



## Holistic processing impairment can be restricted to faces in acquired prosopagnosia: Evidence from the global/local Navon effect

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Previous studies have shown that acquired prosopagnosia is characterized by impairment at holistic/configural processing. However, this view is essentially supported by studies performed with patients whose face recognition difficulties are part of a more general visual (integrative) agnosia. Here, we tested the patient PS, a case of acquired prosopagnosia whose face-specific recognition difficulties have been related to the inability to process individual faces holistically (absence of inversion, composite, and whole–part effects with faces). Here, we show that in contrast to this impairment, the patient presents with an entirely normal response profile in a Navon hierarchical letter task: she was as fast as normal controls, faster to identify global than local letters, and her sensitivity to global interference during identification of local letters was at least as large as normal observers. These observations indicate that holistic processing as measured with global/local interference in the Navon paradigm is functionally distinct from the ability to perceive an individual face holistically.

Acquired prosopagnosia is classically defined as the inability to recognize individual faces following brain damage, an impairment that cannot be attributed to intellectual deficiencies or low-level visual problems (Bodamer, 1947; Quaglino & Borelli, 1867; Rondot & Tzavaras, 1969). Over the years, tens of cases of prosopagnosia following brain damage have been reported, although in-depth neuropsychological investigations of prosopagnosic patients remain quite rare.

What is the *nature* of the prosopagnosic disorder? An influential idea is that these patients have difficulties in *perceiving a face (w)holistically*. This long-standing view (Galli, 1964) was originally inspired from the Gestaltist approach of visual perception in general (e.g., Köhler, 1929; for a review, see Wertheimer, 1967), a view that has been revitalized by several authors (e.g., Beck, 1982; Navon, 1977; Shepp & Ballesteros, 1989; Uttal, 1988; for a review, see Kimchi, 1992). According to the holistic view, visual patterns are not only made of featural elements, but are also defined by the

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interactions between these constituents, a property that is called *configuration* or *(w)holistic property* (e.g., Navon, 2003). A whole item is qualitatively different from the sum of its components, the whole exceeding the sum of its parts.

Following this early account of prosopagnosia (Galli, 1964), many patients have been reported to present with such an inability to integrate simultaneously different features into a coherent global representation (Davidoff, Matthews, & Newcombe, 1986; Levine & Calvanio, 1989; Riddoch & Humphreys, 1987; Saumier, Arguin, & Lassonde, 2001; Sergent & Villemure, 1989; Spillmann, Laskowski, Lange, Kasper, & Schmidt, 2000). For example, Riddoch and Humphreys (1987) described the patient HJA as presenting with ‘an impairment in integrating local part information with information about global shape, in that local parts are treated separately and not grouped together to elaborate the global shape description’ (p. 1444).

In line with the scientific literature on normal face processing, two labels have been used to refer to this kind of impairment in prosopagnosia. While some authors used the term ‘configural’, others rather used the term ‘holistic’. For example, Levine and Calvanio (1989) defined LH’s perceptual defect as reflecting an impairment of visual *configural* processing, defined as ‘the ability to identify by getting an overview of an item as a whole in a single glance’ (p. 159). Other authors, such as Spillmann *et al.* (2000), mentioned that their patient, WL, was unable to form a *holistic* percept of a face, i.e., ‘the ability to create an integrated, unitary percept or a Gestalt of human face enabling him to assign identity to an individual’ (p. 98). However, despite the use of different terms, these authors appeared to refer to the same process: the perception of the visual stimulus, with its multiple parts, as an integrated whole.

What is the empirical evidence supporting these claims? Different visual tasks have been used in the literature to assess holistic processing in acquired prosopagnosia, most of the time with non-face visual patterns: the *Street Figure-Completion Test* (Street, 1931), the *Gollin incomplete pictures* (Gollin, 1960), the *Kanizsa figures* (Kanizsa, 1955) or other *visual closure* tasks (e.g., Levine & Calvanio, 1989), and *overlapping figures* recognition tests (e.g., Ghent, 1956; Poppelreuter, 1917). The large majority of the acquired prosopagnosic patients were impaired at these tasks (e.g., Behrmann & Kimchi, 2003; Delvenne, Seron, Coyette, & Rossion, 2004; De Renzi, 1986; De Renzi, Faglioni, Grossi, & Nichelli, 1991; Lê *et al.*, 2002; Levine & Calvanio, 1989; Lhermitte, Chain, Escourolle, Ducarne, & Pillon, 1972; Shuttleworth, Syring, & Allen, 1982).

However, the classical and most widely used paradigm is based on the ‘Navon effect’ (Kimchi, 1992). In his original paper, Navon (1977) tested the hypothesis that perceptual processes proceed from global structuring towards more and more fine-grained analysis, a theory that he termed *global addressability*. To test this theory, Navon created hierarchical letters, in which global letters are composed of small versions of the same or different letters. He showed that normal observers have an advantage at processing the global letters, and that processing of the local letters is influenced by the global letters. Brain-damaged patients usually fail to show the *Navon effect* (e.g., Lamb, Robertson, & Knight, 1989), particularly those patients with visual integrative agnosia and prosopagnosia (e.g., HJA, Humphreys, Riddoch, & Quinlan, 1985; WJ and BH, Rapcsak, Polster, Comer, & Rubens, 1994; RN, Behrmann & Kimchi, 2003; SE, Aviezer *et al.*, 2007, several cases in Behrmann, Avidan, Marotta, & Kimchi, 2005). In a recent study, Barton (2009) used a modified version of the classical Navon (1977) task in order to assess holistic processing of non-face visual patterns in a group of eight prosopagnosic patients [one childhood-onset patient (001) and seven adult-onset patients (004, 005, 006, 007, 009, 010, 011)]. As a group, the prosopagnosic patients

were faster to detect the presence of the target when it was present at both the local and the global levels, and faster in the global-only condition in comparison with the local-only condition. Even though these data indicated the presence of residual holistic processing, the patients were significantly slowed down in comparison with age-matched controls, so that, as acknowledged by the author, the patients' holistic processing may not be entirely preserved. Moreover, the majority of patients tested in that study (Barton, 2009) were reported in previous studies as presenting difficulties at other global object processing tasks: 004, 007, and 010 were impaired on a task of overlapping figures recognition (Barton, Cherkasova, Press, Intriligator, & O'Connor, 2004), 006 was impaired at reconstructing incomplete letters (Barton *et al.*, 2004), and 011 - better known under the initials LH - was impaired on tasks of visual closure and recognition of fragmented figures (Levine & Calvanio, 1989).

Considering these observations altogether, it appears that the large majority of acquired prosopagnosic patients present with impairment in holistic processing. This observation supports, at first glance, the claim of Levine and Calvanio (1989) that '(acquired) prosopagnosia is a general impairment at configural (i.e., holistic) processing'.<sup>1</sup>

There is, however, a serious issue that has not been considered deeply enough to reach this kind of conclusion. That is, all the patients who did not present with the Navon effect or other measures of holistic processing with non-face objects are cases of prosopagnosia who, on top of their difficulties of face recognition, present with significant object recognition difficulties. This is for instance the case of HJA (Humphreys *et al.*, 1985), LA and GD (De Renzi *et al.*, 1991), SB (Lê *et al.*, 2002), RN (Behrmann & Kimchi, 2003), SE (Aviezer *et al.*, 2007). This is also true, although perhaps to a lesser extent, for the patients included in Barton (2009)'s study, all patients but one (009) having difficulties in recognizing non-face objects (e.g., fruits and vegetables, Barton, 2008). In contrast, several cases of acquired prosopagnosia with no known object recognition deficit actually succeeded in tasks of visual closure: three patients studied by De Renzi and colleagues [patient no. 4 (De Renzi, 1986), VA (De Renzi *et al.*, 1991), and Anna (De Renzi & di Pellegrino, 1998)] presented with no impairment in the Street's completion or in the overlapping figures recognition tests. Two cases in Takahashi, Kawamura, Hirayama, Shiota, and Isono (1995) with no basic object recognition difficulties (cases no. 1 and no. 3) also succeeded in tasks of Gestalt completion and overlapping figures recognition and showed a normal Kanizsa effect. Another case of prosopagnosia with no general visual agnosia, MT (Henke, Schweinberger, Grigo, Klos, & Sommer, 1998), also succeeded the Street's completion task and recognized easily overlapping figures.

These last observations pose great difficulty to the view that prosopagnosia is an impairment at holistic/configural processing. Indeed, if impairment at holistic processing is found only in cases whose recognition difficulties are not restricted to faces, one may question the relevance of this holistic processing hypothesis with respect to understanding the nature of the face recognition impairment in prosopagnosia.

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<sup>1</sup>Note that this statement referred to cases of acquired prosopagnosia, but not to patients with developmental or congenital prosopagnosia, who may (Behrmann *et al.*, 2005; Bentin, DeGutis, D'Esposito, & Robertson, 2007) or may not (Bentin, Deouell, & Soroker, 1999; Duchaine, 2000; Duchaine, Germine, & Nakayama, 2007; Nunn, Postma, & Pearson, 2001) be impaired at tasks measuring holistic processing such as the Navon task.

Regarding this issue, there are two possibilities. Either the pure cases of prosopagnosia reported in the literature do not have difficulties at holistic processing, even when faces are concerned. Or, their holistic processing impairment is restricted to face stimuli.

Our previous work with a pure case of prosopagnosia following brain damage, PS (Rossion *et al.*, 2003) rather supports the second view. Throughout a set of recent studies, we showed that when it comes to individualize faces, PS proceeds feature-by-feature, without being influenced by other features than the one she fixates at a given time (Orban de Xivry, Ramon, Lefèvre, & Rossion, 2008; Ramon, Busigny, & Rossion, 2010; Ramon & Rossion, 2010; Van Belle, de Graef, Verfaillie, Busigny, & Rossion, 2010). It is not the first time that one demonstrates such a behaviour, interpreted as a loss of holistic face processing, in a case of prosopagnosia (e.g., Boutsen & Humphreys, 2002; Saumier *et al.*, 2001; Sergent & Villemure, 1989; Spillmann *et al.*, 2000). However, the studies of the patient PS showed for the first time that an impairment of holistic processing can characterize well the nature of prosopagnosia in a patient who is nonetheless perfectly capable of normal object recognition (Rossion *et al.*, 2003). What we have *not* demonstrated in previous studies, however, is that PS' ability to process non-face objects holistically is intact. This was the goal of the present study, which was theoretically motivated by our belief that what is meant by holistic processing for objects and faces differ fundamentally on at least one aspect: contrary to non-face objects, holistic processing for faces takes place at the individual level, i.e., when one has to distinguish between individual members of the visual category.

## **Experiment: the Navon effect as tested with patient PS**

Here, we tested the patient PS who presents with a clear prosopagnosia with no impairment in object recognition, neither at the basic level, neither at more subordinate levels (Busigny, Graf, Mayer, & Rossion, 2010; Busigny & Rossion, 2009; Ramon *et al.*, 2010; Ramon & Rossion, 2010; Rossion *et al.*, 2003; Schiltz *et al.*, 2006). This patient presents with impairment in individualization of faces and previous studies showed that she does not have any face inversion effect (Busigny & Rossion, 2009), and that she does not show the whole-part face advantage and the composite face effect (Ramon *et al.*, 2010). Thus, we have previously concluded that PS does not process individual faces holistically. In the present study, we aimed at assessing if this impairment extends to non-face object processing. As Barton (2009) and others (Aviezer *et al.*, 2007; Behrmann & Kimchi, 2003; Humphreys *et al.*, 1985; see also Behrmann *et al.*, 2005), we used a task with Navon hierarchical letters. If PS' impairment in holistic processing is not specific for individual faces, she should not present with a Navon effect as large as normal observers. However, since PS does not present with any difficulties in basic-level object recognition (Rossion *et al.*, 2003), we rather hypothesized that she will present with normal performance in this task.

## **Methods**

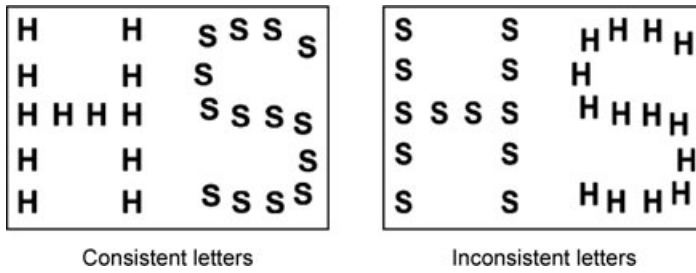
### **Participants**

PS and seven gender- and age-matched participants were administered with the Navon effect task. When she performed the task, PS was aged 58 years (2009). Control participants had no history of neurological or vascular disease, head injury or alcohol

abuse, and did not have cognitive complaints (mean age: 57.1; *SD*: 3.89). All participants gave informed consent. PS is a case of acquired prosopagnosia who has been reported in detail in several publications focusing on her behavioural and neural processing of faces (e.g., Busigny & Rossion, 2009; Caldara *et al.*, 2005; Rossion *et al.*, 2003; Rossion, Legrand, Kaiser, Bub, & Tanaka, 2009; Sorger, Goebel, Schiltz, & Rossion, 2007). To summarize briefly, PS was born in 1950 and sustained closed head injury in 1992 that left her with extensive lesions of right inferior occipital cortex and the left mid-ventral (mainly fusiform) gyrus. Minor damage to the left posterior cerebellum and the right middle temporal gyrus were also detected (see Sorger *et al.*, 2007, for extensive anatomical details). After medical treatment and neuropsychological rehabilitation, PS recovered extremely well from her cognitive deficits following the accident. Her only continuing complaint remains a profound difficulty in recognizing familiar faces, including her own face on photographs, and family members' faces when presented out of context. To determine a person's identity, she relies on external cues such as haircut, moustache, or glasses, but also on the person's voice, posture, gait, etc. She may also use suboptimal facial cues such as the mouth or the lower external contour to recognize faces, and is particularly impaired at extracting diagnostic information from the eyes of the face (Caldara *et al.*, 2005; Rossion, Legrand, Kaiser, Bub, & Tanaka, 2009). For discriminating faces from other objects, PS performs as well as normal participants but is impaired and slowed down at recognizing faces at the individual level (Rossion *et al.*, 2003; Schiltz *et al.*, 2006). The Benton Face Recognition Test (Benton & Van Allen, 1968), which tests ability to match photographs of faces that vary with respect to viewpoint and lighting, ranks her as highly impaired [18/54 as tested shortly after her accident; 39/54 (72.2%) as tested in 2007, which is below normal range for age- and sex-matched controls ( $84.7\% \pm 6.09$ ), while taking 37.5 min to perform a test that is done in about 6 min ( $351 \pm 7.7$  s) by normal age-matched controls]. Her score at the Warrington Recognition Memory Test (Warrington, 1984) for faces characterizes her as significantly less accurate as controls (see Table 1 in Sorger *et al.*, 2007). PS does not present any difficulty in recognizing visual objects: she does not complain of any object recognition problems, she was perfect and fast at recognizing the colourized Snodgrass and Vanderwart stimuli (Rossion & Pourtois, 2004). PS also performed in the normal range at discriminating numerous non-face objects in previous studies: cars, novel multipart objects, living and non-living objects (Busigny & Rossion, 2009; Busigny *et al.*, 2010; Rossion *et al.*, 2003; Schiltz *et al.*, 2006). PS's visual field is almost full (with exception of a small left paracentral scotoma, as in many cases of acquired prosopagnosia following right posterior ventral lesions; see Bouvier & Engel, 2006; Hécaen & Angelergues, 1962), her visual acuity is good (0.8 for both eyes as tested in August 2003), and despite the right hemisphere lesion encompassing area V4/V8, her colour perception is in the lower normal range (see Sorger *et al.*, 2007).

### **Stimuli**

The stimuli were four hierarchical letters of two types: consistent and inconsistent letters. In the consistent letters, the global and the local letters were identical (i.e., a large H made of smaller Hs and a large S made of small Ss). In the inconsistent letters, the global and the local letters were different (i.e., a large H made of smaller Ss and a large S made of smaller Hs; Figure 1). The global letters subtended  $3.2^\circ$  in height and  $2.3^\circ$  in width, and the local letter subtended  $0.53^\circ$  in height and  $0.44^\circ$  in width.



**Figure 1.** Stimuli used in the Navon hierarchical letters task.

**Procedure and analyses**

The stimuli were presented using E-Prime 1.1 (Schneider, Eschman, & Zuccolotto, 2002). Participants were positioned at about 40 cm from the screen. They were asked to provide a binary response using the keyboard of the laptop computer. Each stimulus was presented one by one for unlimited time with the instruction to identify either the global letter, or the local letter, by pressing a corresponding key. A 500 ms ISI and a 500 ms fixation cross preceded each trial. The experiment was divided into 4 blocks of 48 consistent and inconsistent randomized trials. In the blocks 1 and 3, the instructions were to identify the global letter, in the blocks 2 and 4, the instructions were to identify the local letters. The order was kept identical for each control and the patient.

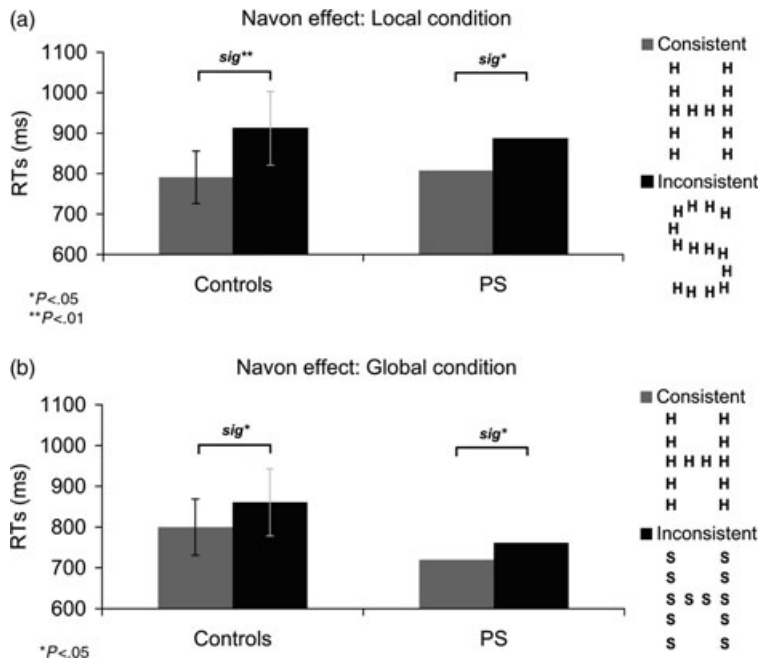
For intra-subject and -group statistical analyses, we used respectively classical independent sample *t* tests and paired sample *t* tests. These analyses were conducted by SPSS 18.0 within the framework of one-tailed hypothesis (.05 *p* value). Percentages of correct responses and response times on correct trials were calculated. RTs that were longer than 2SDs of the mean were discarded (2 trials for PS, analyses without these outlier values gave the same results).

To compare the results of PS to the control participants, we used the modified *t* test of Crawford and Howell (1998) for single case studies. This procedure decreases the Type I error as it tests whether a patient’s score is significantly below controls by providing a point estimate of the abnormality of the score. Here, we used a .05 *p* value within the framework of a unilateral hypothesis. Consequently, all scores associated with a *p* value under .05 were considered as reflecting an abnormal result. Analyses were conducted with a computerized version of the Crawford and Howell’s method: *SINGLIMS.EXE: Point estimate and confidence limits on the abnormality of a test score* (Crawford & Garthwaite, 2002).

**Results**

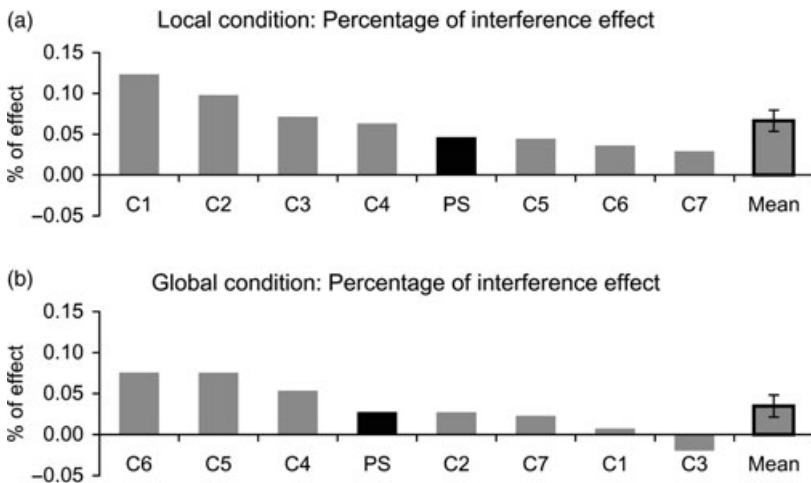
First, regarding the accuracy, all control participants as well as PS achieved ceiling performance. Through the four conditions, the age-matched controls succeeded with 99.3% and PS made no mistake (100% in each condition).

Next, concerning the correct RTs, as it is typically demonstrated (Navon, 1977), the age-matched controls showed an interference effect in the local condition: the identification of the smaller letter was influenced by the large one, the performance being significantly lower when the global and the local letters were inconsistent ( $t_6 = 3.708, p < .01$ ; Figure 2a). We also found an interference effect in the global condition: the identification of the large letter was influenced by the smaller ones, the performance

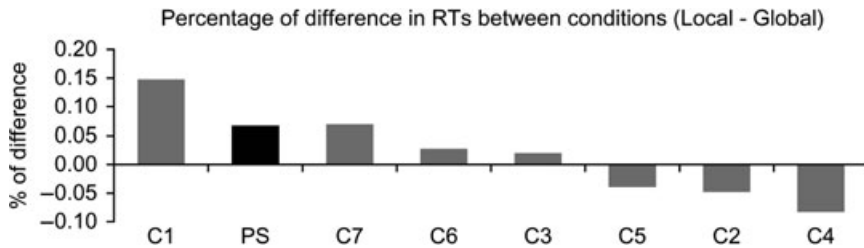


**Figure 2.** Results of PS and age-matched controls in the Navon hierarchical letters task. (a) Results in the local condition, in which participants have to identify the local letter. (b) Results in the global condition, in which participants have to identify the global letter. Bars represent standard errors.

being significantly lower when the global and the local letters were inconsistent ( $t_6 = 2.374, p < .05$ ; Figure 2b). This effect was not originally demonstrated by Navon in his first study (Navon, 1977), but it was found in subsequent studies (e.g., Barton, 2009; Behrmann *et al.*, 2005). Although there was a tendency for the interference to be larger



**Figure 3.** Interference indexes calculated for each single participant in both local and global conditions. (a) Percentage of interference effect in the local condition. (b) Percentage of interference effect in the global condition.



**Figure 4.** Percentage of difference calculated between local and global conditions for each single participant.

in the local than in the global condition, it did not reach significance ( $t_6 = 1.381$ ,  $p = .11$ ).

Regarding PS's response times, they were in the normal range for the four conditions: local/consistent (PS: 808 ms; mean: 791 ms;  $t = 0.092$ ,  $p = .47$ ), local/inconsistent (PS: 886 ms; mean: 912 ms;  $t = 0.101$ ,  $p = .46$ ), global/consistent (PS: 720 ms; mean: 800 ms;  $t = 0.411$ ,  $p = .35$ ), and global/inconsistent (PS: 761 ms; mean: 861 ms;  $t = 0.429$ ,  $p = .34$ ; Figure 2). Second, PS was significantly sensitive to the interference both in the local condition ( $t_{94} = 1.931$ ,  $p < .05$ ) and in the global condition ( $t_{94} = 1.936$ ,  $p < .05$ ; Figure 2).

Third, we computed the indexes of interference using the formula [(consistent - inconsistent)/(consistent + inconsistent)] for both the local and global conditions. PS obtained the same level of interference indexes as the age-matched controls in the local condition (PS: 4.63%; mean: 6.65%;  $t = 0.551$ ,  $p = .30$ ) and in the global condition (PS: 2.77%; mean: 3.47%;  $t = 0.184$ ,  $p = .43$ ). Figure 3 shows that the effects magnitude of PS was completely in the range of normal controls for both local and global conditions.

Finally, we compared the global and the local conditions between each other. Age-matched controls did not present with a significant difference between the two conditions (global mean: 830 ms, local mean: 851 ms;  $t_6 = 0.359$ ,  $p = .38$ ), some controls being faster in the global than the local condition, while others showed the opposite difference (Figure 4). Regarding PS, she was significantly faster in the global condition (global mean: 741 ms, local mean: 847 ms;  $t_{190} = 4.576$ ,  $p < .001$ ), which is the classical profile observed in previous studies (e.g., Barton, 2009; Navon, 1977). Finally, PS showed the same magnitude of effect in the local condition and the global condition (no interaction effect between Condition  $\times$  Congruency:  $F_{1,191} = 0.667$ ,  $p = .21$ ).

In summary, PS has a completely normal profile: she is as fast as controls in each of the two conditions, she is faster in global than in local condition, and when she has to identify a local letter she is normally influenced by the global context. These results show that PS is able to derive normally a global configuration from the organization of local elements, suggesting that she has preserved general visual holistic processing.

## Discussion

Previous studies revealed that the patient PS has a large impairment in holistic face processing, showing no face inversion effect, no whole-part face advantage, and no



composite face effect (Busigny & Rossion, 2009; Ramon *et al.*, 2010). In contrast, the present observations indicate that PS has a normal response profile in the Navon hierarchical letters task: she was as fast as controls, she was faster in the global condition in comparison with the local condition, and she showed a normal global to local interference. These findings provide evidence that PS is able to perceive visual patterns at the global level, just like normal observers.

This observation stands in contrast to the profile of response found in the same task in many patients with visual agnosia, whose recognition impairment *includes* faces (Aviezer *et al.*, 2007; Behrmann *et al.*, 2005; Behrmann & Kimchi, 2003; Humphreys *et al.*, 1985; Rapcsak *et al.*, 1994). However, as mentioned in the introduction, it is not the first time that a prosopagnosic patient succeeds at tasks measuring holistic processing with non-face visual stimuli (De Renzi, 1986; De Renzi & di Pellegrino, 1998; De Renzi *et al.*, 1991; Henke *et al.*, 1998; Takahashi *et al.*, 1995), even though the evidence provided here is particularly compelling, since the patient showed a global advantage and a global-to-local interference that was as large as normal controls. Moreover, PS performed this task as fast as controls, unlike the prosopagnosic patients tested in a similar task by Barton (2009).

Interestingly, the prosopagnosic patients who showed evidence for preserved general holistic processing apparently had, like PS, no object recognition difficulties. However, the present evidence collected on PS is particularly interesting because, while showing normal performance at the Navon task, she is clearly impaired at holistic *face* processing (see Busigny & Rossion, 2009; Ramon *et al.*, 2010). We note that evidence for such a dissociation between preserved general holistic processing and impaired holistic face processing could also possibly concern a previous case of acquired prosopagnosia reported by Barton (2009): patient 009. Previous studies showed that patient 009 is able to name vegetables and fruits, succeeds in tasks of overlapping figures and incomplete letters recognition (Barton *et al.*, 2004). Even though his individual data was not available, he may also have a normal Navon effect (Barton, 2009). In contrast, this patient did not present with the classical face whole-part advantage (De Gelder, Frissen, Barton, & Hadjikhani, 2003), and he was strongly impaired at discriminating changes in face configurations (Barton, 2008; Barton & Cherkasova, 2005).

Considering these observations altogether, we would like to stress the importance of making distinctions between face-specific visual agnosia (prosopagnosia), and a more extended visual agnosia characterized by impairment in both face and object recognition. We believe that this distinction is crucial for understanding the nature of acquired prosopagnosia. For the large majority of cases of prosopagnosia, the loss of holistic/configural face processing is included in a wider deficit that makes patients unable to process objects at the global level. This is the case for well-known prosopagnosic/visual agnosic patients such as HJA (Riddoch & Humphreys, 1987), RB (Davidoff & Landis, 1990), CR (Gauthier, Behrmann, & Tarr, 1999; Marotta, McKeef, & Behrmann, 2002), SM (Behrmann & Kimchi, 2003; Gauthier, Behrmann, & Tarr, 1999), RN (Behrmann & Kimchi, 2003; Marotta *et al.*, 2002), or DF (Steeves *et al.*, 2006), and also for patients whose visual recognition difficulties are more important for faces than objects (e.g., Levine & Calvanio, 1989; Spillmann *et al.*, 2000). However, some patients like PS, as indicated by the present observations, do not appear to be impaired at all at general holistic processing.

Altogether, these observations indicate that holistic processing as measured in the Navon paradigm or other tests (visual closure, incomplete pictures, overlapping figures, Kanizsa triangles, three-dimensional geometric figures, ...) can be functionally dissociated

from impairment at holistic face processing as measured in the inversion, composite, and whole-part face paradigms.

Why such a functional distinction? After all, faces are made of multiple parts (eye, nose, mouth, ...) that are embedded in, and form, a global organization. Like in the Navon task, the key aspect of holistic face processing as measured in these latter paradigms is also that the processing of a local part (or even half of a face in the composite face effect) is influenced by the global configuration of the stimulus. However, there is at least one fundamental difference between processes measured by the global-to-local influence in the Navon task as compared to the measures of holistic face processing: the level at which it is applied, i.e., basic versus individual level of categorization. We recently showed (Dricot, Busigny, Goebel, & Rossion, 2010) that the prosopagnosic patient PS is capable of categorizing a visual stimulus as a face, even if it requires global perception, for instance with Mooney face stimuli or in Arcimboldo paintings. In contrast, she is in trouble when having to *individualize* faces, and her impairment in holistic face processing always concerns the individualization of faces (Ramon *et al.*, 2010). Thus, it may be that pure prosopagnosics' impairment is restricted to the category of faces because it is the only category of visual items for which holistic processing at a fine-grained (individual) level is necessary.

### Conclusion

In the present study, we showed that the pure prosopagnosic patient PS tested in a Navon hierarchical letters task presents with entirely normal object holistic processing. These results contrast with the severe impairment of PS in processing individual faces holistically and consequently indicate that holistic processing as measured with global/local interference in the Navon paradigm is functionally distinct from the ability to perceive an individual face holistically.

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