Functional organisation of facial processing

Intro

We can accomplish a lot be looking at people’s faces. From a very early age we are able to infer the mental state of another, understand more accurately what they may be saying or implying, recognize a friend or threat, or acquire information such as age, gender, emotional disposition and attractiveness (Young, De Haan & Bauer, 2008).

Setting up the argument(s)

There is an abundance of research dedicated to whether facial perception can be deemed as ‘ special’. At its simplest, the argument for whether facial perception is ‘ special’ or not is whether faces can be regarded as a special stimulus that is treated differently from other representations within the brain.

Unfortunately a polarisation has occurred between both the yes and no positions that are based not on empirical determinants, but rather on conceptual determinants, wherein evidence is built upon a single criterion of a multi-dimensional problem (Liu & Chaudhuri, 2003).

Consider the following examples of conflicting research.

An experiment by Kanwisher (2000, pp. 759), the researcher concluded that facial recognition was special after their results suggested that different cognitive and neural systems were implicated in the recognition of both face and non-face objects. However, a case study by Farah (2000), documented a child with both impaired face recognition and impaired recognition for similar

objects (e. g. confusing a cigar as a crayon), suggesting that both there is at least some overlap between the two systems if they are not synonymous.

Other researchers have posited that a new-born’s tendency to track faces at longer intervals than shapes of similar complexity and spatial frequency, are evidence of a special component dedicated to facial processing (Valenza, Simion, Cassia & Umiltá, 1996). In a similar vein, Carey (1992) highlights the fact that children are notoriously bad at facial recognition in clinical tasks, they perform at about the same level as an adult with brain damage; suggesting that facial recognition is more related to expertise than any predetermined species typical trait.

Additionally, Allison et al. (1999) assert that facial processing merits special status as it has been associated with specific “ subsystem of the ventral visual pathway known to be involved in object recognition. (p. 415)”. On the other hand, an abundance of fMRI research has implicated in facial processing in widely distributed patches of cortices (Haxby, Hoffman & Gobbini, 2000; Puce et al., 1996).

The three paired examples of conflicting research highlight three important points that must be considered in order to answer our question. Firstly, it serves to demonstrate a small kernel of the huge discrepancy within the literature pertaining ‘ specialness’ debate. Secondly, demonstrates how both sides are supported by evidence build on several diverse measures and manipulations. Secondly, as Liu and Chaudhuri (2003) point out; the debate can be had on multiple levels with various determinants.

The first pair of examples reflects an argument on domain specificity or modularity; is face processing special by virtue of there being a module or mechanism within the brain that specializes in recognising or encoding information relating to visage over other objects?

The second pair of examples reveals an argument based on the innateness, maturation and learning of facial processing. This argument relates to “ specialness” from within developmental framework where innateness would be considered new-borns having either, an inherent module that is exclusively dedicated to faces, or a domain general object module that develops face specialization prior to object processing (Liu & Chaudhuri, 2003). Moreover, the role of expertise is central to this argument or whether there is anything special about the mature face perception system (outside of a developmental framework).

Finally, specialness of facial perception in relation to location and neural representation is emphasized in the third example. This relates to whether it can be said that faces and objects are processed by the same or alternative mechanism, or if there are face selective cells in absence of any object cells.

To avoid any conflation it is important to distinguish the conceptual difference between domain-specificity and localisation, where the former relates to functional aspects of specific brain mechanisms and the latter refers to neuroanatomical locations which serve said functions (Liu & Chaudhuri, 2003).

Domain specificity and modularity

Two contrasting explanations for the functional organisation of facial processing have emerged in the literature; the modular view of object processing, and a ‘ distributed processing’ account (Cowell & Cottrell, 2013).

Subscribing to the former of these explanations, involves the belief that specific domains within the inferotemporal cortex exist for visual recognition of objects, and that one of these domains is dedicated predominantly to processing of faces (Kanwisher et al., 1997; McCarthy, Puce, Gore & Allison, 1997). Kanwisher (2010) suggests that these specific regions have both an evolutionary as well as development origin. Unlike the latter explanation, the modularity view would suggest that face processing is indeed ‘ special’.

The alternative account asserts that object representations, including those of faces are distributed across a wide span of the inferotemporal cortex and within this region are “ continuous representations of object form, with a topological organization that reflects the distinctions between object categories” (Cowell & Cottrell, 2013, p. 1777). Critics of the modular approach assert that this topology gives rise to the illusion of modularity, owing to the fact that informational characteristics of categorized objects cluster together, forming a region that responds to specific categories (e. g. faces, word forms, places).

However, critics of functional brain imaging as a tool for understanding the functional aspects of face processing argue that neuroimaging methods of these kinds fail to tell us anything about the mind (Coltheart, 2006). Cowel & Cottrell (2013) used a neurocomputational model that was absent of any

specialized architecture or processing mechanism in order to investigate the validity of both accounts and found that they were able to replicate fMRI findings for both camps, suggesting the fMRI studies need to be re-evaluated or at least approached with caution.

Outside of neuroimaging, early studies thought to support the modularity account come from Yin’s (1969) inversion effect. Yin (1969) demonstrated that individuals showed a loss of proficiency for face perception when faces were inverted, while showing the same effect was not presented for other objects (e. g. a house). It has since been shown that facial recognition is orientation sensitive and relies on perceiving the configuration of features and not just the features themselves (Diamond & Carey, 1986).

Interestingly, Diamond & Carey (1986) also demonstrated the inversion effect in recognition of breed of dogs among breeders. While their evidence does not conclusively show that human facial recognition and object recognition (dog faces) are processed within the same or different categories, it does cast doubt on the inversion effect in facial processing being evidence a special phenomenon.

Prosopagnosia, a severe deficit in facial recognition is often cited as evidence to support or refute modularity in facial processing. The condition is thought to be associated with bilateral damage to a specific part of the fusiform gyrus (Damasio, 1990; Farah, 1990), while sufficient damage to the right hemisphere has been shown to manifest the same problem while sparing object recognition of equal complexity (Moscovitch, Winocur & Behrmann, (1997).

Evidence for modularity of specialness of facial processing is often presented as examples of where individuals have visual object agnosia but unimpaired face recognition (DeRenzi & Di Pellegrino, 1998; Farah, Levinson & Klein, 1995). In a parallel vein, other researchers have shown that individuals can have severe object agnosia while showing no deficits in their ability to recognise faces (Humphreys & Rumiati, 1998; Moscovitch et al., 1997).

This ‘ double dissociation’ between object and facial processing is perhaps the most convincing evidence of functionally segregated modules within the brain.

Innateness and expertise

Our second consideration in determining whether facial processing is indeed special, involves determining whether individuals are hardwired for facial recognition, or whether the proficiency is built on constant exposure to the stimuli.

An abundance of evidence has been accumulated in relation to new-borns and recognition of faces. Empirical data has been presented to suggest that babies follow patterns items with similar complexity, contrast and spatial frequency, over dissimilar patterns (Johnson et al., 1991; Valenza et al., 1996). Furthermore, babies less than three days old show a preference for attractive faces rather than unattractive (based on internal features), suggesting predetermined representation of the human face (Slater et al., 2000).

Morton and Johnson (1991) argue that infants have two systems that are implicated in infant facial processing; the ‘ CONSPEC’ and the ‘ CONLERN’.

The CONSPEC is thought to be innate, face-specific system that provides the infant with a facial template, similar to those in chicks whereas, the CONLERN facilitates discrimination of faces based on an exemplar model, through experience.

A similar model has been proposed by De Gelder & Rouw (2001), who also suggest that facial recognition is facilitated by both an innate face detection system and functionally different identification system. Where the two models differ is that the face identification system is thought to implicate several various cortices while the CONLERN is restricted to one area within the fusiform gyrus (Morton & Johnson, 1991; De Gelder & Rouw, 2001).

It is difficult to ignore the evidence suggesting that infants display at least a very basis form of innate facial processing. Outside of a developmental perspective however, we are still left begging the question; is there anything special about a fully mature face processing system? Even if we are given a head start towards recognising faces, it does not follow that this predisposition is the basis for our ability to perceive faces so efficiently.

Alternatively, researchers who subscribe to expertise models, posit that because it takes the same amount of time to become proficient at facial processing than it does to become proficient at discriminating other objects or animals, facial recognition in humans in more reflective of experienced based efficacy than any special innate trait (for review see Tanaka & Gauthier, 1997). Expertise models can also account for phenomena that were once thought to be evidence of domain specific modularity, such as the inversion effect (Diamond & Carey, 1986).