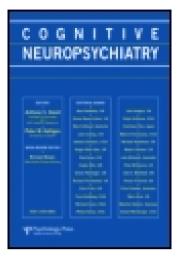
This article was downloaded by: [University of South Florida] On: 05 December 2014, At: 06:11 Publisher: Routledge Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Cognitive Neuropsychiatry

Publication details, including instructions for authors and subscription information: <u>http://www.tandfonline.com/loi/pcnp20</u>

"Far from the heart far from the eye": Evidence from the Capgras delusion

Gianni Brighetti $^{\rm a}$, Paola Bonifacci $^{\rm a}$, Rosita Borlimi $^{\rm a}$ & Cristina Ottaviani $^{\rm a}$

^a Department of Psychology, University of Bologna, Bologna, Italy

Published online: 18 Apr 2007.

To cite this article: Gianni Brighetti , Paola Bonifacci , Rosita Borlimi & Cristina Ottaviani (2007) "Far from the heart far from the eye": Evidence from the Capgras delusion, Cognitive Neuropsychiatry, 12:3, 189-197, DOI: <u>10.1080/13546800600892183</u>

To link to this article: http://dx.doi.org/10.1080/13546800600892183

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at http://www.tandfonline.com/page/terms-and-conditions

"Far from the heart far from the eye": Evidence from the Capgras delusion

Gianni Brighetti, Paola Bonifacci, Rosita Borlimi, and Cristina Ottaviani

Department of Psychology, University of Bologna, Bologna, Italy

Introduction. Capgras syndrome is characterised by the belief that a significant other has been replaced by an identical-looking impostor. These patients have no difficulties with visual recognition but fail to show a skin conductance response (SCR) to the objects of the delusion. A case of Capgras delusion (YY), specifically characterised by the absence of brain lesions, constituted a good opportunity to test the relationship between SCR hyporesponsiveness and eye movement patterns to familiar and unfamiliar faces.

Methods. Visual scan path and SCR were recorded for YY and 8 controls during the presentation of family members' photographs matched with unfamiliar faces of the same sex, age, and physical likeness. Eye movement patterns were explored by selecting three specific areas of interest (AOI) involving the eyes, the mouth, and the face regions.

Results. In contrast with controls, YY showed a reduction in number and sum of fixation durations to the eyes (p < .01) and no differential SCRs (p > .05) to familiar vs. nonfamiliar faces. SCR and fixation duration to family members' eyes were significantly correlated (r = .77) in both YY and controls.

Conclusions. Eye region exploration seems to be related to the autonomic reactivity elicited by the affective valence of familiar faces.

INTRODUCTION

Autonomic responses and eye movements are involved in face perception; the first considered an index of subcortical processing (Williams et al., 2004), the second commonly used as an index of cognitive processing (Irwin, 2004). Although these two dimensions have never been investigated together, studies on psychiatric populations have shown abnormal scan paths to facial stimuli (Loughland, Williams, & Gordon, 2002; Manor et al., 1999;

Correspondence should be addressed to Paola Bonifacci, Department of Psychology, Viale Berti Pichat 5, 40127 Bologna, Italy. E-mail: paola.bonifacci@unibo.it

We thank Silvana Contento, Silvia Cabrini, Valeria Nucifora, and David Shapiro for personal and technical assistance.

^{© 2007} Psychology Press, an imprint of the Taylor & Francis Group, an Informa business http://www.psypress.com/cogneuropsychiatry DOI: 10.1080/13546800600892183

Williams, Loughland, Gordon, & Davidson, 1999; Williams, Loughland, Green, Harris, & Gordon, 2003), or abnormal skin conductance response (SCR) in face processing tasks (Ellis & Lewis, 2001). A case of Capgras, characterised by the absence of obvious brain lesions, offered the opportunity to test the relationship between SCR hyporesponsiveness and eye movements to familiar and unfamiliar faces.

Autonomic discrimination in the form of larger SCRs to familiar than unfamiliar faces seems to be an extremely consistent finding for normal participants (Tranel, Fowles, & Damasio, 1985; Ellis, Quayle, & Young, 1999) and has been observed even without awareness of recognition (Ellis, Young, & Koenken, 1993). Similarly, the phenomenon of reduced SCR to familiar faces in patients with Capgras delusion has now been robustly attested (Ellis, Young, Quayle, & de Pauw, 1997; Hirstein & Ramachandran, 1997) and cannot be explained by the general autonomic hyporesponsivity that characterises schizophrenic patients (Perry, Felger, & Braff, 1998). Thus, it has been proposed that the Capgras delusion might arise from the conflicting experience of recognising a known face without any accompanying affective reaction, a phenomenon that could lead the patient to the erroneous conclusion that the person was an impostor (Ellis & Young, 1990).

Face recognition impairments have primarily been investigated when brain damage has occurred, such as in prosopoagnosia (Tranel & Damasio, 1985). Alterations in scan paths, due to a lack of exploration in the eye region during an emotion recognition task, have been demonstrated after bilateral amygdala damage (Adolphs et al., 2005), or psychiatric disorders (Loughland et al., 2002). Rizzo, Hurtig, and Damasio (1987) proposed that properties of scanning could be used as an index of higher neural processing to achieve comparable finding to that obtained with autonomic studies of covert recognition in prosopoagnosia. Opposite to the pattern observed in prosopoagnosia, Capgras subjects recognise the structural features of familiar faces but may have impairments in the affective route to face recognition (Ellis, Lewis, Moselhy, & Young, 2000; Schweinberger & Burton, 2003), as documented by the SCR hyporesponsiveness. Given the importance of the eye region in face processing (Emery, 2000), we further explored whether the lack of autonomic activation to the objects of the delusion was associated with abnormalities in the exploration of this specific area.

METHODS AND MATERIALS

Subjects

We studied YY, a 22-year-old female University student with normal IQ (Wechsler Adult Intelligence Scale Revised: verbal IQ = 103; performance IQ = 87; full scale IQ = 96). Structured Clinical Interview for DSM-IV

excluded comorbidity with other psychiatric disorders (i.e., schizophrenia), but a perseverative behaviour in decision making was evidenced by the Iowa Gambling Task (net score = -48). Medications were Serenase 3 mg and Seroquel 700 mg once daily.

Optometric parameters were within the normal range except for a corrected to normal myopia. Computed tomography and neurological assessment did not reveal neuroanatomical deficits. YY represented one of the rare cases of Capgras delusion where the belief that significant others have been replaced by an identical-looking impostor was accompanied neither by obvious brain damages nor by other psychiatric symptoms. The assessment was carried out 1 year after the onset of the symptomatology.

We compared YY to eight female controls of comparable mean age (24 years, 3 months).

The delusion

YY never had psychiatric symptoms before the first episode of delusion occurred. At that time, YY was 20 years old and she was a University student. YY's school career has always been mediocre. In July 2004, YY failed a written exam. When the professor asked her to read the manuscript, YY was unable to do it as she unexpectedly could not understand her own handwriting. The causes of this episode are still unknown. Afterwards, YY referred that she felt offended by the professor—who apparently treated her inappropriately, and made fun of her in front of other students. YY went out from the classroom in a state of shock and sat for 4 hours at a bus station. Her parents found YY in a complete state of catatony: she could neither talk nor move. On arrival at hospital she gradually recovered. A CT brain scan excluded lesions or anatomical deficits. A neurological assessment demonstrated normal attention, language, memory, and motor skills and she was perfectly oriented. No medical problems emerged and all physical measures fell within the normal range. The only symptom that her parents reported when YY left the hospital was a reduced emotional warmth towards them. The day after her arrival at home, the father could not open the front door because YY had locked it from the inside. He rang the bell and YY called the police because "there was an impostor outside the house who was picking the lock and pretending to be her father". YY was admitted to the psychiatric hospital where the diagnosis of Capgras delusion was made and she was treated with antipsychotic drugs for 2 months. From that point and for the next two months, YY failed to acknowledge six family members (mother, father, uncle, paternal grandparents, maternal grandfather) and the professor mentioned above. She correctly identified all of her other relatives including her aunts and her maternal grandmother, and had no difficulty in

192 BRIGHETTI ET AL.

identifying friends and schoolmates. On coming out of hospital the delusion was still present, but it involved only the father. At the time of testing the delusion was persistent and confirmed by YY's attempts to remove what she believed was the impostor's mask. Furthermore, YY repeatedly tested her father (whom she misidentified) with questions about her childhood (e.g., "Where did we celebrate my 10-year-old birthday?") with the aim of exposing him as an impostor. When YY was asked where her father was, she said that her mother and the impostor killed him to start a new life together.

Task

Seven photographs of immediate family members matched with seven unfamiliar faces of the same sex, age, and physical likeness and ten filler photographs of neutral objects were collected for YY. Family members' photographs were divided as follows: five photographs out of seven included the known faces for whom she had her first episode of Capgras delusion (uncle, mother, paternal grandparents, maternal grandfather), which have since been resolved; one photograph related to the familiar face (father) who was still object of the delusion at the time of testing; and one photograph included a family member for whom the Capgras delusion never existed (maternal grandmother). Four photographs of family members matched with four unfamiliar faces and eight photographs of neutral objects were used for controls.

Participants sat 56 cm distant from a 30.5 cm \times 23 cm (visual angle 30° \times 23.12°) monitor screen. Faces were randomly presented for 5 s, with a 20 s interval, and subjects were asked to look at the stimuli presented on the screen. The width of the faces subtended a visual angle between 13° and 15°.

Data acquisition

Eye movements were measured using an Applied Science Laboratory Model 504, (120 Hz) corneal reflection eyetracking system based on a remote pan/ tilt infrared camera accurate to 0.5° . Eye movements were explored by selecting three areas of interest (AOI) involving the eyes, the mouth, and the remaining part of the face. Number and sum of fixation durations were calculated for each AOI during the presentation of each stimulus. A drift in the viewer's gaze by less than 1° within 100 ms identified a fixation.

SCRs were monitored throughout the presentation, and reactivity scores were converted into a within-subject standardised ratio according to published guidelines (Tranel et al., 1985). SCRs were measured with the Biopac electrodermal response amplifier using Ag/AgCl electrodes attached to the palmar surface of the index and middle fingers of the nondominant

hand. We recorded SCR (in μ S) every 500 ms and stored them on computer. All SCRs were square-root-transformed to attain statistical normality. Finally, we tested YY's ability to attribute the correct identity to familiar faces.

RESULTS

Table 1 shows the effects of familiarity on both eye movements and SCR for YY and controls. Compared with control subjects, YY showed a restriction in total fixation number and a decrease in scan path length for familiar faces. While controls revealed the normal, higher SCR to familiar compared with unfamiliar faces, YY's SCRs to both conditions were essentially identical.

Number and sum of fixation durations in the eye region for familiar and unfamiliar faces were compared using paired *t*-tests. No differences emerged either in controls' number, t = 1.37, df = 7, p = .22, or sum of fixation durations, t = 1.06, df = 7, p = .32. Conversely, a significant difference across trials was found for YY's number, t = -4.05, df = 6, p < .005, and sum of fixation durations, t = -3.54, df = 6, p < .01, in the eye region, with lower values for familiar faces. No differences were found for either controls or the Capgras patient in the number and sum of fixation durations for the other face areas (mouth, face).

A paired *t*-test was conducted on controls' SCRs for familiar (mean differential SCR = $1.53 \ \mu$ S) and unfamiliar faces (mean differential SCR = $-0.38 \ \mu$ S) to analyse responses to the targets across conditions. The analysis revealed a significant effect of familiarity, *t* = 3.03, *df* = 14, *p* < .005. In contrast, the patient showed no differential SCRs, *t* = 0.29, *df* = 22, *p* = .77, to familiar (mean differential SCR = $0.46 \ \mu$ S) versus unfamiliar faces (mean differential SCR = $0.45 \ \mu$ S). YY's recognition of the identity of faces was

TABLE 1	
---------	--

Effects of familiarity on eye movements	(number and sum of fixation durations in
the eye region) and skin conductanc	e response (GSR) for YY and controls

	Familiar	Unfamiliar
YY.		
\triangle SCR (μ S)	0.46	0.45
Number fixations	0.42	3.28
Sum fixations' duration (s)	0.24	2.09
Mean controls		
\triangle SCR (μ S)	1. 53	-0.38
Number fixations	6.87	6.40
Sum fixation durations (s)	2.85	2.64

fully preserved: she correctly identified seven out of seven photographs of familiar faces.

A Pearson correlation between SCR means and the number and sum of fixation durations in the eye region for each stimulus was carried out for the control group. A significant correlation, r = .77, between SCR and fixation duration for familiar faces was found: the higher the subject's SCR, the longer the eye region was explored, whereas familiar faces characterised by SCR hyporesponsiveness were associated with a lack of fixations in the eye region. No relationship emerged for unfamiliar faces, or the other regions (mouth, face), for either familiar or unfamiliar faces.

Figure 1 shows the specificity of autonomic and visual scan path impairments for YY. Interestingly, eye movements when looking at faces believed to have been substituted (Figure 1a, Stimuli 1a, 2a, 4a, 5a) differ from those to other familiar faces for whom the Capgras delusion never existed (Figure 1a, Stimulus 3a), the latter being similar to the eye patterns related to unfamiliar faces (Figure 1a, Stimuli 1b, 2b, 3b, 4b, 5b). Accordingly, a few fixations to the eyes were limited to the family member who had never been objects of delusion (Figure 1c, Stimulus 3) and partially to the mother (Figure 1c, Stimulus 2), for whom the misidentification recovered; this pattern was accompanied by a slight although not significant SCR increase (Figure 1b, Stimuli 2, 3).

DISCUSSION

The present data confirmed previous results on SCR hyporesponsiveness to familiar faces in Capgras delusion and demonstrated its association with concurrent abnormalities in visual scan path. In line with previous studies (Adolphs et al., 2005) underlying the peculiarity of the eye region in face processing, our results suggested a specific impairment in the exploration of this region only for those faces that were or had been thought to be impostors.

Rizzo et al. (1987) suggested that the scan paths of personally meaningful faces, whether or not they were consciously recognised, were less predictable than those of other faces and proposed the existence of an internal and relatively specific schema for familiar faces sufficient to alter the predictable scan path used for nonfamiliar faces. Considering that YY has preserved abilities to recognise the structural features of faces as belonging to family members, we suggest that the internal schema of familiarity might be mediated by low-level processes (Johnson, 2005). Although reciprocal interactions between central and autonomic face processing have been suggested, one can speculate on the effect of one system to the other, simply considering their time courses of activation. Given that SCR has been widely

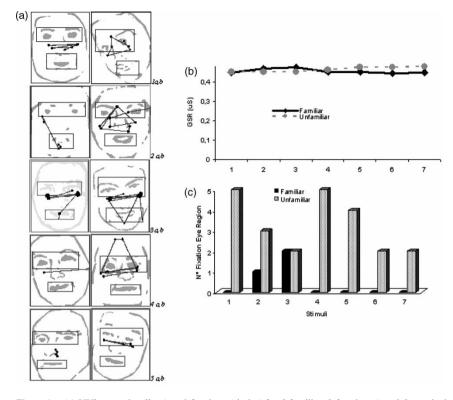


Figure 1. (a) YY's saccades (lines) and fixations (circles) for 5 familiar (left column) and 5 matched unfamiliar faces (right column). Boxes define the areas of interest (eyes, mouth, and face). YY fails to fixate on the eyes when viewing familiar faces. (b) YY's SCR for 7 familiar (black line) and 7 matched unfamiliar faces (grey line). The autonomic response to familiar and unfamiliar faces is almost identical as expressed by the overlap of the two lines. (c) YY's fixation number related to the eye region for 7 familiar (black bar) and 7 matched unfamiliar faces (grey bar). Number of fixations on the eyes is abnormally low for familiar faces.

used as an index of subcortical processing in subliminal studies (Glascher & Adolphs, 2003), suggesting that an autonomic response occurs even before the activation of the primary visual cortex, we postulated that the apparent top-down mechanism in the neural control of eye movements is indeed modulated by subcortical afferences. In agreement with recent studies suggesting that subcortical processing precedes and modulates cortical functions in face perception (Vuilleumier, Armony, Driver, & Dolan, 2003), we hypothesise that abnormal subcortical activation, as indexed by SCR, might modulate eye movements. Specifically, our data suggest that not only does the amygdala feedback to the visual cortex, thereby modulating early visual information processing, but might also influence the visual information that our eyes seek in the first place. In line with recent findings

196 BRIGHETTI ET AL.

from brain-imaging studies, both on controls (Kawashima et al., 1999) and psychiatric populations (Dalton et al., 2005, on autistic children), there seems to be evidence of a participation of the amygdala in processing information about the eye region of the face, suggesting that the exploration of this specific region is related to the affective valence of the stimuli.

On the basis of this theoretical background we tentatively suggest the implications of the present study as follows: (1) the absence of identity recognition, accompanied by a lack of SCR, encourages the subject fully to explore unfamiliar faces; (2) recognition of faces as familiar, associated with spurts in SCR, leads to a more elaborate exploration in the eye region; (3) identity recognition of familiar faces, associated with a lack of SCR, results in gaze avoidance of the eye region.

The Capgras delusion has received a rigorous scientific investigation in order to attempt to delineate the factors underlying its form and content, with a particular focus on face perception. The innovative testing of face processing in Capgras delusion patients has enabled a more sophisticated understanding of normal face recognition.

To test the robustness of the present findings we are undoubtedly in need of replication with a larger sample size and a wider range of tasks. Despite these necessary cautions, to our knowledge this is the first study providing behavioural evidence of a specific association between autonomic functioning and eye movements in face recognition. Evidences of the relationship between subcortical processing and eye movements have been mainly referred to as effects of specific lesions or severe functional abnormalities in the amygdala associated with marked alterations in eye scanning paths. We suggest it should rather be explained as a moment by moment modulating activity, which proceeds on a continuum and that can be traced in psychiatric populations as well as in healthy subjects.

> Manuscript received 3 April 2006 Revised manuscript received 29 June 2006

REFERENCES

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature*, 433, 68–72.

- Dalton, K. M., Nacewicz, B. M, Johnstone, T., Schaefer, H. S., Gernsbacher, M. A., Goldsmith, H. H., et al. (2005). Gaze fixation and the neural circuitry of face processing in autism. *Nature Neuroscience*, 8, 519–526.
- Ellis, H. D., & Lewis, M. B. (2001). Capgras delusion: A window on face recognition. *Trends in Cognitive Science*, 5, 149–156.
- Ellis, H. D., Lewis, M. B., Moselhy, H., & Young, A. W. (2000). Automatic without autonomic responses to familiar faces: Differential components of implicit face recognition in a case of Capgras delusion. *Cognitive Neuropsychiatry*, 5, 255–269.

- Ellis, H. D., Quayle, A. H., & Young, A. W. (1999). The emotional impact of faces (but not names): Face specific changes in skin conductance responses to familiar and unfamiliar people. *Current Psychology*, 18, 88–97.
- Ellis, H. D., & Young, A. W. (1990). Accounting for delusional misidentifications. British Journal of Psychiatry, 157, 239–248.
- Ellis, H. D., Young, A. W., & Koenken, G. (1993). Covert face recognition without prosopagnosia. Behavioural Neurology, 6, 27–32.
- Ellis, H. D., Young, A. W., Quayle, A. H., & de Pauw, K. W. (1997). Reduced autonomic responses to faces in Capgras delusion. *Proceedings of the Royal Society: Biological Science*, 264, 1085– 1092.
- Emery, N. J. (2000). The eyes have it: The neuroethology, function and evolution of social gaze. *Neuroscience and Biobehavioral Reviews*, 24, 581–604.
- Glascher, J., & Adolphs, R. (2003). Processing of the arousal of subliminal and supraliminal emotional stimuli by the human amygdala. *Journal of Neuroscience*, 23, 10274–10282.
- Hirstein, W., & Ramachandran, V. S. (1997). Capgras syndrome: A novel probe for understanding the neural representation of the identity and familiarity of persons. *Proceedings of the Royal Society: Biological Science*, 264, 437–444.
- Irwin, D. E. (2004). Fixation location and fixation duration as indices of cognitive processing. In J. M. Henderson & F. Ferreira (Eds.), *The interface of language, vision, and action: Eye movements and the visual world* (pp. 105–133). New York: Psychology Press.
- Johnson, M. H. (2005). Subcortical face processing. Nature, 6, 766-774.
- Kawashima, R., Sugiura, M., Kato, T., Nakamura, A., Hatano, K., Ito, K., et al. (1999). The human amygdala plays an important role in gaze monitoring. *Brain*, 122, 779–783.
- Loughland, C. M., Williams, L. M., & Gordon, E. (2002). Schizophrenia and affective psychosis show different visual scanpath strategies for faces: A trait versus state-based distinction? *Biological Psychiatry*, 52, 338–348.
- Manor, B. R., Gordon, E., Williams, L. M., Rennie, C. J., Bahramali, H., Latimer, C. R., et al. (1999). Eye movements reflect impaired face processing in patients with schizophrenia. *Biological Psychiatry*, 46, 963–969.
- Perry, W., Felger, T., & Braff, D. (1998). The relationship between skin conductance hyporesponsivity and perseverations in schizophrenia patients. *Biological Psychiatry*, 15, 459–465.
- Rizzo, M., Hurtig, R., & Damasio, A. R. (1987). The role of scanpaths in facial recognition and learning. Annals of Neurology, 22(1), 41–45.
- Schweinberger, R., & Burton, M. (2003). Covert recognition and the neural system for face processing. *Cortex*, 39, 9–30.
- Tranel, D., & Damasio, A. R. (1985). Knowledge without awareness: An autonomic index of facial recognition by prosopoagnosics. *Science*, 228, 1453–1454.
- Tranel, D., Fowles, D. C., & Damasio, A. R. (1985). Electrodermal discrimination of familiar and unfamiliar faces: A methodology. *Psychophysiology*, 22, 403–408.
- Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neuroscience*, 6, 624–631.
- Williams, L. M., Liddell, B. J., Rathjen, J., Brown, K. J., Gray, J., Phillips, M., et al. (2004). Mapping the time course of nonconscious and conscious perception of fear: An integration of central and peripheral measures. *Human Brain Mapping*, 21, 64–74.
- Williams, L. M., Loughland, C. M., Gordon, E., & Davidson, D. (1999). Visual scanpaths in schizophrenia: Is there a deficit in face recognition? *Schizophrenia Research*, 40(3), 189–199.
- Williams, L. M., Loughland, C. M., Green, M. J., Harris, A. W., & Gordon, E. (2003). Emotion perception in schizophrenia: An eye movement study comparing the effectiveness of risperidone vs. haloperidol. *Psychiatry Research*, 120(1), 13–27.