Compensatory strategy in face processing : a case study of a prosopagnosic patient

Jean-Yves Baudouin, G. W. Humphreys

Compensatory strategies in processing facial emotions:

Evidence fromprosopagnosia

Jean-Yves Baudouin & Glyn W. Humphreys

We report data on the processing of facial emotion in a prosopagnosic patient (H.J.A.). H.J.A. was relatively accurate at discriminating happyfrom angry upright faces, but he performed at chance when the faces were inverted. Furthermore, with upright faces there was no configuralinterference effect on emotion judgements, when face parts expressing different emotions were aligned to express a new emergent emotion. Wepropose that H.J.A.'s emotion judgements relied on local rather than on configuralinformation, and this local information was disrupted byinversion. A compensatory strategy, based on processing local face parts, can be sufficient to process at least some facial emotions.

Prosopagnosia is a disability in recognising familiar peoplefrom their faces (Bodamer, 1947). The recognition of peoplefrom other cues – such as their voice or their gait – is generallypreserved, and the ability to recognise other visual categoriesof objects can sometimes be spared (for reviews, see Benton,1990; De Renzi, 1997;Young, 1992). Many studies also indicatethat prosopagnosic patients can sometimes process other kindsof facial information, such as emotional facial expressions andgender, whilst the matching of unfamiliar faces can be performedaccurately (for a review, see Nachson, 1995; Young & Bruce,1991). Reversed patterns of impairment, for example where theprocessing of facial emotion but not identity is impaired, has alsobeen reported (e.g., Humphreys, Donnelly, &Riddoch, 1993;Kurucz&Feldmar, 1979; Parry, Young, Saul, & Moss, 1991).Such data provide support for face recognition models where differentmechanisms are held to process contrasting types of facialinformation (identity, expression, gender, etc.; see, for example,Bruce & Young, 1986; Young, 1992; Young & Bruce, 1991).It is also established that facial information can be processedin a number of differentways. For instance, there is considerableevidence that face recognition mainly relies on the processing of configural or holistic information rather than on componentialanalysis of the parts of faces; this configural representationtakes into account not only the identity of features but also factorssuch as the distances separating features (for a review, seeRakover, 2002). Configural processing can also be observedwhen processing facial emotions (see Calder & Jansen, 2005;Calder, Young, Keane, & Dean, 2000). However, whilst configuralprocessing may be dominant and more efficient for faceprocessing, componential (parts-based) analyses can also play apart. For example, Cabeza and Kato (2000) compared the prototypeeffect in recognition memory for configural and featuralprototypes (the tendency to make false positive responses tonovel faces that are prototypical within the range of stimuli presented).They reported a tendency for participants to commitfalse alarms for both featural and configural prototypes.Following brain lesion there can be deficits in processing configuralinformation in faces (e.g., Boutsen& Humphreys, 2002;De Gelder&Rouw, 2000; Levine &Calvanio, 1989; Saumier,Arguin, &Lassonde, 2001). These deficits are demonstratedeither by the absence of an usual configural effect in prosopagnosicpatients (e.g., Boutsen& Humphreys, 2002; Saumier etal., 2001), or by a paradoxical configuration effect (where faceprocessing is better when the saliency of configural informationis reduced, e.g., with upside-down faces, De Gelder&Rouw, 2000). Though such patients may be able to conduct parts-basedanalyses of faces, such analyses are either inefficient for the taskat hand or patients may be overwhelmed by impaired configuralinformation, which interferes with responses to local parts (e.g.,Boutsen& Humphreys, 2002; De Gelder&Rouw, 2000, seealso De Gelder&Rouw, 2001).To date, most studies of configural processing in prosopagnosiahave concentrated either on recognition tasks or on tasksrequiring responses to the structural identity of faces (e.g., identitymatching). Consequently, we know little about the role thatconfigural or local part processing might play in the analysisof non-identity information by patients with face processingimpairments. Indeed, it is possible that some of the dissociationsreported between processing facial identity and otherfacial properties might reflect the differential contribution ofcomponential analyses to contrasting face processing tasks –for example, if componential analyses can support tasks such asgender or emotion discrimination even when they fail to supportface recognition. Indeed, Parry et al. (1991) state that "itis possible that some of the dissociations reported in the existingliterature might actually reflect the effect of different taskdemands, rather than the existence of dissociable face processingpathways" (p. 549). This point is particularly pertinent whenwe consider emotion recognition, which can involve the assignmentof faces into a limited number of emotion categories (seeEkman, 1992; Ekman & Friesen, 1975). Here it is possible thatlocal information about the shape of the mouth or eyebrowsmay be sufficient to assign a face to an emotion category. Thereis prior evidence that componential analyses can be used tosupport identity judgements in a limited set of circumstances(e.g., Newcombe, 1979; Young & Ellis, 1989). For example,Newcombe (1979) observed that prosopagnosic patients hadnormal performance in identity matching when hairstyle wasvisible, but not when it was cancelled. Such effects may be evenmore pronounced when facial emotions have to be categorized.In the present study, we report the case of a severelyprosopagnosic patient, H.J.A., who is impaired at identifyingany famous or familiar faces by sight (Humphreys &Riddoch,1987; Humphreys et al., 1993). H.J.A. also shows poor discriminationof gender and facial emotion (Humphreys et al.,1993). Humphreys and Riddoch (1987) initially reported thatH.J.A. tended to use individual features rather than configuralrepresentations to recognise faces. This is supported by studiesof H.J.A.'s memory for facial information, since he canremember individual features of faces whilst being impaired atmaking judgements from memory about the configural properties(Young, Humphreys, Riddoch, Hellawell, & De Haan,1994). More recent investigations have confirmed that H.J.A.does not benefit from configural information in perceptual discriminationtasks, when required to discriminate 'normal' from'thatcherised' faces (where local parts have been inverted). Here,for example, he shows an (abnormal) advantage for face partsover whole faces, though face parts appearing in isolation lackimportant configural cues (Boutsen& Humphreys, 2002).Tests of H.J.A.'s ability to discriminate facial emotion are ofinterest because H.J.A. is able to use different forms of informationto support task performance. For example, in earlierstudies H.J.A. performed normally when he had to recognize facial emotion from a pattern of moving points placed on faces.Also, though impaired with static images, his emotion judgementsnevertheless remained above chance. It is possible thatthis residual ability with static faces is based on local facial features.Such a pattern would be consistent with arguments madefrom studies of object processing in H.J.A., where the evidencesuggests that local features are extracted but not well integrated(see Humphreys, 1999). This was investigated here. It shouldalso be noted that the study took place some ten years after theinitial study of H.J.A.'s processing of facial emotion. Studies ofH.J.A.'s object processing have revealed that, over a protractedperiod following his lesion, H.J.A. improved at using visualinformation for some tasks even though basic visual processing remained at a constant level (Riddoch, Humphreys, Gannon,Blott, & Jones, 1999). It is possible, then, that at the time of thepresent investigation, H.J.A. may be able to use local features toperform emotion judgements even if his configural processingremains impaired. This may reflect some compensatory recoveryalong with a stable perceptual impairment.In the present paper we tested H.J.A.'s ability to process facialemotion when we varied the information available for makingthe judgements. In Experiment 1, H.J.A.'s ability to processfacial emotion was assessed with upright whole faces, whereboth parts-based and configural information may be present.Subsequently, H.J.A. performed the same task with upside-downfaces. Face inversion is known to interfere with the processing ofconfigural and relational information in faces (for reviews, seeHancock, Bruce, & Burton, 2000; Valentine, 1988). If H.J.A.was disrupted in emotion judgements by the presence of configuralinformation (De Gelder&Rouw, 2000), then he may(paradoxically) improve when presented with inverted relativeto upright faces (though see Boutsen& Humphreys, 2002, forcontrary evidence in a tasks stressing the processing of structuralidentity). In a second study, H.J.A. performed an emotionrecognition task using composite faces (see Young, Hellawell&Hay, 1987). Calder et al. (2000) examined facial emotion judgementsto composite faces and reported evidence for a role ofconfigural processing. They found that recognition of the emotionof one facial part (top or bottom) was interfered with by thealignment of another half part that displayed another emotion.This effectwas not observed when both parts were misaligned orwhen the faces were upside-down. Such results suggest that thealignment of parts expressing different emotions creates a new,emergent emotional configuration, that interferes with access tothe emotions present in the separate parts. This interfering configuralinformation is made less salient when faces are inverted,so the disruptive effect of alignment is reduced. Recently, Calderand Jansen (2005) have further studied the composite effect onthe recognition of facial emotions, suggesting that it arises atan early stage in face processing (i.e., at a structural encodingstage), common to both facial identity and facial expressionprocessing. If H.J.A. is sensitive to configural information whenmaking emotion judgements, then, like normals, he should beimpaired when facial parts expressing different emotions arecombined, even when the response ought to be made to just onepart, and this effect should reduce under face inversion. However, previous testing of H.J.A.'s ability to process configuralinformation has shown that he is impaired at using this informationto perform both recognition and discrimination tasks(Boutsen& Humphreys, 2002; Humphreys &Riddoch, 1987;Young et al., 1994). We can then predict that H.J.A. would notmanifest effects of configural information in a facial emotiontask, if the composite effect arises at a common level for bothidentity and emotion judgements (Calder & Jansen, 2005). Anyability to judge facial emotions would then not depend on 'normal'configural processes, but rather it would result from thecompensatory use of local information

1. Case history

H.J.A., born in 1920, was an executive in an Americancompany before he suffered a peri-operative posterior cerebralartery stroke in 1981. Previous investigations have demonstratedthat H.J.A. has visual agnosia, prosopagnosia, alexia withoutagraphia, achromatopsia, and topographical impairments (fordetailed neurological and psychological reports, see Humphreys&Riddoch, 1987; Riddoch et al., 1999). The stoke resulted inbilateral lesions to the occipital lobe extending towards the anteriortemporal lobe.AMRI scan in 1989 revealed bilateral lesionsof the inferior temporal gyrus, the lateral occipitotemporalgyrus,the fusiform gyrus, and the lingual gyrus. In prior studies ofhis face processing abilities (Humphreys et al., 1993; see alsoBoutsen& Humphreys, 2002; Young et al., 1994), it has beenfound that H.J.A. is severely impaired at both face identification(he failed to name or provide any semantic information about 20famous faces) and familiarity discrimination (he was 50% correct– i.e., at chance level – when he was told to decide whetherthe 20 famous faces mixed with 20 unknown faces were familiaror not). He is also impaired at using facial configurations in discriminationtasks. For example, unlike normal subjects, H.J.A.was better at judging whether a facewas normal or 'thatcherised'(had its eyes and mouth inverted) when presented with the faceparts in isolation relative to when he was presented with a fullface. In contrast, normal participants use configural informationin whole faces to facilitate discrimination relative to when faceparts are shownin isolation (Boutsen&Humphreys, 2002). Consistentwith H.J.A. having a perceptual form of prosopagnosia,there was no evidence for implicit recognition (e.g., Lander,Humphreys & Bruce, 2004), and his semantic knowledge aboutpeople familiar before his lesion is reasonably spared (Young etal., 1994). Similarly, H.J.A.'s conceptual knowledge about emotionsis intact, and he can access knowledge about emotions frommoving facial expressions (Humphreys et al., 1993). H.J.A. was81 years old at the time of testing.

2. General method

2.1. Controls

H.J.A.'s performance was compared with that of four agematchedmale controls, aged from 74 to 86 years olds (controlA: 86, control B: 74, control C: 81, control D: 74). The controlsreported no antecedent neurological or psychiatric disorders.They also had either normal or corrected-to-normal vision, withthe exception of control A, who reported some problems in seeingdistant stimuli, whilst control C had a small blind area offield. All the controls performed the upright versus upside-downfacial-emotion recognition task. ControlsAandBperformed thecomposite task on the top halves, controlsAand C on the bottomhalves. There was no evidence of any differential performancebetween the controls as a function of their age.

2.2. Material

We used 75 high-resolution colour photographs of 25 individuals,all seen from a frontal viewpoint and expressing threekinds of emotion; happiness, anger, and fear. The head sizes werestandardised (15 cm from top to bottom). Photographs were ofvolunteers from 18 to 31 years old, who were instructed to posewith various emotional facial expressions. These photographswere presented with another set of emotional photographs to agroup of 11 young control subjects who were asked to classifythe emotions into six categories ("happiness", "sadness", "fear","disgust", "anger", "neutral", and "other"). For each emotionthere was at least 82% agreement for the classification acrossthe control subjects. The experimental task was a two-choiceemotion-discrimination, requiring participants to judge whetherhappiness or anger was being expressed. Happiness and angerwere preferred to other possible pairs of emotions because (i)they are visually easy to discriminate, with various distinctivecues on both the bottom and the top parts, (ii) in the study byCalder et al. (2000), participants made similar proportions oferrors when identifying the emotion displayed in the top parts offaces for happiness and anger (respectively, .20 and .28). Theseproportions were not equivalent for the bottom part (respectively,.01 and .49), but the only emotion with a low proportionof errors for the bottom halves of faces was disgust (.14), butthis emotion had the disadvantage of being hard to recognize from the top part (.62). To rule against angry emotions beingparticularly difficult to identify from the bottom halves of thefaces we used, we pre-selected faces so that the two emotionswere equally discriminable. The top and bottom halves of eachface were separated by cutting the face horizontally at the levelof the bridge of the nose. These half faces were presented toa new group of eight young control subjects who had to say ifthe faces were happy, angry, or fearful.We selected 20 top partsand 20 bottom parts, and within each set 10 were judged happyand the other 10 were judged angry by at least 6/8 control subjects.Five top and five bottom angry parts as well as four topand four bottom happy parts were from the same original fullphotographs. Consequently, the 40 selected parts were derivedfrom 31 full photographs. These 31 photographs were also usedin the emotion recognition tasks with full faces. Overall, fromthe original 25 people photographed, 5 were used for both thehappy and angry conditions, 10 for the happy condition only,and 10 for the angry condition only.

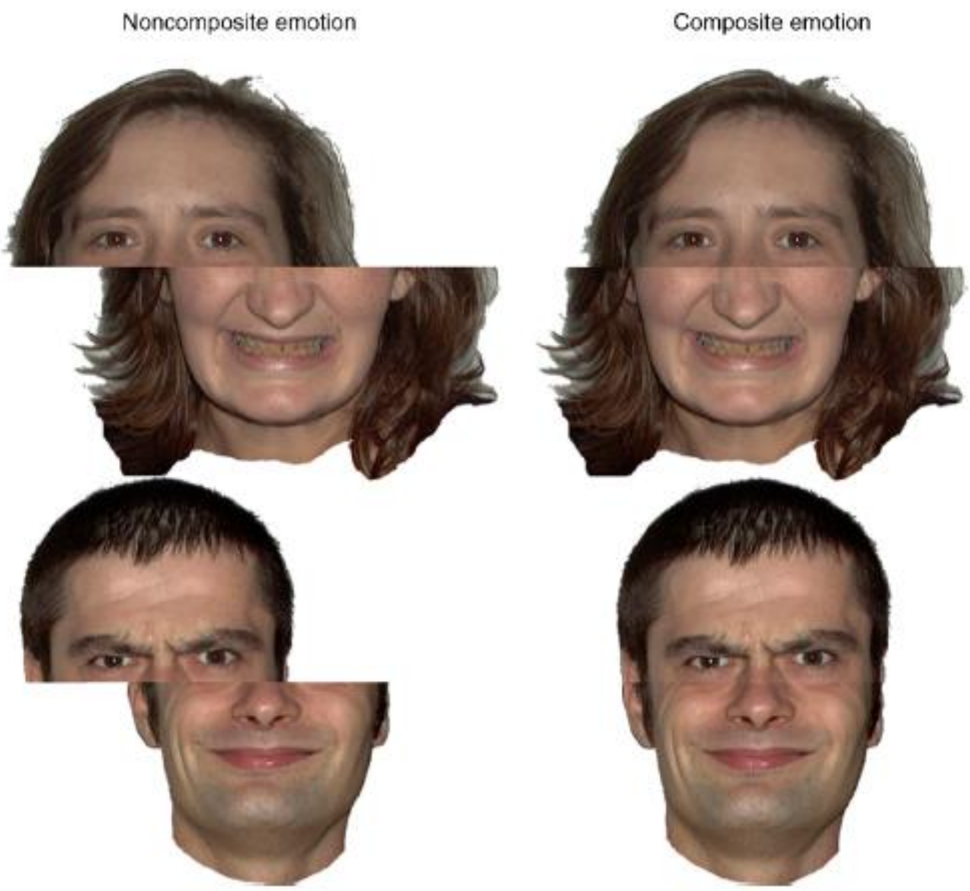


Fig. 1. Illustration of composite and noncomposite emotions

The selected half faces expressing each emotion were associated with the counterpart of the same person with another emotion. In addition, we used faces expressing fear as the alternative (irrelevant) part of the critical faces on half the trials. Thiswas done in order to stop participants from guessing the criticalexpression after detecting the expression in the irrelevant part ofthe face; both happy and angry faces were equally likely to bepaired with a fearful part face. For the critical 10 angry half parts,5 were associated with a happy counterpart and 5 with a fearfulone; for the critical 10 happy half parts, 5 were associated witha angry counterpart and 5 with a fearful one. Composite versusnoncomposite faces were created by aligning the top and bottomhalves of the faces (to create a composite emotion) or by shiftingthe top photograph to the left or right of the bottom one by abouthalf the face's width (the noncomposite emotion condition, seeFig. 1 for an illustration). The side of the shift was varied acrossstimuli with an equal proportion of each shift in each responsecategory. From this we obtained 20 composite and 20 noncompositeemotions, half with a happy top and an angry bottom half,and half with an angry top half and a happy bottom half.

2.3. Procedure

The photographs were presented on a monitor approximately1m from the subject's eye, with E-prime. A trial consisted inthe presentation of a fixation cross for 500 ms, followed by ablank screen for 500 ms. After this a photograph appeared andremained on the screen until the subjects responded. For all thetasks, subjects were required to press one key on a keyboardfor a happy face or half face, and another key for an angry faceor half face. Participants were instructed to respond as fast aspossible, but without neglecting accuracy.

2.4. Experiment 1: emotion judgements to full upright orupside-down faces

The 31 full photographs were presented in a random order intwo separate sessions; the faces were upright in one and invertedin the other session. H.J.A. as well as controls A, B, and Dperformed the upright session first. Control C performed theupside-down session first.

2.5. Experiment 2: emotion judgements to composite versusnoncomposite faces

There were two sessions. In one the subject had to respond tothe top face part, and in the other session the task was to respondto the bottom half, without paying attention to the other part. The 20 composite and 20 noncomposite emotions were presented inan upright orientation, in a random order in each session, with theface part required for the decision being placed at the centre ofthe screen. H.J.A. and two controls performed each session twotimes on different days. Controls A and B performed the task onthe top halves of the faces, whereas controls A and C performedthe session on the bottom halves. When an interference effectfrom the counterpart emotion was observed in the compositecondition (i.e., lower accuracy or/and longer response time thanfor noncomposite emotions), subjects were required to performthe same task with upside-down stimuli. This last task was carriedout to ensure that any interference with upright compositefaces was due to configural information that should be strongerin upright than in inverted faces.

2.6. Data analysis

For all tasks, we tested whether H.J.A. and controls significantlydiffered from chance level by computing $\chi 2$ statisticaltests. H.J.A. and individual controls were considered as singlecases. H.J.A.'s accuracy was also contrasted with that of thecontrols in Experiment 1 to see if he was impaired at recognizing emotions from full faces. $\chi 2$ statistical tests were alsoused for each participant to compare the critical conditions inExperiment 1 (upright versus upside-down) and Experiment 2(composite versus noncomposite). RTs were analysed by itemsby Mann–Whitney U statistic between latencies for correctresponses in contrasting conditions.

3. Experiment 1: recognition of emotions from fullupright and upside-down faces

3.1. Results

The results for H.J.A. and the age-matched controls are presentedin Table 1.

Table 1
H.J.A.'s and controls' accuracy and RTs to recognise emotional expression of upright vs. upside-down faces

Face orientation	Upright	Upside-down
Correct responses[a]		
H.J.A.	26/31 (83.9)	12/31 (38.7)
Control A	31/31 (100)	28/31 (90.3)
Control B	28/31 (90.3)	26/31 (83.9)
Control C	31/31 (100)	27/31 (87.1)
Control D	30/31 (96.8)	28/31 (90.3)
Mean latency for correct recognition[b]		
H.J.A.	2687 ms (1131)	5990 ms (2322)
Control A	2202 ms (1808)	2575 ms (2233)
Control B	1366 ms (227)	2963 ms (2830)
Control C	1022 ms (263)	3124 ms (610)
Control D	662 ms (137)	946 ms (240)

[a] Percentage between brackets.
[b] S.D. between brackets.

3.1.1. H.J.A.

H.J.A. performed at a better than chance level with uprightfaces (83.9% correct, $\chi2(1) = 14.23$, $p < .001$), but not withupside-down faces (38.7% correct, $\chi2(1) = 1.58$). The differencebetween upright and inverted faces was reliable (38.7% versus83.9% correct, $\chi2(1) = 46.74$, $p < .0001$). RTs for upright versusupside-down faces were not analysed because of H.J.A.'s chancelevel of performance with inverted faces. Although better thanwith inverted faces, H.J.A.'s accuracy for upright faces was significantlylower than that of the mean of the controls (83.9%versus 95.2% correct, $\chi2(1) = 8.58$, $p < .01$), though it did notdiffer significantly from the least accurate control (83.9% versus90.0%, $\chi2(1) = 1.48$). H.J.A.'s performance with inverted faceswas impaired relative to both the mean of the controls (38.7%versus 87.1%, $\chi2(1) = 64.58$, $p < .0001$) and to the worst control(38.7% versus 83.9%, $\chi2(1) = 46.74$, $p < .0001$).

3.1.2. Controls

All controls performed at a better than chance level withboth upright and upside-down faces. For upright faces, controlsA and C: 100% correct, $\chi2(1) = 31.00$, $p < .0001$; controlB: 90.3% correct, $\chi2(1) = 20.16$, $p < .0001$; control D: 96.8%correct, $\chi2(1) = 27.13$, $p < .0001$. For inverted faces, controlsA and D: 90.3% correct, $\chi2(1) = 20.16$, $p < .0001$; control B:83.9% correct, $\chi2(1) = 14.23$, $p < .001$; control C: 97.1% correct,$\chi2(1) = 17.06$, $p < .0001$. Controls A, C, and D, but not control B, were significantly less accurate for upside-down faceswhen compared with upright faces (control A: 90.3% versus100%, $\chi2(1) > 4.13$, $p < .05$; control B: $\chi2(1) = 1.48$; control C:87.1% versus 100%, $\chi2(1) > 9.30$, $p < .01$; control D: 90.3% versus96.8%, $\chi2(1) = 4.13$, $p < .05$), whereas controls B–D, but notcontrol A, were significantly slower with inverted faces (controlA:$U(28, 31) = 363$, $z = 1.08$; control B: 2963 ms versus 1366 ms,$U(26, 28) = 97$, $z = 4.62$, $p < .0001$; control C: 3124 ms versus1022 ms, $U(27, 31) = 0$, $z = 6.52$, $p < .0001$; control D: 946 msversus 662 ms, $U(28, 30) = 129$, $z = 4.53$, $p < .0001$).

3.2. Discussion

H.J.A. generally performed at a lower level than the controls,confirming prior reports of H.J.A. being impaired at judgingemotion from static facial images (Humphreys et al., 1993).Nevertheless, H.J.A. was able to make the forced-choice judgementsat a reasonable level, when presented with upright faces.He also showed a strong effect of inversion, with performancedropping to chance level when faces were inverted.With controlsinversion lowered accuracy and increased RTs, but performancewas always substantially above chance. The detrimental effectof inversion here mirrors prior data with H.J.A. when he wasrequired to make judgements about the structural properties offaces (Boutsen& Humphreys, 2002). In each case, there is noevidence for a paradoxical, beneficial effect of face inversion, aswould be expected if H.J.A. was disrupted by configural informationpresent in faces (cf. De Gelder&Rouw, 2000). Insteadthe data suggest that the information used by H.J.A. to classifyfacial emotion in the images was strongly degraded by inversion.From Experiment 1, however, we cannot tell if H.J.A. wasusing configural information to make the emotion judgementsor whether his judgements were based on face parts, which weredegraded by inversion along with any degradation of the configuralinformation present (for a report on an inversion effectin participants performing a featural-change detection task, seeMondloch, Le Grand, & Maurer, 2002). Whether local part orconfigural information was being used by H.J.A. was tested inExperiment 2, where we compared performance with compositeand noncomposite faces. If there is configural processing, judgementsto a face half should be disrupted when the half is part ofa face composite compared with when it is in a noncompositeimage.

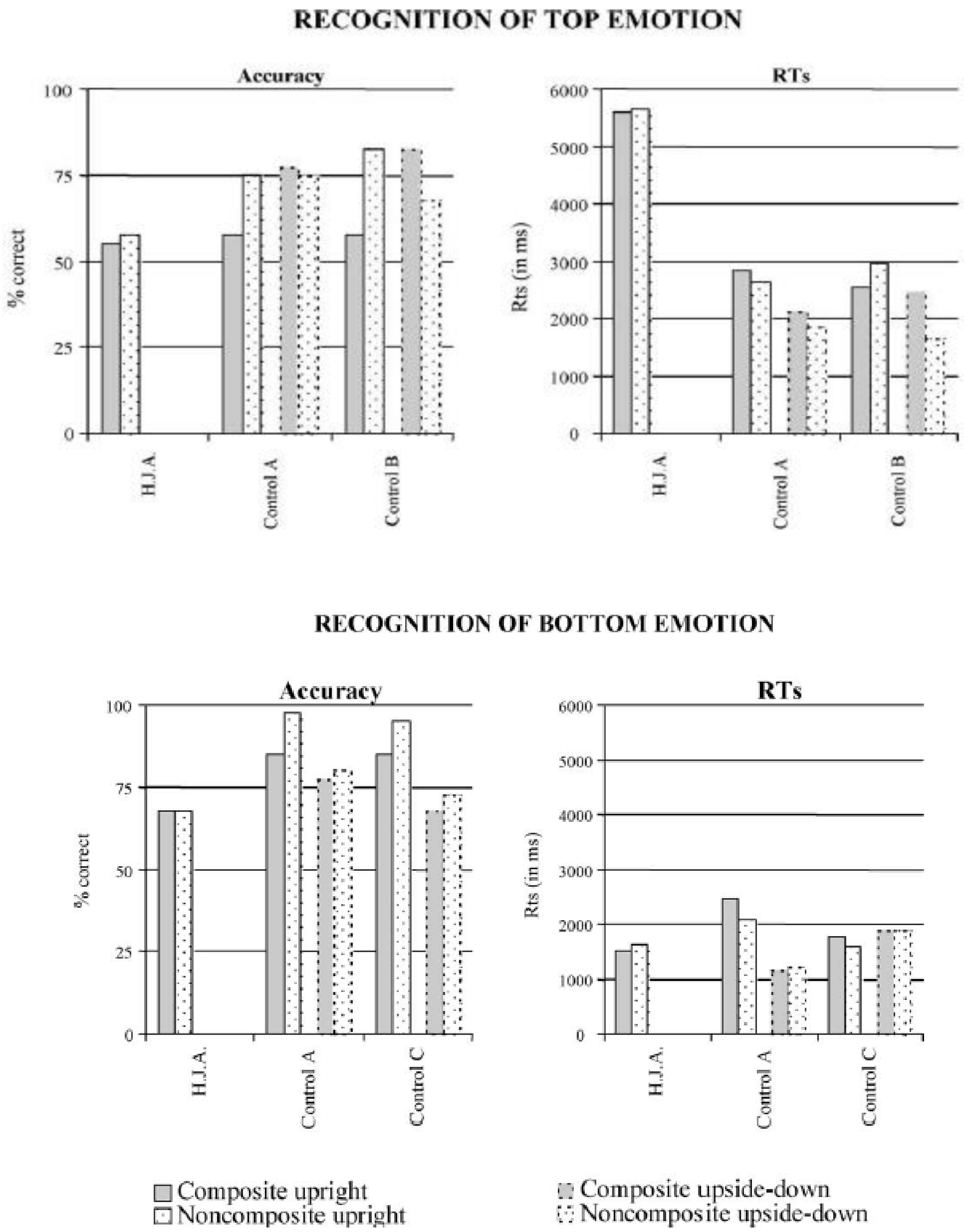
4. Experiment 2: recognition of composite versusnoncomposite facial emotion

4.1. Results

The results are illustrated in Fig. 2.

4.1.1. H.J.A.

H.J.A. performed at chance level when attending to the emotionof the top parts of the faces for both composite (55%correct, $\chi2(1) = .40$) and noncomposite faces (57.5% correct,$\chi2(1) = .90$). When attending to the emotion of the bottomFig. 2.part, H.J.A. performed better than chance for both composite (67.5% correct, $\chi2(1) = 4.90$, $p < .05$) and noncomposite emotions (67.5% correct, $\chi2(1) = 4.90$, $p < .05$). Therewas no significant difference between composite and noncomposite emotions. RTs for correct responses were analysed when attending to the bottom part: there was no significant difference between composite and noncomposite faces ($U(27, 27) = 321$, $z = .75$). Thus, H.J.A. showed no interference from configural information from the whole face when attending to a half part to make an emotion decision. For this reason, he did not perform the tasks with upside-down stimuli.



. 2. H.J.A. and controls accuracy (in % correct) and RTs (in ms) for composite vs. noncomposite emotion recognition of the top and bottom parts.

4.1.2. Controls

When attending to the emotion in the top parts of thefaces, controls A and B responded better than chance withnoncomposite stimuli (control A: 75% correct, $\chi2(1) = 10.00$,$p < .01$; control B: 82.5% correct, $\chi2(1) = 16.90$, $p < .0001$),but not to composite stimuli (both controls: 57.5% correct,$\chi2(1) = 1.80$). The difference between composite and noncompositeemotions was reliable (control A: 57.5% versus75%, $\chi2(1) = 6.53$, $p < .05$; control B: 57.5% versus 82.5%,$\chi2(1) = 17.32$, $p < .0001$). With upside-down stimuli, controlsA and B responded better than chance for both composite(control A: 77.5% correct, $\chi2(1) = 12.10$, $p < .001$; control B:82.5% correct, $\chi2(1) = 16.90$, $p < .0001$) and noncomposite stimuli(control A: 75% correct, $\chi2(1) = 10.00$, $p < .01$; control B:67.5% correct, $\chi2(1) = 4.90$, $p < .05$). There was no significantdifference between the judgement to composite and noncompositestimuli, with the exception of control B who was moreaccurate for composite faces, i.e., the reverse of the usual compositeeffect (control A: $\chi2(1) = .13$; control B: 82.5% versus67.5%, $\chi2(1) = 4.10$, $p < .05$). There were no differences in RTsacross the conditions, though there was a tendency for controlB to be slower with composite than with noncompositeemotions (2463 ms versus 1628 ms, $U(27, 33) = 322$, $z = 1.84$,$p < .07$), suggesting that his better accuracy for inverted compositefaces resulted from a speed accuracy trade-off effect.

Thus, controls exhibited a strong interference effect from configuralinformation in upright but not inverted faces when theyhad to recognise the emotion of the top half of composite stimuli.When attending to the bottom parts of the faces, controlsA and C were better than chance for both composite (controlA: 85% correct, $\chi2(1) = 19.60$, $p < .0001$; control C: 85% correct,$\chi2(1) = 19.60$, $p < .0001$) and noncomposite faces (controlA: 97.5% correct, $\chi2(1) = 36.10$, $p < .0001$; control C: 95% correct,$\chi2(1) = 32.40$, $p < .0001$), but they were less accurate withcomposite than with noncomposite faces (control A: 85% versus97.5%, $\chi2(1) = 25.64$, $p < .0001$; control C: 85% versus 95%,$\chi2(1) = 8.42$, $p < .01$). RTs did not differ across the conditions.With upside-down stimuli, controls A and C responded betterthan chance for both composite (control A: 77.5% correct,$\chi2(1) = 12.10$, $p < .001$; control C: 67.5% correct, $\chi2(1) = 4.90$,$p < .05$) and noncomposite stimuli (control A: 80% correct,$\chi2(1) = 14.40$, $p < .001$; control C: 72.5% correct, $\chi2(1) = 8.10$,$p < .01$), and there was now no significant difference betweencomposite and noncomposite faces (control A: $\chi2(1) = .16$; controlC: $\chi2(1) = .50$). There were no reliable RT differences acrossthe conditions with inverted faces.

In sum, the controls showed an interference effect from compositefaces, both when attending to the top and the bottom halfof the faces. This interference effect was eliminated when thefaces were inverted, providing converging evidence that it wasdue to configural information in upright faces. These resultswith elderly controls match those reported with young controlsby Calder et al. (2000).

4.2. Discussion

Contrary to controls, H.J.A. showed no interference fromconfigural information when he had to judge emotions fromparts of a face. At least for the bottom half of the face he was asaccurate for composite as for noncomposite faces. In contrast,controls showed a composite effect in the processing of bothparts with upright faces, with the discrimination of emotion forpart of the face being affected by the irrelevant part of a compositeface, making them less accurate for facial composites thanfor noncomposite faces. This composite effect appears to resultfrom the creation of a new emotional configuration, since it wasnot evidenced with upside-down faces.The finding that H.J.A. was only better than chance withjudgements to the bottom half of faces suggests that he is stronglydependent on features such as the form of the mouth, whenmaking emotion judgements. The effect is unlikely to be dueto H.J.A.'s upper altitudinal field defect, given that the stimuliwere present for unlimited durations and H.J.A. is perfectly ableto scan across the visual field (e.g., see Humphreys, Riddoch,Quinlan, Price, & Donnelly, 1992). Also, it should be notedthat H.J.A.'s judgements to the bottom half of both compositeand noncomposite faces, in Experiment 2, were lower than hisjudgements to whole faces in Experiment 1 (respectively, 67.5%versus 83.9%). This suggests that features in the top half of thefaces were processed and contributed to his decision when theywere consistent with features in the bottom half (in whole facesin Experiment 1, but not in composites and noncomposites inExperiment 2).

5. Conclusion

The prosopagnosic patient H.J.A. was able to discriminatebetween happy and angry emotions in static, full faces whenthey were upright, though performance was impaired relative tocontrols. He also showed an inversion effect, with performancefalling to chance when faces were inverted. With facial compositesH.J.A.'s emotion judgements were less accurate again,though he still performed above chance when judging the emotionsexpressed in the bottom halves of faces. However, hisemotion judgements were not influenced by whether the halveswere presented within a composite or noncomposite face. Thecontrol participants were also affected by inversion with fullfaces, but, unlike H.J.A., they were also disrupted when facehalves were part of a composite relative to a noncompositeimage. The disruptive effect of the composite was eliminatedwhen faces were inverted, linking the disruptive effect to configuralcues emerging from composite, upright faces.These data indicate that there can be a residual ability to judgefacial emotions at an above chance level, even with a patientwith severe prosopagnosia who is apparently unable to accessany stored knowledge based on the structural identity of faces(e.g., in familiarity judgements, or in tests sensitive to implicitknowledge about faces; e.g., Lander et al., 2004). However, thisdoes not mean that facial information about emotions is processednormally in such a case. Our study indicates that H.J.A.'sprocessing of facial emotion differed qualitatively from that ofcontrol participants. Control participants appeared sensitive toconfigural information present in whole, upright faces (see alsoCalder et al., 2000). H.J.A. did not, since he was unaffectedby our manipulation contrasting composite with noncompositefaces. Instead, we suggest that H.J.A. based his emotionjudgements on the presence of critical local features. There wasparticular weight placed on features in the lower half of the face,but there was also some contribution from features in the upperregion when they matched features in the lower region. Thismay represent a residual, feature-based process that is presentwhen normal participants make judgements to facial emotion,with the process being revealed when the extraction of configuralinformation is disrupted by a brain lesion. Alternatively,it may represent a compensatory strategy developed by H.J.A.,perhaps even linked to his spared ability to use facial motion tomake emotion judgements (Humphreys et al., 1993). For example,movements of the mouth may be particularly salient whenpeople change emotional expression, leading to H.J.A. weightingthat region strongly even when asked to make emotionaljudgements to static images. Whatever the case, the importantpoint is that we should be cautious to infer functionally separateprocesses for extracting facial emotion and identity from acase such as H.J.A.'s, where identity judgements are at floor butemotion judgements are above chance. This does not mean thatemotion judgements operate in a normal manner.Given that H.J.A. showed no sign of using configural information(Experiment 2; see also Boutsen& Humphreys, 2002;Humphreys&Riddoch, 1987;Young et al., 1994), it is of interestthat he was strongly affected by face inversion, in Experiment 1.This in turn suggests that inversion effects are not solely due tothe loss of configural cues, but they can also come about becausethe processing of local facial features is sensitive to their familiarorientation. The degree to which a feature-based strategy canplay a role in emotion judgement probably also depends on thechoice of emotions being tested. Here we examined the contrastbetween angry and happy faces, and feature-based cues may bea relatively reliable means of distinguishing these two emotions.As finer distinctions are required, we may expect that emergent,configural cues will play a more important part. This requiresempirical testing.Another point is the fact that H.J.A. mainly relied on thebottom half of the face to recognise facial emotion. In recentstudies, Caldara et al. (2005) have reported a similar observationwith another prosopagnosic patient engaged in face recognition.Moreover, Bukach, Bub, Gauthier, and Tarr (2006) reportedthat it is possible to main observe a 'local expertise effect' inprosopagnosia, suggesting configural processing but over a localregion. The question raised by such observations is whetherHJA did process local configural information from the mouthregion, which would explain why there is an inversion effect.This hypothesis needs further investigation. Nevertheless, evenif this assumption is verified, it remains the case that he used anabnormal strategy to perform the task.The data reported here emphasise the importance of showingthat face processing is qualitatively similar in patients and controls,before judgements are made about whether dissociationsreflect a difference between the computational uses to whichcommon information is put (e.g., for accessing facial identityrelative to facial emotion). In the present case, we suggest thatthere is a difference in theway facial features can be used to makecontrasting judgements, but there is not necessarily a differencebetween processing facial identity and emotion. A failure todemonstrate qualitative similarities between a residual ability ina patient and the normal process in controls means that it is possibleto challenge the view that two distinct and/or independentregions sustain identity and emotion processing (e.g., Baudouin,Martin, Tiberghien, Verlut, & Franck, 2002; Ganel& Goshen-Gottstein, 2004; Martin, Baudouin, Tiberghien,&Franck, 2005;Schweinberger, Burton, & Kelly, 1999; Tiberghien, Baudouin,Guillaume, &Montoute, 2003).

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