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Discussion forum

Normal social evaluations of faces in acquired prosopagnosia

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People frequently evaluate facial attractiveness and make inferences about character traits from faces, and these evaluations are consistent across observers (Todorov, Said, & Verosky, 2011). Do these face evaluations rely on the same perceptual mechanisms as facial identity recognition? Recent studies claim they do not. Some individuals with developmental prosopagnosia make typical trustworthiness (Todorov & Duchaine, 2008) and attractiveness (Carbon, Grüter, Grüter, Weber, & Lueschow, 2010) judgments, and one acquired prosopagnosic judged attractiveness and several character traits normally (Quadflieg, Todorov, Laguesse, & Rossion, 2012).

These studies however suffer from three methodological limitations that raise concerns about the validity of their findings. First, face evaluations were measured only with ratings, a format that may not be sensitive enough to detect subtle impairments. Second, while face evaluations were measured with ratings, identity perception was assessed with different formats. Third, the faces evaluated by prosopagnosics in two studies (Carbon et al., 2010; Quadflieg et al., 2012) were in color and included hair. Both hair and color can influence evaluations (Stephen, Coetsee, & Perrett, 2011; Todorov & Duchaine, 2008) and some prosopagnosics can perceive these cues normally (Fox, Hanif, Iaria, Duchaine, & Barton, 2011; Garrido et al., 2009).

To overcome these limitations here we investigated perceptions of facial attractiveness, trustworthiness and aggressiveness for greyscale faces without external facial cues. We assessed each evaluation using three formats: rating, sorting, and categorisation. We chose attractiveness because of its evolutionary importance (Rhodes, 2006), and trustworthiness and aggressiveness because of their central roles in a leading model of face evaluation (Oosterhof & Todorov, 2008).

We tested four acquired prosopagnosics. Florence is a 29-year-old nurse, (R-AT1 in Fox et al., 2011). In 2006 she became prosopagnosic following a right amygdalohippocampectomy to treat epilepsy. In 2010 a second operation removed most of her right anterior temporal lobe. Grace is a 43-year-old pharmacist (B-OT/AT1 in Dalrymple et al., 2011). At 14 she became severely prosopagnosic and dyschromatopsic following infection with herpes simplex encephalitis. She has a large lesion of the right anterior temporal lobe extending to the middle fusiform and inferior temporal gyri. Kepler is a 53-year-old man who became prosopagnosic after a right inferior occipitotemporal stroke, and has a left upper quadrantanopia that involves the macular region. Sandy is a 36-year-old woman who developed left hemianopia and prosopagnosia following a resection for epilepsy in 1997 that was complicated by a peri-operative stroke. All four individuals had severe deficits processing facial identity (Fig. 1, leftmost column).

In the first test format, participants rated 20 unique faces (half female) for each dimension on a scale from 1 to 9. Controls were 30 students ($M = 19.1$ years old, $SD = 1.0$; 14 female). The second format matched the Cambridge Face Perception Test (CFPT) (Duchaine, Yovel, & Nakayama, 2007), which we used to measure identity perception. In ten trials, participants had one minute to sort six faces on a particular dimension (e.g., from least trustworthy to most trustworthy). Controls were 32 students for CFPT trustworthiness ($M = 19.1$, $SD = 1.0$; 25 female), 35 students for CFPT attractiveness ($M = 18.9$, $SD = 0.9$; 25 female) and 31 students for CFPT Aggressiveness ($M = 19.3$, $SD = 1.2$; 22 female). The third format was a categorisation task called the Odd-One-Out (OOO). Participants were presented, for three seconds, with three faces

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simultaneously and were asked to select the face that is different from the other two on a particular dimension. Control data were provided by 30 participants ($M = 30.1$, $SD = 16.4$; 17 female) for all three OOs. The ‘correct’ sorting orders in

the CFPTs and the ‘correct’ responses in the OOs were determined based on average ratings obtained previously from 338 online participants (each average score included at least 48 data points).

Rating: “how trustworthy is this individual, on a scale from 1 (not at all) to 9 (extremely trustworthy)?”



Categorisation: “which individual differs from the other two in terms of trustworthiness?”



Sorting: “sort these individuals according to how trustworthy they appear to you”

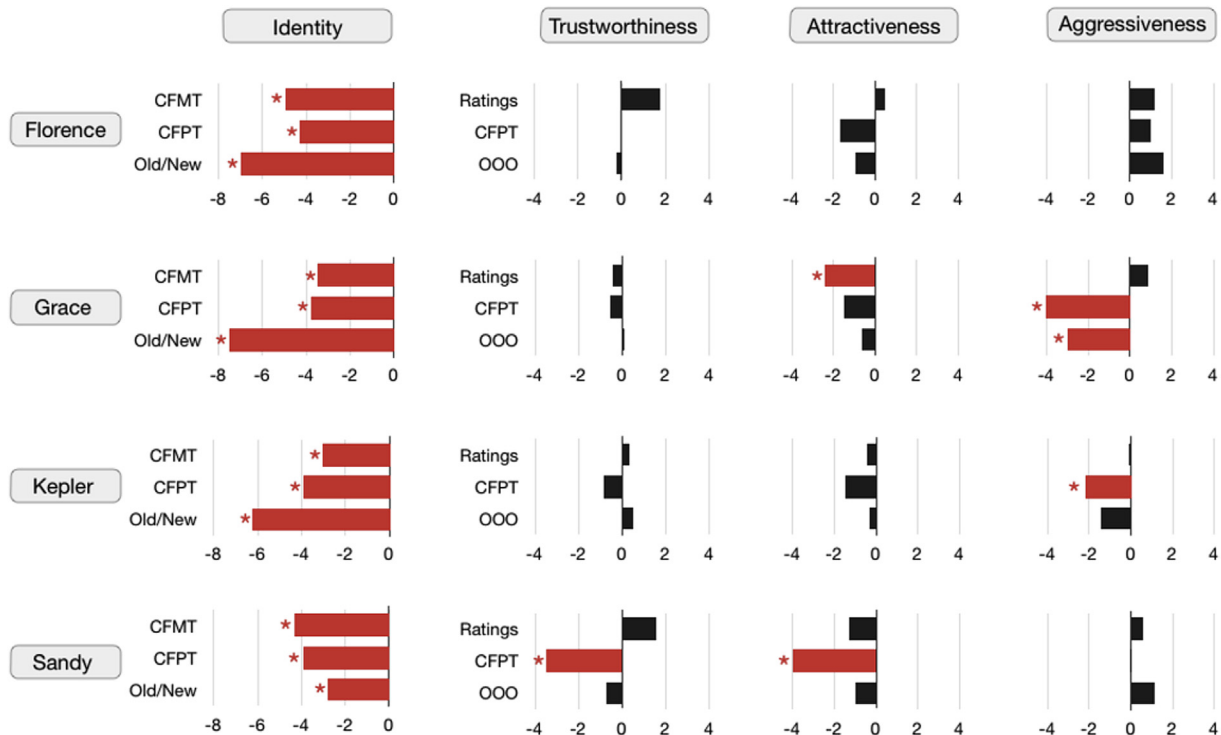
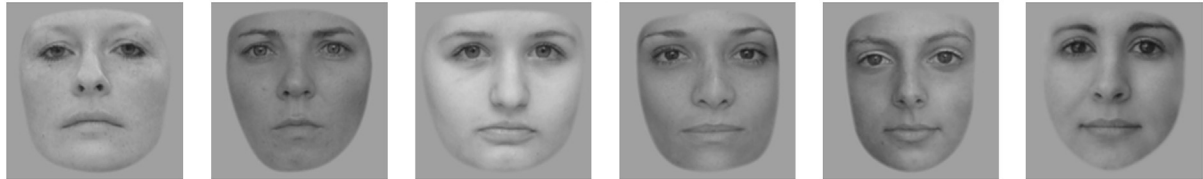


Fig. 1 – Face identity processing and face evaluations in four acquired prosopagnosics. We used three test formats to measure perception of face attractiveness, trustworthiness and aggressiveness. All tests presented greyscale faces in neutral expressions. For CFPT and OOO we computed accuracy, while for ratings we computed the correlation between a participant’s ratings and consensus ratings. Bars represent z-scores relative to controls (Grace’s z-score on CFPT Aggressiveness was -4.5 , and Sandy’s z-score on Attractiveness was -4.5 , but for ease of comparison we kept the scale minimum at -4). Note the difference scales between identity and face evaluation tests. Stars and red bars show significant differences to controls using the Crawford’s modified t test for single-case studies (Crawford & Howell, 1998). The significance levels were not corrected for multiple comparisons; this conservative approach was employed to detect even minor impairments, strengthening our claim that some prosopagnosics have intact face evaluations. Face identity deficits were confirmed by the Cambridge Face Memory Test (CFMT, Duchaine & Nakayama, 2006), Face Old/New Discrimination Test (Duchaine & Nakayama, 2005) and the Cambridge Face Perception Test (CFPT, Duchaine et al., 2007).

Fig. 1 shows the results. Florence's performance was normal for all nine tests (3 face evaluations \times 3 formats). Grace was normal with trustworthiness. For attractiveness, she was impaired with ratings ($t = 2.28, p = .030$), but normal with CFPT and OOO. For aggressiveness, she provided typical ratings, but was impaired with the CFPT ($t = 4.51, p < .001$) and OOO formats ($t = 2.95, p = .006$). Kepler was normal with trustworthiness and attractiveness, but impaired with aggressiveness in the CFPT ($t = 2.14, p = .041$) and scored in the lower range for the OOO ($t = 1.41, p = .166$). Sandy was impaired at CFPT Trustworthiness ($t = 3.32, p = .002$) and CFPT Attractiveness ($t = 4.11, p < .001$), but fine with rating and categorisation. She was normal with aggressiveness.

Our findings demonstrate that face evaluations can be normal when face identity recognition is impaired. Critically, all prosopagnosics had normal evaluations of at least one dimension across all three test formats. Florence's results were especially convincing; she was normal with all evaluations. Grace was normal with trustworthiness, Kepler with trustworthiness and attractiveness, and Sandy with aggressiveness. These results strongly suggest that the perceptual mechanisms underlying these judgments are dissociable from those used for identity.

While our results are consistent with the previous reports of identity-evaluation dissociations in prosopagnosia, they also show that individuals who 'succeed' with ratings do not necessarily have normal perception of face attractiveness and traits. Several prosopagnosics performed normally with ratings for a dimension but were impaired with the sorting and categorization tasks. For example, Grace showed normal aggressiveness ratings, but was impaired with aggressiveness sorting and categorization. This suggests the rating format in isolation may not be sufficiently sensitive for neuropsychological investigations. Indeed, the average of correlations to consensus judgments in controls was relatively low (between .42 and .58) and the standard deviations large (.16–.29), which is likely to lead to floor effects that could mask subtle impairments. These limitations of ratings were also noted in Todorov and Duchaine (2008) and Quadflieg et al. (2012). In one case, normal performance with CFPT and OOO occurred together with atypical ratings (Grace for attractiveness), underlining more generally the importance of using multiple measurements and formats to assess these evaluations.

To conclude, our findings suggest future research should use multiple formats in studies of face evaluations. More importantly, by using three test formats, one of which is identical to the format used to assess identity processing (CFPT), our findings provide firm evidence that identity processing and face evaluations can dissociate in prosopagnosia.

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REFERENCES

- Carbon, C. C., Grüter, T., Grüter, M., Weber, J. E., & Lueschow, A. (2010). Dissociation of facial attractiveness and distinctiveness processing in congenital prosopagnosia. *Visual Cognition*, 18(5), 641–654.
- Crawford, J. R., & Howell, D. C. (1998). Comparing an individual's test score against norms derived from small samples. *Clinical Neuropsychologist*, 12, 482–486.
- Dalrymple, K. A., Oruç, I., Duchaine, B., Pancaroglu, R., Fox, C. J., Iaria, G., et al. (2011). The anatomic basis of the right face-selective N170 in acquired prosopagnosia: a combined ERP/fMRI study. *Neuropsychologia*, 49(9), 2553–2563.
- Duchaine, B., & Nakayama, K. (2005). Dissociations of face and object recognition in developmental prosopagnosia. *Journal of Cognitive Neuroscience*, 17(2), 249–261.
- Duchaine, B., & Nakayama, K. (2006). The Cambridge Face Memory Test: results for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic participants. *Neuropsychologia*, 44(4), 576–585.
- Duchaine, B., Yovel, G., & Nakayama, K. (2007). No global processing deficit in the Navon task in 14 developmental prosopagnosics. *Social Cognitive and Affective Neuroscience*, 2(2), 104–113.
- Fox, C. J., Hanif, H. M., Iaria, G., Duchaine, B., & Barton, J. J. S. (2011). Perceptual and anatomic patterns of selective deficits in facial identity and expression processing. *Neuropsychologia*, 49(12), 3188–3200.
- Garrido, L., Furl, N., Draganski, B., Weiskopf, N., Stevens, J., Tan, G. C. Y., et al. (2009). Voxel-based morphometry reveals reduced grey matter volume in the temporal cortex of developmental prosopagnosics. *Brain*, 132(12), 3443–3455.
- Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences of the United States of America*, 105(32), 11087–11092.
- Quadflieg, S., Todorov, A., Laguesse, R., & Rossion, B. (2012). Normal face-based judgements of social characteristics despite severely impaired holistic face processing. *Visual Cognition*, 20(8), 865–882.
- Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology*, 57, 199–226.
- Stephen, I. D., Coetzee, V., & Perrett, D. I. (2011). Carotenoid and melanin pigment coloration affect perceived human health. *Evolution and Human Behavior*, 32(3), 216–227.
- Todorov, A., & Duchaine, B. (2008). Reading trustworthiness in faces without recognizing faces. *Cognitive Neuropsychology*, 25(3), 395–410.
- Todorov, A., Said, C. P., & Verosky, S. C. (2011). Personality impressions from facial appearance. In A. Calder, J. V. Haxby, M. Johnson, & G. Rhodes (Eds.), *The Oxford Handbook of Face Perception* (pp. 631–652). Oxford: Oxford University Press.

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