Behavioural Neurology (1994), 7, 135–142

Reduplication of visual stimuli

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Investigation of P.T., a man who experienced reduplicative delusions, revealed significant impairments on tests of recognition memory for faces and understanding of emotional facial expressions. On formal tests of his recognition abilities, P.T. showed reduplication to familiar faces, buildings, and written names, but not to familiar voices. Reduplication may therefore have been a genuinely visual problem in P.T.'s case, since it was not found to auditory stimuli. This is consistent with hypotheses which propose that the basis of reduplication can lie in part in malfunction of the visual system.

Keywords: Delusions – Face recognition – Facial expressions – Reduplication – Voice recognition

INTRODUCTION

Reduplication is a curious phenomenon in which patients are convinced that people or things have exact or nearly exact duplicates (Weinstein and Burnham, 1991). Cases have been described involving reduplication of people [such as the Capgras delusion (Capgras and Reboul-Lachaux, 1923)], places [reduplicative paramnesia (Pick, 1903)] and everyday objects [e.g. the belief that one's possessions have been replaced (Anderson, 1988)]. For many years, accounts of reduplication of people, and especially the Capgras delusion, appeared mainly in the psychiatric literature whereas reduplicative paramnesia was considered a neurological problem, despite the fact that Pick's (1903) original report included a patient who reduplicated both people and places. However, studies showing the presence of brain disease in Capgras cases (Förstl *et al.*, 1991) have led to the recognition of an underlying similarity between these different forms of reduplication (Alexander *et al.*, 1979; Weinstein and Burnham, 1991).

Although the now frequent observation of brain disease in patients who show reduplication is obviously important, it does not in itself explain the strange content of these delusions. One promising approach is to argue that they reflect an interaction of impairments, in which some form of anomalous experience created by a cognitive or perceptual deficit is itself misinterpreted, thus giving rise to the delusion (Fleminger, 1992; Fleminger and Burns, 1993; Young *et al.*, 1993; Ellis and de Pauw, 1994).

In fact, a number of researchers take the view that reduplication is based on a combination of perceptual, memory and cognitive deficits (Benson *et al.*, 1976; Patterson and Mack, 1985; Kapur *et al.*, 1988). Since these may interact to create reduplicative delusions, the roles of different hypothesized causal factors need not necessarily be mutually exclusive; it is possible that some factors are more important than others in particular cases (Fleminger and Burns, 1993). However, it should still be possible to tease out their relative contributions.

A number of possible bases for the impairment underlying reduplication have been proposed. Here, we will distinguish six hypotheses which have been advanced.

(1) The *psychodynamic* hypothesis (Berson, 1983; Enoch and Trethowan, 1991) proposes that conflicting or ambivalent feelings of love and hate are resolved by the delusion (the "double" can be hated without guilt).
(2) The *cerebral hemisphere disconnection* hypothesis (Joseph, 1986) proposes that each cerebral hemisphere independently processes visual information, and that reduplicative delusions arise when the two processes fail to integrate.
(3) The *categorization failure* hypothesis (Cutting, 1991) suggests that reduplicative delusions reflect a disturbance in the judgement of identity or uniqueness, owing to a breakdown of the normal structure of semantic categories.

(4) The *memory deficit* hypothesis (Staton *et al.*, 1982) maintains that there is a failure in the updating of the patient's mental representations of familiar visual stimuli, and that reduplicative delusions result from the consequent mismatch between what is seen and its outdated representation.
(5) The Capgras delusion has been said to represent a state of *pathological unfamiliarity*, resembling a state of selective persisting *jamais vu* (Feinberg and Shapiro, 1989). Ellis and de Pauw (1994) have extended this by using Mandler's (1980) idea that recognition of a stimulus (in the sense of assigning it an identity learnt in previous encounters) is separate from the processing of familiarity, and suggesting that patients may lose the latter and retain the former.
(6) The *affective response* hypothesis argues that the basis of the Capgras and other reduplicative delusions lies in damage to neuro-anatomical pathways responsible for appropriate emotional reactions to familiar visual stimuli, and that the delusions represent the patients' attempts to make sense of the fact that these visual stimuli no longer have appropriate affective significance. This conception can be traced back to Brochado's (1936) description of a thesis by Derombies (1935), and has recently been emphasized by several authors (Anderson, 1988; Lewis, 1987; Ellis and Young, 1990; Weinstein and Burnham, 1991).

These hypotheses obviously differ in a number of ways, and are couched at different levels of description. For example, Hypotheses 5 and 6 are more closely related than the others, since they can each be seen as variants of a more general proposal of impaired processing of affective familiarity.

The available evidence suggests that Hypotheses 1 and 2 are unlikely to provide adequate accounts of reduplication. The cerebral hemisphere disconnection hypothesis (Hypothesis 2) has not been supported by empirical work (Ellis *et al.*, 1993). The psychodynamic hypothesis (Hypothesis 1) does not imply a direct role for brain disease, and hence has difficulty in accommodating the now frequent finding of an organic contribution. It is also difficult to see how reduplication of objects fits the psychodynamic view, even though the duplicate objects are often those with personal significance (Anderson, 1988), since it seems unlikely that objects would evoke the strongly ambivalent feelings required by the psychodynamic account. Furthermore, the attitudes of patients with the Capgras delusion to the "doubles" often fail to show the overt hostility which would be expected on the psychodynamic view (Wallis, 1986). In making these points we are not trying to deny that *psychological* factors may play a role in some or all cases of reduplication; we only seek to point out that the psychodynamic account is insufficient as a sole explanation.

The remaining hypotheses (Hypotheses 3–6) differ in the postulated mechanisms, and these differences predict differences in the patterns of cognitive impairment which should accompany reduplicative delusions; detailed testing of different cognitive abilities may thus prove useful in understanding them (Ellis and Young, 1990). A particularly striking difference of this type is that some hypotheses (primarily Hypotheses 4–6) treat reduplication as a malfunction of the visual recognition system, whereas on the categorization failure hypothesis (Hypothesis 3) the problem should arise regardless of input domain.

We report here a patient with reduplicative delusions in whom we investigated recognition of faces, names, objects and buildings to determine what defects there were in visual recognition, and also tested voice recognition to determine the extent to which reduplication might reflect a specific malfunction of the visual recognition system or a more general problem.

CASE DESCRIPTION

P.T. was a 41 year old single man who lived with his parents. He was first admitted in 1983 (when he was 33 years old) after becoming increasingly withdrawn, preoccupied with religion and with a belief that there was a conspiracy between several ex-workmates and the DHSS offices against him. He believed his thoughts were being controlled, that they were broadcast to other people, and that he heard the voices of others talking to him. At this time he also believed that John the Baptist had visited him, being sent by God in the guise of a charge nurse.

A diagnosis of paranoid schizophrenia was made, and P.T. responded well to neuroleptic medication. He was maintained in the community in a day centre until 1988, when he re-presented after decreasing his medication. He became deluded that the staff at the day centre were abusing the patients, and that his house was bugged. On this admission he described how he now believed that there were two distinct consultants looking after him. The first (named John Smith) was "a nice bloke", whereas the second (a Dr J. Smith) was someone who was "distant and aloof". P.T. was insistent that these were two separate individuals, both psychiatrists who could be "brothers or cousins".

He was again readmitted in late 1990, once again paranoid, self-neglectful and suspicious. He claimed that "poisonous gas" was being pumped into his house. He also claimed that furniture in his house had been "replaced" by exact replicas, consistent with an inanimate Capgras-like delusion. At times during this admission P.T. frequently claimed to know unfamiliar people from many years ago. For example, he thought that two student nurses whom he had not seen before were in fact cousins of his, this belief once again probably reflecting a delusional misidentification.

During this latest admission P.T. was investigated more fully. A computed tomography (CT) head scan was reported as normal. An electroencephalogram (EEG) showed almost continuous fairly rhythmic 2-6 Hz activity, bilaterally represented, and fairly frequent short bursts of rhythmic delta activity maximal in the mid and anterior temporal regions with a slight right hemisphere preponderance. Both features were enhanced by overbreathing, and the EEG was thought to contain more slow activity than is commonly found in schizophrenia. A later investigation by single photon emission tomography (SPECT) using a ^{99m}Tc PAO tracer was carried out when P.T.'s delusions had been controlled by medication. This showed reduced uptake anteriorly, more marked on the left side, with extension to include the temporal area on that side. These SPECT findings are consistent with other studies of blood flow in schizophrenia (Devous, 1989).

P.T. responded slowly to treatment with high-dose pimozide, no longer voicing his delusional ideas, and was eventualy discharged back to the community.

INVESTIGATION OF RECOGNITION ABILITIES

We were able to test P.T. whilst he was still making delusional misidentifications involving reduplication. These investigations were carried out in the first 2 months of his latest admission, during which there were several reported incidents.

During this period, P.T. was correctly oriented in time and place, and there was no evidence of impairment of basic visual functions, with normal spatial contrast sensitivity function on the Vistech VCTS6000 chart. He was initially suspicious about our purposes, however, thinking that we might be acting on behalf of the police to collect evidence against him. Despite this suspicion, he took part willingly when appropriate assurances were given.

The large number of tasks used can be divided into three types for convenience of exposition. These examined: (1) face processing, and recognition memory for faces and words; (2) person recognition from face, name or voice; and (3) recognition of everyday objects and recognition of buildings. For all of these tasks, P.T.'s performance was compared with that of 20 control subjects (10 men, 10 women) aged 30-49 years. This control group was well matched to P.T. on age (P.T. = 41 years; control mean = 40.30 years, S.D. = 7.16), and on predicted IQ using the revised version of the National Adult Reading Test (Nelson, 1991; P.T. = 110; control mean = 115.05, S.D. = 10.03).

TABLE I. P.T.'s performance on tests of facial expression labelling, unfamiliar face matching, and recognition memory for faces, words and pronounceable non-words

	P.T.	Controls	
		Mean	S.D.
Facial expressions			
Labelling	12/24***	22.05	1.99
Unfamiliar face matching			
Benton test	49/54	49.00	3.63
Disguise test	19/24	22.65	2.52
Recognition memory			
Warrington RMT: Faces	35/50***	45.65	3.22
Warrington RMT: Words	47/50	47.40	3.47
Recognition memory for non-words	42/50	44.20	3.52

Significantly impaired in comparison with the performance of controls: ***$z > 3.10$, $p < 0.001$.

Face processing and recognition memory for faces and words

Tasks using unfamiliar faces were given, to examine P.T.'s ability to determine facial expression and to match unfamiliar faces. He was also given a standard test involving recognition memory for faces and words (Warrington, 1984), and a variant of this test which we produced to assess recognition memory for pronounceable non-words. The results are summarized in Table I.

Facial expressions. Ability to recognize emotional facial expressions was tested with 24 photographs from the Ekman and Friesen (1976) series, presented one at a time with a list of six possible emotion labels printed below each face (Young *et al.*, 1990). The task required P.T. to choose the correct label describing the facial expression. He performed very poorly, both on initial testing (12/24 correct, shown in Table I) and on retesting 2 months later (15/24 correct, still below control mean at $p < 0.001$).

Unfamiliar face matching. The Benton Test of Facial Recognition (Benton *et al.*, 1983) was given.

TABLE II. P.T.'s ability to recognize familiar people from face, name or voice

	P.T.	Controls	
		Mean	S.D.
Identification of familiar faces			
High familiarity faces			
Familiarity	20/20[1]	18.16	1.42
Occupation	18/20[1]	17.68	1.80
Name	17/20[1]	15.53	3.29
Unfamiliar faces			
Correct rejections	9/20***	19.11	1.15
Identification of familiar names			
High familiarity names			
Familiarity	19/20	19.16	1.01
Occupation	19/20	19.05	0.97
Unfamiliar names			
Correct rejections	18/20	19.05	2.30
Identification of familiar voices			
Familiar voices			
Familiarity	21/30	22.45	4.27
Recognized	21/30	18.25	5.32
Named	17/30	14.35	6.60
Unfamiliar voices			
Correct rejections	10/10	9.20	0.83

[1] P.T. recognized most of the faces correctly, but made spontaneous comments about duplicates, e.g. "It's one of them Jimmy Saviles".
Significantly impaired in comparison with the performance of controls: ***$z > 3.10$, $p < 0.001$.

In this test, subjects have to choose which of six photographs of unfamiliar faces are pictures of the same person as a simultaneously presented target face photograph. The test includes items involving choice of identical photographs, as well as transformations of orientation or lighting, which are pooled to form an overall composite score. P.T.'s overall score (49/54 correct) was unimpaired both in terms of the test's norms and our own control data.

A second unfamiliar face matching test examined ability to match disguised faces. Two separate test sheets were used, each showing a 4 × 4 matrix of faces in which each of the four faces in the top row appeared three times in disguised or undisguised forms elsewhere on the sheet (Young *et al.*, 1990). P.T.'s accuracy was not significantly impaired at matching these faces ($z = 1.44$, $0.1 > p > 0.05$), but his performance of the task was slow and unusual in that all his errors involved refusals to accept that some of the faces appeared more than once or twice.

Recognition memory. The Warrington Recognition Memory Test (Warrington, 1984) was given. In this test, recognition memory is tested separately for faces and words. In the Faces part of the test, 50 faces are shown at the rate of one every 3 s for a "pleasant or unpleasant" decision, and recognition memory is then tested immediately by pressing each of the faces paired with a distractor, with the subject having to choose which has been seen before. A similar procedure is used with Words. P.T.'s score of 35/50 correct for the Faces part of the test was impaired in terms of the test's norms and our own control data (shown in Table I), and markedly different from his score of 47/50 correct on recognition memory for Words (significant Faces discrepancy score on the test's norms). A retest given 2 months later (not shown in Table I) produced no change in performance (Faces 33/50 correct; Words 46/50 correct).

To assess further P.T.'s recognition memory, we developed an equivalent test using pronounceable non-words, in which 50 non-words were shown at the rate of every 3 s for a "pleasant or unpleasant" decision, and then recognition memory was tested by presenting each of the non-words paired with a distractor, with the subject having to choose which had been seen before. The reasoning behind this was that we wanted to explore recognition memory for unfamiliar verbal stimuli. P.T.'s performance (42/50 correct, see Table I) was unimpaired.

Person recognition

Tests were used to assess P.T.'s ability to recognize familiar people from face, name or voice. Results of these are summarized in Table II.

Identification of familiar faces. Twenty highly familiar faces, 20 moderately familiar, and 20 unfamiliar faces, were presented one at a time in random order. For each face P.T. was asked whether or not it was a familiar person and, if so, his or her occupation and name. The data of interest concern P.T.'s ability to recognize as familiar and give correct occupations and names to the 20 highly familiar faces, and the rate at which the 20 unfamiliar faces were misidentified. Data for the moderately familiar faces are not included in Table II, because the control subjects showed high variance in their responses to these items.

P.T. was as accurate as control subjects at recognizing and identifying the highly familiar faces, but he made spontaneous comments about duplicates to some of the stimuli (2/20 highly familiar faces; 2/20 of the moderately familiar faces). For example, "It's one of them Jimmy Saviles". When asked what he meant by this, P.T. added that "It could be one of his brothers—there's lots of them." Similar comments to the effect that this was only one of a number of otherwise near-identical people with the same name

were made to photographs of Marilyn Monroe, Anna Ford and Diana Dors. In addition, P.T. showed a pronounced tendency to think that the unfamiliar faces were people he knew, with only 9/20 correct rejections of unfamiliar faces.

Because of his comments, P.T. was interviewed about the "doubles". He commented that "Some of them are bad—there's good ones and bad ones. They can switch from good to bad but it's not always the same person. You just think it is. There's more than one of them. You can just tell they're different, but you've got to be careful. Some people wouldn't notice." In line with his remarks, we observed that he continued to be very suspicious of many people, but he was no more noticeably so toward the duplicates.

Identification of familiar names. A parallel test to the familiar face recognition test was given, using written names of the 20 highly familiar people and 20 moderately familiar people from the face recognition test, interspersed with 20 unfamiliar names. For each name P.T. was asked whether or not it was a familiar person and, if so, his or her occupation. His performance was unimpaired, both in terms of recognition of highly familiar faces and rejection of unfamiliar names. There were a further two comments about duplicates, though both of these may have referred back to remarks he had previously made about the faces (Diana Dors and Anna Ford—in each case from the moderately familiar set).

Identification of familiar voices. It was not possible immediately to get recordings of the voices of all the people used in the face and name recognition tests. P.T. was therefore tested on a set of voices already available to us, which included 30 voices of famous people and 10 unfamiliar voices, recorded in clips of about 5 s duration each, with few useful cues to identify from the content of what they were saying. P.T. was asked whether or not each voice was familiar and, if so, to give the person's occupation and his or her name. He achieved a normal level of performance at recognizing the familiar voices, and made no comments about duplicates. All of the unfamiliar voices were correctly rejected.

These formal test results were backed up by several informal observations that P.T. did not make comments about duplicates to recordings of people's voices, whereas he made them to several photographs of faces.

Object recognition

As well as testing his ability to recognize familiar people, we examined P.T.'s ability to recognize objects and buildings. Data from these tasks are summarized in Table III.

TABLE III. P.T.'s ability to identify objects and buildings

	P.T.	Controls	
		Mean	S.D.
Identification of familiar objects			
Living	19/20	19.20	0.83
Non-living	20/20	19.55	0.76
Identification of familiar buildings			
Familiar buildings			
Recognized	16/20[1]	17.60	2.66
Named	15/20[1]	14.90	4.32
Unfamiliar buildings			
Correct rejections	10/10	9.45	0.60

[1] P.T. recognized most of the buildings correctly, but made spontaneous comments about duplicates, e.g. "The White House—but not as we know it—there are a few of them", "The Post Office Tower—but a different version of it", etc.

Identification of familiar objects. P.T. showed no problems in recognizing line drawings of objects. He correctly identified 19/20 drawings of living objects and 20/20 non-living objects from the set used by Young and Ellis (1989), and made no comments about duplicates. Of course, object recognition tests generally require only that an object is assigned to a general category (a horse, a hammer, etc.) rather than given a specific, individual identity. Hence, comments about an object being "one of them horses" or "one of them hammers" would in any case be less unusual.

Identification of familiar buildings. To test P.T.'s ability to assign individual identities in tests of object recognition, we used buildings. He was shown 20 photographs of familiar buildings (the White House, Sydney Opera House, etc.) and 10 photographs of grand but largely unfamiliar buildings, in random order, and asked whether each was familiar and, if so, what it was. Although P.T. had no problems in correctly recognizing or naming the famous buildings, there were again comments about duplicates for 6/20 famous buildings; "the White House—but not as we know it—there are a few of them", "the Post Office Tower—but a different version of it", etc. All of the unfamiliar buildings were correctly rejected.

DISCUSSION

P.T.'s clinical history included a number of incidents involving delusional misidentification. The most strik-

ing of these were of a reduplicative form, including the two consultants and the replica furniture in his house. The claim of duplicate consultants seems closely related to the Capgras delusion, but P.T. maintained that these consultants were two separate people, rather than that one was an impostor. However, there were also less easily classified incidents, including the charge nurse/John the Baptist, claims to know people from years ago, and the student nurses/cousins. Some of these inhabit the grey area between more general delusions and delusional misidentification, but others probably did reflect genuine misidentification.

On formal testing, P.T. showed reduplication of familiar faces and buildings, and some evidence of reduplication from written names (though we suspect that this might refer back to previous incidents with the same people's faces), but he did not reduplicate voices at all. Hence it appears that reduplication was a genuinely visual problem for P.T., since it was not found to auditory stimuli. Of course, we cannot prove that P.T. never reduplicated auditory stimuli; we can only note that he did not do so under any circumstances we observed, whereas he regularly reduplicated visual stimuli. Further studies of reduplication of visual and auditory stimuli in other cases should therefore be of interest.

The florid reduplications produced by P.T. in tests of recognition of buildings and faces are consistent with the idea that there is a parallel between reduplication of people and reduplication of places (Alexander *et al.*, 1979). This is particularly interesting because P.T. had not shown any clinical evidence of reduplication of places. The reduplicative delusions noted in his case history were primarily for people, with some relating to everyday objects.

Reduplication was found in visual tests for which P.T. had to assign a unique identity to visual stimuli (the White House, Jimmy Savile, etc.). In contrast, no problems were evident in tests of recognition of everyday objects, which only required recognition of the general category to which an object belongs (a cup, a guitar, etc.). However, it was clear from P.T.'s case history that he did reduplicate objects in everyday life when correspondingly required to assign them individual identities (he thought that *his* furniture had been replaced, etc.).

This finding that reduplication was only evident in tasks that required the assignment of a unique identity is reminiscent of the categorization failure hypothesis (Hypothesis 3). The fact that this only held for visual stimuli, however, is inconsistent with a strong form of this hypothesis, because models of semantic memory usually assume that visual and auditory stimuli access the same semantic representations. Any degradation of the semantic representations themselves should therefore affect both input modalities, rather than creating the specifically visual problem noted for P.T.

A deficit in assigning an unique identity to visual stimuli belonging to a common superordinate category has been considered by some authorities to be the cardinal feature of the neurological condition prosopagnosia (Damasio *et al.*, 1982). This is of interest because there have been attempts to draw parallels between prosopagnosia and one of the most widely recognized forms of reduplication, the Capgras delusion (Hayman and Abrams, 1977). The parallel has been bolstered by reports of fact processing impairments in Capgras patients (Shraberg and Weitzel, 1979; Tzavaras *et al.*, 1986), but in our view it needs to be treated cautiously. P.T. certainly did not show the inability to recognize familiar faces which is characteristic of prosopagnosia. Instead, he recognized just as many familiar faces as control subjects, but made comments about their being duplicates, and showed a pronounced tendency to produce false recognitions of unfamiliar faces.

The visual basis for P.T.'s reduplication fits most easily with those hypotheses (Hypotheses 4, 5 and 6) that propose a specific role for visual dysfunction. Additional support comes from the fact that P.T. showed a deficit in facial expression processing and impaired recognition memory for faces. However, a key issue relating to findings of face processing impairments or other visual problems in cases of reduplication concerns whether these deficits are instrumental in the production of reduplicative delusions, or arise coincidentally because of the nature of the underlying cerebral dysfunction. These problems of interpretation of associated deficits are widely recognized in neuropsychology.

Lewis (1987), Anderson (1988), and Ellis and Young (1990) have independently suggested that the basis of the Capgras and related reduplicative delusions lies in damage to neuro-anatomical pathways responsible for appropriate emotional reactions to familiar visual stimuli (Hypothesis 6). Since substantial parts of these pathways which imbue visual stimuli with affective significance are in close proximity to those involved in visual recognition (Bauer, 1984), one would expect that few brain disorders will compromise emotional reactions to visual stimuli without also affecting other visual functions to some extent, and this would be consistent with our observations of defective face processing abilities for P.T. On this hypothesis, P.T. showed defective face processing abilities because these are, for neuro-anatomical

reasons, likely to co-occur with the fundamental problem in affective reactions.

As would be expected on the hypothesis that reduplication is based on an interaction of deficits, it is possible that this dysfunction is coupled with another problem in forming correct judgements and attributions. P.T.'s SPECT scan revealed anterior as well as temporal blood flow abnormalities, which are consistent with Benson and Stuss's (1990) view that reduplicative phenomena implicate prefrontal areas involved in reality testing and self-analysis.

Our investigation of P.T., then, demonstrated a visual basis for reduplication which would fit most easily with those hypotheses (Hypotheses 4, 5 and 6) that propose a specific role for visual dysfunction. Of course, we do not claim that it is anything other than an empirical question whether this will prove to be so for all other cases involving reduplication. We suspect not from some of the other reports in the literature. For example, reports of the Capgras delusion in blind patients show that it cannot have an exclusively visual basis (Signer *et al.*, 1990; Rojo *et al.*, 1991; Reid *et al.*, 1993). Hence it may well turn out that there are parallel forms of impairment affecting other sensory modalities, or that ideas such as the categorization failure hypothesis (Hypothesis 3) are more appropriate in some cases than others.

To date, the classification of reduplicative delusions has largely been based on the type of material affected (people, places, etc.). Our findings suggest that, with the development of appropriate methods of investigation, it may eventually become possible to arrive at a more sophisticated classification of these delusions in terms of their functional basis. More generally, these findings further strengthen the view that significant advances in the understanding of delusional beliefs can be achieved by careful testing of underlying cognitive deficits (Ellis and de Pauw, 1994; Young, 1994; Young *et al.*, 1994).

Acknowledgements

We gratefully acknowledge the support provided by the EJLB Foundation, Canada. The SPECT scan was kindly performed by Dr H.J. Testa, Department of Nuclear Medicine, Manchester Royal Infirmary.

REFERENCES

Alexander MP, Stuss DT and Benson DF (1979) Capgras syndrome: a reduplicative phenomenon. *Neurology*, **29**, 334-339.

Anderson DN (1988) The delusion of inanimate doubles. Implications for understanding the Capgras phenomenon. *British Journal of Psychiatry*, **153**, 694-699.

Bauer RM (1984) Autonomic recognition of names and faces in prosopagnosia: a neuropsychological application of the guilty knowledge test. *Neuropsychologia*, **22**, 457-469.

Benson DF and Stuss DT (1990) Frontal lobe influences on delusions: a clinical perspective. *Schizophrenia Bulletin*, **16**, 403-411.

Benson DF, Gardner H and Meadows JC (1976) Reduplicative paramnesia. *Neurology*, **26**, 147-151.

Benton AL, Hamsher K de S, Varney N and Spreen O (1983) *Contributions to Neuropsychological Assessment: a Clinical Manual.* Oxford University Press, Oxford.

Berson RJ (1983) Capgras' syndrome. *American Journal of Psychiatry*, **140**, 969-978.

Brochado A (1936) Le syndrome de Capgras. *Annales Médico-Psychologiques*, **15**, 706-717.

Capgras J and Reboul-Lachaux J (1923) L'illusion des "sosies" dans un délire systématisé chronique. *Bulletin de la Société Clinique de Médicine Mentale*, **11**, 6-16.

Cutting J (1991) Delusional misidentification and the role of the right hemisphere in the appreciation of identity. *British Journal of Psychiatry*, **159**, 70-75.

Damasio AR, Damasio H and Van Hoesen GW (1982) Prosopagnosia: anatomic basis and behavioural mechanisms. *Neurology*, **32**, 331-341.

Derombies M (1935) L'illusion de sosies, forme particulière de la méconnaissance systématique. Thèse de Paris, Paris.

Devous MD (1989) Blood flow in schizophrenia. In: *Brain Imaging: Applications in Psychiatry* (Ed. NC Andreasen), pp. 195-204. American Psychiatric Press.

Ekman P and Friesen WV (1976) *Pictures of Facial Affect.* Consulting Psychologists Press, Palo Alto, CA.

Ellis HD and de Pauw KW (1994) The cognitive neuropsychiatric origins of the Capgras delusion. In: *The Neuropsychology of Schizophrenia* (Eds AS David and JC Cutting), pp. 317-335. Lawrence Erlbaum, Hove.

Ellis HD and Young AW (1990) Accounting for delusional misidentifications. *British Journal of Psychiatry*, **157**, 239-248.

Ellis HD, de Pauw KW, Christodoulou GN, Papageorgiou L, Milne AB and Joseph AB (1993) Responses to facial and non-facial stimuli presented tachistoscopically in either or both visual fields by patients with the Capgras delusion and paranoid schizophrenics. *Journal of Neurology, Neurosurgery and Psychiatry*, **56**, 215-219.

Enoch MD and Trethowan WH (1991) *Uncommon Psychiatric Syndromes*, 3rd edn. Butterworth-Heinemann, Oxford.

Feinberg TE and Shapiro RM (1989) Misidentification-reduplication and the right hemisphere. *Neuropsychiatry, Neuropsychology and Behavioral Neurology*, **2**, 39-48.

Fleminger S (1992) Seeing is believing: the role of 'preconscious' perceptual processing in delusional misidentification. *British Journal of Psychiatry*, **160**, 293-303.

Fleminger S and Burns A (1993) The delusional misidentification syndromes in patients with and without evidence of organic cerebral disorder: a structured review of case reports. *Biological Psychiatry*, **33**, 22-32.

Förstl H, Almeida OP, Owen AM, Burns A and Howard R (1991) Psychiatric, neurological and medical aspects of misidentification syndromes: a review of 260 cases. *Psychological Medicine*, **21**, 905-910.

Hayman MA and Abrams R (1977) Capgras' syndrome and cerebral dysfunction. *British Journal of Psychiatry*, **130**, 68-71.

Joseph AB (1986) Focal central nervous system abnormalities in patients with misidentification syndromes. *Bibliotheca Psychiatrica*, **164**, 68-79.

Kapur N, Turner A and King C (1988) Reduplicative paramnesia: possible anatomical and neuropsychological mechanisms. *Journal of Neurology, Neurosurgery and Psychiatry*, **51**, 579-581.

Lewis SW (1987) Brain imaging in a case of Capgras' syndrome. *British Journal of Psychiatry*, **150**, 117-121.

Mandler G (1980) Recognizing: the judgment of previous occurrence. *Psychological Review*, **87**, 252-271.

Nelson HE (1991) *National Adult Reading Test (NART): Test Manual* (revised). NFER-Nelson, Windsor.

Patterson MB and Mack JL (1985) Neuropsychological analysis of a case of reduplicative paramnesia. *Journal of Clinical and Experimental Neuropsychology*, **7**, 111-121.

Pick A (1903) Clinical studies: III. On reduplicative paramnesia. *Brain*, **26**, 260-267.

Reid I, Young AW and Hellawell DJ (1993) Voice recognition impairment in a blind Capgras patient. *Behavioural Neurology*, **6**, 225-228.

Rojo VI, Caballero L, Iruela LM and Baca E (1991) Capgras' syndrome in a blind patient. *American Journal of Psychiatry*, **148**, 1272.

Shraberg D and Weitzel WD (1979) Prosopagnosia and the Capgras syndrome. *Journal of Clinical Psychiatry*, **40**, 313-316.

Signer SF, Van Ness PC and Davis RJ (1990) Capgras's syndrome associated with sensory loss. *Western Journal of Medicine*, **152**, 719-720.

Staton RD, Brumback RA and Wilson H (1982) Reduplicative paramnesia: a disconnection syndrome of memory. *Cortex*, **18**, 23-26.

Tzavaras A, Luauté JP and Bidault E (1986) Face recognition dysfunction and delusional misidentification syndromes (DMS). In: *Aspects of Face Processing* (Eds HD Ellis, MA Jeeves, F Newcombe and A Young), pp. 310-316. Martinus Nijhoff, Dordrecht.

Wallis G (1986) Nature of the misidentified in the Capgras syndrome. *Bibliotheca Psychiatrica*, **164**, 40-48.

Warrington EK (1984) *Recognition Memory Test*. NFER-Nelson, Windsor.

Weinstein EA and Burnham DL (1991) Reduplication and the syndrome of Capgras. *Psychiatry*, **54**, 78-88.

Young AW (1994) Recognition and reality. In: *The Neurological Boundaries of Reality* (Ed. EMR Critchley), pp. 83-100. Farrand, London.

Young AW and Ellis HD (1989) Childhood prosopagnosia. *Brain and Cognition*, **9**, 16-47.

Young AW, Ellis HD, Szulecka TK and de Pauw KW (1990) Face processing impairments and delusional misidentification. *Behavioural Neurology*, **3**, 153-168.

Young AW, Reid I, Wright S and Hellawell DJ (1993) Face-processing impairments and the Capgras delusion. *British Journal of Psychiatry*, **162**, 695-698.

Young AW, Leafhead K and Szulecka TK (1994) The Capgras and Cotard delusions. *Psychopathology*, **27**, 226-231.

(Received 30 November 1993; accepted as revised 27 October 1994)