangement of the object's features. However, it is unwise to assume that objects are only perceived via a discrete strategy, and faces only perceived via a holistic strategy (Ellis & Young, 1989), as Matthews (1978) demonstrated that face perception requires an initial overall examination of external features, and subsequent analysis of internal features.

Although, this may not be the case with novel stimuli, such as inverted faces, as evidenced by the effects of Thompson's (1980) "Thatcherized" images. This experiment found that when grotesquely distorted faces were inverted they were perceived as would any normal face, it was not until presented upright, that participants realised that the eyes and lips of the stimulus face were upside-down. Due to its orientation, the inverted face was perceived using local processing, not the typical holistic and configural processing used for upright faces; as such the unrealistic features were not recognized. When faces are presented inverted, the accuracy and speed of identification is reduced relative to faces presented in an up-right configuration. Lewis (2001) found that the change between configural processing to component, or local processing for inverted faces is gradual as an image is rotated, this gradual increase also carries over to reaction times to identify whether a face was "Thatcherised" or not.

However, an experiment in discriminating artificial patterns conducted by Gauthier and Tarr (1997) found evidence of an inversion effect, as a group of trained observers lost all advantage in accuracy, and speed over a group of naïve observers when the images were inverted. Diamond and Carey (1986) also illustrated a loss in advantage in the recognition of dog breeds between dog breeders and nonexperts, when the images were inverted. They argued that this result was due to the experts' reliance on second-order relational features, i.e., the configuration of small features and their differences, to discriminate between the different, yet often highly similar types of dog. This process was disrupted by the inversion as the configurational arrangements which usually cue the breeder, now possessed differing and novel proportions. Following on in this logic, one could deduce that given ample practice; any classification of object can become special (Tovée, 1998), or rather utilize a configural, as opposed to local processing mechanism. Furthermore, research investigating the accuracy in recognition of features of "scrambled" faces against normal "whole" faces indicates that individuals are better at identifying features. This result provides more evidence for the hypothesis that faces are processed holistically, in natural orientations (Tanaka & Farah, 1993).

Tovée (1998) listed the necessity for separate anatomical features that mediate face recognition if it were to be considered special. Functional imaging studies have revealed bilateral activity in the fusiform gyri when individuals are subjected to facial stimulus. However, this activity is not likely, solely indicative of a face-specific area, as faces may also be viewed as objects when broken down into simpler components, thus this general function of the visual system would also be shown through functional imaging, even if there is a face-specific area. McCarthy et al. (1997) attempted to isolate the face-specific area by occupying the object recognition system with a continually changing montage of normal objects, and "scrambled" objects to act as a control. Within this montage faces would then be shown simultaneously, thus with the object recognition system already activated and seen on the fMRI, the only new area to be stimulated and visible would be responsible for processing faces alone. The object montage activated bilateral regions in the fusiform gyrus, but when viewed amongst the objects, faces activated a focal region in the right fusiform region. A similar study which utilized Magnetoencephalography (MEG) found that source locations of face-specific responses varied across the seven subjects. However, all sources were in the posterior brain regions. Not all subjects demonstrated right-hemisphere preference, although the majority did. The right-hemisphere sources were however, more superior and located anteriorly or posteriorly. This variability may be due to individual differences in the location of cortical areas specific to face processing (Sams et al. 1997).

The preferential activation of the right hemisphere in face recognition had been demonstrated in many previous studies involving unilaterally and bilaterally brain damaged patients, Yin (1970) found that compared to the control group on the upright faces recognition task the right posterior hemisphere damaged group were particularly impaired. When inverted, this group scored as well as the control, which suggests the object recognition system was used. Similar studies have found defective ability and disadvantage to match and remember unfamiliar faces in patients with right hemisphere injuries (e.g. Benton & Van Allen, 1968). Although further studies have found the deficit in discrimination in patients with right hemispheric damage to be carried into the recognition of canine faces (Bruyer & Velge, 1981). However, with such studies the full extent of damage to the right hemisphere differs for each patient, and thus it is difficult to conclude any definite claims. Nonetheless, should such a specialized area exist, the face-specific area responsible for processing faces with a wholistic strategy, as hypothesized by Yin (1978), must surely be located somewhere in the right posterior hemisphere, most likely with the fusiform gyrus.

Despite the predominance of face processing occurring in the fusiform gyrus in normally developed humans as illustrated through PET and fMRI investigations (Cabeza & Nyberg, 2000), there is evidence that in some specific populations this is not the case. Pierce et al. (2001) found that in a group of seven autistic subjects, only one demonstrated strong activation within the fusiform gyrus, though this was still minimal in comparison to that of a normally developed subject. The remainder demonstrated weak, or no activation when viewing a face stimulus, instead faces maximally activated aberrant and specific neural sites for each individual, such as in the cerebellum and frontal cortex.

At a further neuronal level, Bruce and Young (1986) argue the existence of at least seven types of information that can be derived from faces, which they call code. These include pictorial, structural, identity-specific semantic, visually derived semantic, facial speech, and expression codes. These codes have been identified as previous research has illustrated through studies of lesions and brain injuries, and specific agnosias, that these functions can all be carried out independently of each other. It is unwise to assume that there are neurons which solely specify in each type of code, though it is not improbable. Instead a modular system may be more appropriate, though whether these modules are located in one region of the brain or spread across the cortex is also inconclusive. In this model recognition of familiar faces is achieved when the products of structural encoding and pre-existing stored structural codes for the physical appearance of familiar faces match. Name codes are then retrieved when identity-specific semantic codes have been accessed, and the resemblance approved by the cognitive system.

This model allows for in-depth comparisons between theoretical models of object recognition by focusing on the interrelationship of the coding processes, which may prove fruitful in identifying face-specific processes. Many authors posit a similar process of accessing semantic and name codes for objects (Nelson & Reed, 1976; Warren & Morton, 1982). However, some experiments demonstrate that objects can be categorized semantically more quickly than they can be named, this can also happen for faces (Young et al., 1986a). In interference experiments between written names and faces, photographs of faces produce similar interference effects to those of objects, whilst the written names interference effects correspond to those exhibited for words (Young et al., 1986b).

The double dissociation of object agnosia without prosopagnosia, and of prosopagnosia without object agnosia, however illustrates a significant difference in the processing of objects and faces (Damasio, Damasio, & Van Hoesen, 1982; Hécaen, 1981). Hay and Young (1982) break down the question of specialized mechanisms in face processing as. whether or not there are some components of face-processing that are qualitatively unique from other visual stimuli, or whether some of the components are used solely for the processing of faces, but possess similarities to that parallel those in processing other stimuli. Farah et al. (1998) posit that a continuum of representation is the most probable solution to this question. Within this continuum faces are processed most holistically, words discretely and part based, and objects an intermediary between both, depending on the circumstances. They argue that the occurrence of double dissociations is indicative of two underlying abilities in representational processing, one essential for face recognition, and useful for object recognition, and one essential for object recognition and useful for object recognition. This is further evidenced by the findings of inversion effects and Thatcherized images (Moscovitch et al. 1997; Thompson, 1980; Lewis, 2001), which demonstrate the ability to process faces both holistically, and discretely, and by Diamond and Carey (1986), as well as Gauthier and Tarr (1997) who demonstrated that inversion effects could be exhibited in objects once subjects specialized in them, thus viewing them configurally and holistically. This interpretation would suggest that faces are special in degree, but are not special in kind (Farah et al., 1998).

From the evidence outlined above it seems most probable that face recognition does involve face-specific cognitive processes, but that these are the result of the considerable amount of experience we have in processing faces. Many studies have illustrated a preference for face-like stimuli in early infancy (Fantz, 1961), and newborns ability to identify specific faces, such as their mother from as early as one day (Walton et al. 1992). As such individuals are actively processing faces, and discriminating between them, their entire lives. This in turn leads to specialization in the processes which we use to perceive them, however similar holistic processing can be developed for other objects given ample time and practice as Tovée (1998), and Gauthier and Tarr (1997) contend. Furthermore, it has been illustrated that the right posterior hemisphere, specifically the fusiform gyrus is specialized for face recognition in most normally developed people (Cabeza & Nyberg, 2000; McCarthey et al., 1997), however, this is not seen across all populations, as in autistic individuals (Pierce et al. 2001) and is most likely due to experience and individual differences, such as the preference of handedness.

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