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Research Report

Discriminating Thatcherised from typical faces in a case of prosopagnosia

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ABSTRACT

We report data from a prosopagnosic patient (PHD), and aged-matched control participants, from experiments where participants categorised individually presented emotional faces (Experiment 1) and Thatcherised (from typical) faces (Experiment 2). In Experiment 2 participants also discriminated between simultaneously presented Thatcherised and typical faces. PHD was at chance categorising Thatcherised from typical faces. He was, however, able to discriminate between Thatcherised and typical faces, and partially able to categorise emotional faces. The results are discussed in terms of a loss of configural processing but preserved feature processing in PHD. The loss of configural processing impacts his categorisation of Thatcherised and typical faces, and his emotion processing, while his preserved feature processing supports his ability to categorise some emotional faces and his ability to discriminate between Thatcherised and typical faces.

1. Discriminating Thatcherised from typical faces in a case of prosopagnosia

The Thatcher illusion (Thompson, 1980) refers to the change in perception of "Thatcherised" faces when they are rotated from upright to inverted orientations. Thatcherised faces are made by inverting the eyes and mouth. These faces appear grotesque when upright but when inverted the grotesqueness disappears and faces look more typical. There have been various accounts put forward to explain the Thatcher illusion. These accounts range from expression analysis (Valentine, 1988), to the phenomenological experience of conflicting reference frames for faces and facial features (Parks, Coss, & Coss, 1985). More recently, and following Bartlett and Searcy (1993), the Thatcher illusion is thought to reveal the orientation specific nature of configural face processing. Perception of grotesqueness in the upright face is attributed to the perception of unusual configural relationships between the features, whilst perception of the typical inverted face relies on feature based processing (Stürzel & Spillmann, 2000). Furthermore, the automaticity with which grotesqueness is experienced makes it a useful test of the presence of configural face processing in atypical populations (Rouse, Donnelly, Hadwin, & Brown, 2004) including congenital prosopagnosia (Carbon, Grüter, Weber, & Lueschow, 2007).

There are two (related) ways in which configural processing (defined here as the encoding of between-feature spatial relationships) might lead to the perception of the Thatcher illusion. First, by a poor match between representations of Thatcherised and prototypical faces. Second, by creating local difficulties in configural processing for inverted eyes and mouths which are in an unusual orientation relative to otherwise upright faces. By the first account, grotesqueness results from the fact that individuals rate average and not distinctive faces as attractive (Rhodes & Tremewan, 1996). By the second account, grotesqueness results from low processing fluency associated with processing Thatcherised faces as faces (Reber, Winkielman, & Schwartz, 1998). Thatcherised faces are poor examples of the face category and lead to a processing difficulty that is experienced as grotesqueness rather than slow processing.

The involvement of emotional coding, in addition to configural processing, in the Thatcher illusion is manifest in recent neuroimaging studies. Specifically, areas known to be involved in social and emotional processing are also involved in the perception of both single Thatcherised faces (Rothstein, Malach, Hadar, Graif, & Hendler, 2001), and when discriminating Thatcherised from typical faces (Donnelly et al., 2011). Therefore, despite being thought of as an illusion demonstrating configural processing in faces, and Thatcherised faces not representing standard emotional faces, the phenomenology of the Thatcher illusion depends on the response of diffuse socio-emotional cortices to Thatcherised faces. The consequence of this fact is that any use of the Thatcher illusion as a marker of configural processing should be accompanied by evidence of broadly intact emotional processing. Otherwise any failure in perception of the Thatcher illusion might result from deficits in socio-emotional processing.

But what do we mean by broadly intact emotional processing in the context of a deficit in configural processing? The issue is

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Table 1
Performance of PHD across a range of cognitive assessments.

Task	Score
WAIS III[a]	
Verbal scale	
Vocabulary	9
Similarities	9
Arithmetic	5
Digit span	10
Performance scale	
Picture completion	6
Digit symbol coding	6
Block design	9
Matrix reasoning	10
Camden memory tests[b]	
Faces	12/25 (chance)
Words	21/25 (2nd percentile)
Scenes	20/30 (7–9th percentile)
Paired Associates	17/48 (< 1st percentile)
Graded naming test[c]	8/30 (< 1st percentile)

[a] Scores represent age – related scores, M = 10, SD = 3, Wechsler (1997);
[b] Warrington (1996);
[c] McKenna and Warrington (1983).

complicated by the fact that configural processing contributes to the perception of some facial emotions. For example, Calder, Young, Keane, and Dean (2000) measured response times to aligned and misaligned composite faces where the face composites are formed from the same or different emotions. By determining which emotions were responded to more quickly when the top and bottom halves of faces were aligned relative to misaligned, Calder et al. were able to determine which emotions have their perception facilitated by configural processing. Table 1 of Calder et al. (2000) indicates the perception of anger, fear and sadness from whole faces cannot be predicted from that of part faces. In contrast, the perception of disgust, happiness and surprise from whole faces can be predicted from that of part faces. This means that the detection of anger, fear and sadness is improved by computing configural information from whole faces.

The role of configurality in emotion processing was also explored by McKelvie (1995). McKelvie compared categorisation accuracy to emotional faces shown in upright and inverted orientations. Inversion led to less accurate categorisation of sadness, fear, anger and disgust than when upright. Happiness, neutrality and surprise were unaffected by orientation. Like Calder et al., McKelvie suggested emotional expressions rely on configurality to different degrees. Together these studies show configurality was important in the perception of anger, fear and sadness. Only in respect of the perception of disgust did the two studies differ.

What impact would the absence of configural processing have on emotion perception in general and the Thatcher illusion in particular? We propose that an absence of configural processing should be manifest in (1) a specific pattern of modest deficit in the recognition of facial emotions that partially rely on configural processing and (2) an inability to perceive Thatcherised faces. In this study we report on a series of experiments conducted on a brain-damaged patient with prosopagnosia. PHD has been reported previously, in an ERP study comparing unfamiliar faces and houses, and does not generate an N170 component in response to faces (Eimer & McCarthy, 1999). If a failure to generate a face effect at N170 is linked to a failure of configural processing in faces through an absence of face categorisation (e.g., Eimer, 2000), we should predict two related findings. First, PHD will be able to categorise facial emotion but only when this can be done from features. Second, PHD will be unable to categorise Thatcherised from typical faces.

We start our exploration of PHD by testing his ability to categorise facial emotions and to discriminate between faces exhibiting different levels of emotion. We predict PHD's categorisation of emotional faces will be impaired in those conditions that rely on configural processing. Nevertheless, we also predict PHD will have intact categorisation and discrimination of emotions and emotional intensity when this can be achieved through featural analysis. The goal of Experiment 1 is, therefore, to show that PHD is able to perform categorisation and discrimination of faces with emotional valence in at least some conditions. In Experiment 2, we go on to explore his ability to categorise and discriminate Thatcherised from typical faces. His ability to perform in these tasks is compared with that of controls.

2. Experiment 1

In Experiment 1, the sensitivity of PHD and age-matched controls participants to categorising emotions was measured. While we were interested in PHD's overall ability to categorise emotions, we were also interested in his ability to do so when only two emotions are possible. In this case, the task demands of categorization are the same as when categorizing Thatcherised from typical faces.

2.1. Method

2.1.1. Participants

An individual with prosopagnosia (PHD) volunteered to participate in studies regarding his deficit. PHD is a left-handed male, who was aged 48 to 51 over the course of the current experiments. He sustained a closed head injury as a result of a road traffic accident at the age of 17. Structural MRI in 2005 (Fig. 1) showed a unilateral lesion in the ventral temporal lobe in the region of the fusiform gyrus on the left with no other macroscopic areas of damage. PHD suffers significant cognitive deficits including apperceptive prosopagnosia and some category specific visual agnosia, especially for the living things domain (animals and fruit and vegetables). He has persistent difficulties recognising people from their faces without context or other supporting information. PHD has a mild deuteranomaly and corrected-to-normal visual acuity with eye-glasses and his visual fields are full.

PHD's most recent cognitive assessment showed him to be functioning at an average level on most subtests of the WAIS-III (Wechsler, 1997, Table 1). On the Visual Object and Spatial Perception Test battery (VOSP, Warrington, & James, 1991) he scored within the normal range on Screening, Fragmented Letters, Object

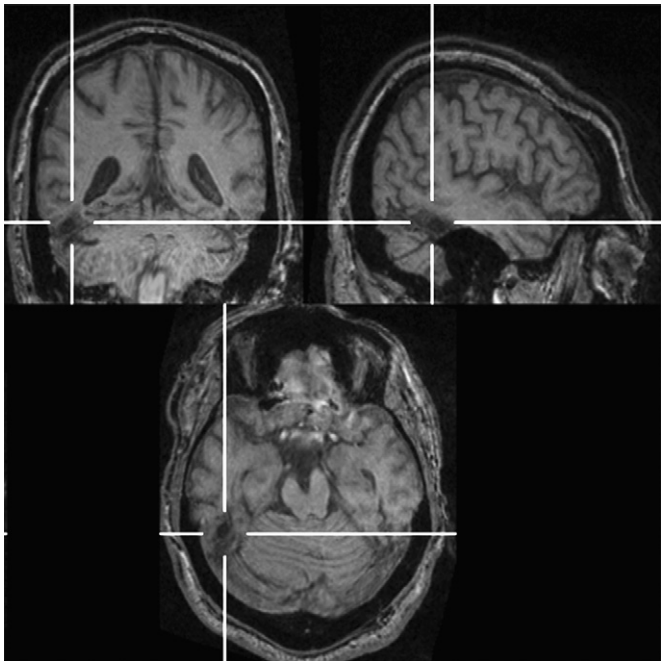

Fig. 1. Structural MRI taken from PHD showing a focal area of injury in the inferior temporal lobe of the left hemisphere in the region of the fusiform gyrus.