A COGNITIVE NEUROPSYCHOLOGICAL APPROACH TO THE STUDY OF DELUSIONS IN LATE-ONSET SCHIZOPHRENIA

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ABSTRACT

Objective. Hypotheses to explain delusion formation include distorted perceptual processing of meaningful stimuli (eg faces), abnormal reasoning, or a combination of both. The study investigated these hypotheses using standardized neuropsychological tests.

Design. A three-patient case-study, compared with a small group (n = 8) of age-matched normal control subjects.

Setting. Hospital in- and outpatients. Age-matched normal controls were from local residential homes.

Patients. Three subjects with late-onset schizophrenia, two currently deluded and one in remission. Both deluded subjects had persecutory beliefs. One had a delusion of misidentification.

Interventions. All subjects were administered standardized neuropsychological tests of facial processing and tests of verbal reasoning.

Main outcome measures. The test scores of the three patients were compared with published normal values and the age-matched control data.

Results. The tests demonstrated impaired matching of unfamiliar faces in deluded subjects, particularly in the subject with delusional misidentification. Increasing the emotional content of logical reasoning problems had a significant effect on the deluded subjects’ reasoning but not that of the normal controls.

Conclusion. The findings suggest impaired visual processing plus abnormal reasoning in deluded subjects. However, these impairments are relatively subtle given the severity of psychiatric disorder in the patients studied.

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Delusions are a defining feature of psychosis. Recently, there has been a reemergence of interest in the employment of the cognitive neuropsychological approach in the study of psychiatric phenomena (David, 1993). Two main hypotheses for delusion formation have been proposed. The first, linked with Maher (1974), proposes that delusions are the result of normal reasoning or logic attempting to provide explanations for primary abnormal perceptions such as hallucinations. This view cannot explain the presence of delusions in the absence of abnormal perceptions (but see David and Howard, 1994) or the presence of different delusional beliefs in various subjects with similar abnormal perceptions (Chapman and Chapman, 1988).

A second hypothesis has been proposed in which it is suggested that delusions result from abnormal reasoning. Various studies have provided evidence for this in subjects with paranoid delusions, who demonstrate a tendency to reach decisions on the basis of little information—ie ‘jump to conclusions’ (Brennan and Hemsley, 1984; Hemsley and Garety, 1986; Huq et al., 1988; Bentall et al., 1991; Garety et al., 1991). Many such studies have employed probabilistic reasoning tasks or have measured attributional style. Tests of logical reasoning, such as syllogisms, have been demonstrated to lead to errors in both non-deluded and deluded patients (von Domarius, 1944) as well as normal subjects (Johnson-Laird et al., 1972; Byrne, 1989; Evans et al., 1993). It has been
suggested (Chapman and Chapman, 1988) that if the nature of reasoning problems were more emotive or threatening, or overlapped with delusional content, this would lead to a worsening of performance. This has not been systematically tested to date.

The content of delusions across cultures often revolves around a person’s relationship to others and role in society rather than neutral or impersonal themes, such as delusions of persecution, reference, grandiosity, jealousy, etc (Brennan and Hemsley, 1984; Bentall et al., 1991). The importance of social context has been highlighted by research on social cognition in deluded subjects such as the attribution of motives and drives to characters in fictional scenes (Bentall et al., 1991). Tests of reasoning with a social context or meaning may, therefore, be performed differently by deluded compared with non-deluded subjects.

If perception and reasoning are to be tested in a socially meaningful way, then it is important that both perceptual stimuli and reasoning tasks are of social relevance. For this reason, human faces make ideal stimuli, since they convey a wealth of social information: expression, age, gender, familiarity and identity (Ellis and Young, 1988). Many studies have provided evidence of abnormal facial processing in subjects with delusional misidentification or schizophrenia (see Phillips and David, 1995). It has been suggested that subjects with delusional misidentification may have more specific facial processing deficits and/or abnormal reasoning depending upon the exact nature of the delusion (Ellis and Young, 1990, in press; Young et al., 1990, 1993).

There is thus evidence for the presence both of abnormal reasoning in deluded subjects, particularly in those with persecutory delusions, and of abnormal processing of socially relevant visual information, namely human faces. Specific facial processing deficits have been demonstrated in subjects with delusional misidentification, whereas a more global impairment has been found in subjects with schizophrenia (Archer et al., 1992). Our aim is to study face perception and non-abstract reasoning and relate this to paranoid delusions. It is therefore important to include a visual perceptual task utilizing stimuli without social relevance, such as tests of space perception, as a control task. In this way, the relative contributions of abnormal reasoning and specific facial processing deficits in the formation of paranoid delusions can be investigated.

Patients with late-onset schizophrenia (sometimes referred to as late paraphrenia) are ideal subjects for the above investigation. They often have well-defined persecutory delusions without the cognitive deficits present in many younger-onset schizophrenic subjects (Howard and Almeida, 1993).

It is also clearly important to control for any confounding effects of medication on perceptual and reasoning tasks. Although it has been demonstrated that neuroleptics are not associated with impairment in performance on cognitive tasks in schizophrenic patients, anticholinergics have been found to disrupt verbal memory (Spohn and Strauss, 1989). Ideally, therefore, patients should be on low doses of medication or medication-free.

We undertook to identify facial processing and/or reasoning deficits using a detailed case-study approach in two late-onset schizophrenic patients with persecutory delusions and a patient in remission, in an attempt to further the understanding of persecutory delusion formation. Normative data of many neuropsychological tests do not include results from elderly (>75 years of age) subjects. In order to control for the effect of age on test performance in the three patients studied, we therefore included a small group of elderly normal controls in the study. The hypotheses were:

1(a). Patients with current persecutory delusions would demonstrate specific facial processing deficits compared with age-matched normal control subjects and non-deluded schizophrenics.

(b). The exact nature of the deficits would relate to the content of the delusions.

2. Patients with delusions would not demonstrate any deficits compared with recovered patients in the perception of visual stimuli devoid of social salience, although both patient groups would be expected to perform less well than normal controls.

3. Patients with persecutory delusions would demonstrate abnormalities in syllogistic and conditional reasoning tests compared with normal control subjects.

METHOD

Subjects

Ethical approval was obtained for the study. Subjects included two symptomatic late-onset
schizophrenics (satisfying DSM-IV criteria for a diagnosis of schizophrenia but with illness onset after 60 years of age) and one patient who was currently asymptomatic. Descriptions of the symptomatology of the three patients are given below. Eight age-matched normal controls recruited from residential homes in the catchment area of the Maudsley Hospital were also tested.

Subjects underwent preliminary tests of visual acuity (near vision), premorbid IQ (NART, the National Adult Reading Test, Nelson and O’Connell, 1978) and cognitive functioning (the Mini-Mental State Examination, Folstein et al., 1975). Subjects were excluded if they had a history of organic brain injury, if they were unable to see the test stimuli clearly, or if scores on the MMSE were less than 24/30. All subjects had similar IQ scores (108–124)—necessarily above average in view of the difficulty of some of the reasoning tasks. In addition, a record of years of education was made and, where appropriate, duration of illness and number of admissions to hospital. Details are given in Table 1.

**Patient 1**

This 80-year-old lady presented with a 5-year history of a well-systematized persecutory delusion. She believed that her neighbour was torturing and spying on her and was a man dressed in the guise of a woman. She believed that special ‘pipes’ were being moved underneath the floor from the neighbour’s house by electricity or gas. The pipes had claws which were used to hold and rape her. She believed that she could see the pipes in certain lights only, and that they appeared to fluoresce. Such events often occurred at night. In addition, she believed that the neighbour used an electric ray to control her, and that this could be heard ‘crackling’ on occasions. She believed that she could be controlled by the neighbour so that she would sometimes drop objects or write illegibly. Although she acknowledged that her beliefs sounded ‘silly’, they were held with full conviction. She did not believe that she had a psychiatric illness. She was not compliant with medication, although she had one admission to a psychiatric hospital in the past. She was otherwise functioning well and living independently. She scored 0/14 on the schedule for assessing the three components of insight (treatment compliance, awareness of illness and correct relabelling of psychotic experiences; David, 1990). A magnetic resonance imaging (MRI) brain scan was reported as normal.

**Patient 2**

This was an 87-year-old lady with a 6-year history of depression following a bereavement. She had developed psychotic symptoms 3 years previously. She presented with a short history (a few weeks only) of a delusion involving the IRA. Her suspicions had been aroused initially by the visit of a ‘lady in black’ to her apartment who had started to talk about one subject and then had abruptly changed the topic. It appears that the lady was the warden of the complex and was not recognized by the patient. Afterwards, the patient felt that the lady was part of an IRA plot and may not have been the warden. A visit by a workman added to her suspicions. This man apparently told her that he had come to pay back some money and then said that he had ‘put things in between the floorboards’ of her room. The patient believed that the water in her bathroom never drained away properly after that visit. She later reasoned that the man had

<table>
<thead>
<tr>
<th>Table 1. Comparison of normal controls and patients</th>
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<tbody>
<tr>
<td><strong>Status</strong></td>
</tr>
<tr>
<td>Age (tr)</td>
</tr>
<tr>
<td>Near visual acuity</td>
</tr>
<tr>
<td>IQ (NART)</td>
</tr>
<tr>
<td>MMSE*</td>
</tr>
<tr>
<td>Education (yr)</td>
</tr>
<tr>
<td>Psychotropic mediation</td>
</tr>
</tbody>
</table>

NC, normal control; P1, deluded patient; P2, deluded patient with delusional misidentification; P3, asymptomatic patient; n, normal near visual acuity with/without spectacles.

*Scores on the Mini-Mental State Examination (max. 30).
placed ‘listening devices’ in between her floorboards. At the same time, she began noticing that the other residents were looking at her in a strange way and believed that they were spying on her. Shortly afterwards, the patient was admitted to hospital and was commenced on thioridazine and dothiepin. Of note in the medical history was a history of hypertension and angina. At the time of testing, the patient continued to demonstrate the above delusional system with very limited insight into the nature of her illness. She was, however, compliant with treatment. Her insight score was 5/14. Neurological examination was unremarkable.

Patient 3

This was a 75-year-old lady who had experienced a well systematized persecutory delusion 4 years earlier. Her belief had involved her priest, who, she felt, was controlling her mind and body. On occasions she heard the voice of the priest despite not being able to see him. She also believed that the priest interrupted her thoughts with his own. Despite no longer experiencing such symptoms, she was able to give an accurate description of her previous illness. She had had five admissions for the illness in the past, but was not taking any medication. She demonstrated insight into the nature of her illness, believing that she had had a psychiatric illness which required treatment, but that she was currently well. An MRI brain scan was reported as normal.

There were eight age-matched normal control subjects recruited from a local day centre and residential home. All subjects performed the following tests:

1. Tests of facial perception

   (i) Judgement of facial expression. Standard set of facial expressions (Ekman and Friesen, 1976) (happy, sad, angry, surprised, neutral), which the subject is asked to identify.

   (ii) Facial recognition. Recognition Memory Test (Warrington, 1984), which has a forced choice design, scored out of 50.

   (iii) Facial matching. Benton test of facial matching (short version; Benton et al., 1983). The procedure involves the matching of identity of one target face with one or more of six face choices photographed at different levels of illumination.

(iv) Recognition of famous faces. Subjects were asked to identify by occupation (TV/sports/Royal Family/politics) (and later name if possible) the black-and-white photographs of faces of 10 well-known celebrities. These varied in age and the extent to which they were then seen in the media. The photographs were black-and-white photographs selected from the Picture Library of the Press Museum (see Appendix). There were also four control photographs: similar-sized photographs of four unfamiliar people. Subjects scored even if they could only identify the occupation without naming the face.

2. Visual Object and Spatial Perception Test (VOSP) (Warrington and James, 1991)

   This comprises four subtests of object perception and four of space perception. The tests of object perception include: recognition of incomplete letters; recognition of animal and object silhouettes; an object decision task involving a one-of-four choice in identifying the silhouette of a real as opposed to unreal object; a decision task in which the subject identifies the object in a series of progressively more informative silhouettes. The tests of space perception include: dot counting; position discrimination; number location; and cube analysis. Results are recorded in terms of pass/fail for each subtest according to a response rate above or below the 5% threshold, respectively.

3. Verbal reasoning tests

   Subjects completed two types of reasoning task, conditionals and syllogisms. These were presented to subjects in the form of two questionnaire booklets. Subjects were instructed to read the information at the beginning of each question in each questionnaire and then choose one of the given answers by ticking or circling the response with a pen.

   The tests were adapted from Evans et al. (1993) (Krasucki et al., 1995). The conditional reasoning task consisted of 40 reasoning problems of the form: ‘If p then q’, phrased in everyday language, eg ‘If she meets her friend (“p”) then she will go to a play (“q”). For each such statement, there were four questions to answer:

   (i) If p, what follows? (valid inference: q—the ‘modus ponens’ (MP));

   (ii) If not q, what follows? (valid inference: not p—the ‘modus tollens’ (MT));
(iii) If not p, what follows? (fallacy: not q—the ‘denial of the antecedent (DA));
(iv) If q, what follows? (fallacy: p—the ‘affirmation of the consequent’ (AC)).

The correct response to DA and AC tasks is ‘cannot say’.

The normal tendency to make the above valid inferences and fallacies can be changed by manipulations to the statement: ‘If p then q’. The provision of alternative premises (‘If r then q’—as an alternative to ‘if p then q’—eg ‘If she has enough money (“r”) then she will go to a play (“q”)’) should lead to a reduction of the endorsement of fallacies (DA and AC) while having no effect on valid inferences (MP and MT) in normal control subjects. The provision of additional premises (‘If r then q’—as an addition to ‘if p then q’—eg ‘If she meets her family (“r”) then she will go to a play (“q”)’) should lead to the suppression of valid inferences while having no effect on the fallacies (Byrne, 1989). Conditional reasoning tasks with content previously judged as emotive by a group of normal controls were included in order to investigate the effect of this on the responses. An example of a ‘high emotive’ syllogism is:

We continue to learn more and more about what happened in World War II.
No Germans are innocent.
Some Nazi war criminals are innocent.
Let us agree that what has just been said is true.
Does it follow that:
Some Nazi war criminals are not German?
True/false (vu)
Etc. . .

(All stimuli are available from the authors on request)

RESULTS

Facial perception

The results for the facial perception tasks are given in Table 2. The scores of the three patients were compared with the mean score and range of the eight elderly normal controls using z-scores. All three patients performed well on the test of facial expression perception, scoring 84% or more correct, within or greater than the range of the elderly normal control group. All three patients scored 70% or more correct on the Recognition Memory Test for faces, with P1 performing at a lower level than the elderly normal controls, but within their range (z-score = −0.61), and P2 and P3 performing at a higher level than the elderly normal controls (z-scores 2.75 and 2.75, respectively; p (two-tailed) < 0.01).

In the Benton facial matching test, all three patients performed within the elderly normal control range (z-scores = −0.53, −0.93 and 0.27, respectively, for P1–P3). For the famous faces recognition test, all three patients also had scores within the normal elderly control range. The results of the tests of facial perception were, therefore, contrary to those predicted in the first hypothesis, with all three patients performing well in most of the tests. There was, however, a non-significant trend for P1 (patient with persecutory
delusions only) to have relatively lower scores on unfamiliar face recognition (RMT) and unfamiliar face matching (Benton), and for P2 (patient with both persecutory delusions and delusional misidentification) to have lower scores on the Benton test and famous faces recognition test.

**Visual Object and Spatial Perception Test (VOSP)**

The results of the VOSP are shown in Table 2. All three patients scored well on tests of object and space perception, especially the former, confirming the second hypothesis above. Surprisingly, the elderly normal controls had difficulty with the object perception tests. Further analysis revealed that this was the result of poorer performance by the elderly controls compared with the published normative data of Warrington and James on the subtest of silhouette recognition.

**Verbal reasoning tests**

The results for normal control subjects and patients in the conditional and syllogistic reasoning tasks are shown in Figs 1(a) and 1(b) and Tables 3(a) and 3(b), respectively. The pattern of results across tasks and between subjects is of most interest. We have performed some statistical tests to complement these, however. In the conditional reasoning tasks, chi-squared tests were performed with Yates’ continuity correction for the total number of responses endorsed in the normal control and patient groups for valid inferences and fallacies in the simple, alternative and additional forms with and without emotive content. Addition of emotive content had a non-significant effect in the normal control subject group (chi-squared = 1.56; \( p > 0.1 \)), but resulted in a significant reduction in the number of responses endorsed in the patients (one-tailed Fisher Exact Test \( p = 0.05 \)).

The overall effect of the alternative compared with the simple premise was a near-significant reduction in number of responses endorsed (chi-squared = 3.2; \( p = 0.07 \)), especially in the patient group (one-tailed Fisher Exact Test \( p = 0.001 \)). The effect of the additional premise on the number of responses endorsed was non-significant overall (chi-squared = 1.18; \( p > 0.1 \))

### Table 2. Results of facial perception and VOSP tests

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean NC</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekman-Friesen*</td>
<td>81 (64–88)</td>
<td>84</td>
<td>88</td>
<td>96</td>
</tr>
<tr>
<td>RMT faces*</td>
<td>74 (68–88)</td>
<td>70</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>Benton*</td>
<td>74 (63–87)</td>
<td>70</td>
<td>67</td>
<td>76</td>
</tr>
<tr>
<td>(normal)</td>
<td>(mod. impd)</td>
<td>(sev. impd)</td>
<td>(normal)</td>
<td></td>
</tr>
<tr>
<td>Famous faces*</td>
<td>76 (57–96)</td>
<td>100</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>(mod. impd)</td>
<td>(sev. impd)</td>
<td>(normal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOSP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object</td>
<td>62.5 (25–75)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Space</td>
<td>87.5 (25–100)</td>
<td>75</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

*Percentage scores.

Notes
1. Numbers in brackets for the normal controls refer to the range.
2. Statements regarding impairment refer to published norms.

### Table 3(a). Syllogistic reasoning results in normal controls

<table>
<thead>
<tr>
<th>Response category</th>
<th>% endorsed</th>
<th>vb</th>
<th>ib</th>
<th>vu</th>
<th>iu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-emotive*</td>
<td></td>
<td>96</td>
<td>88</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td>Emotive</td>
<td></td>
<td>97</td>
<td>82</td>
<td>47</td>
<td>32</td>
</tr>
<tr>
<td>High-emotive</td>
<td></td>
<td>92</td>
<td>92</td>
<td>71</td>
<td>63</td>
</tr>
<tr>
<td>Overall emotive†</td>
<td></td>
<td>95</td>
<td>97</td>
<td>59</td>
<td>48</td>
</tr>
</tbody>
</table>

*Total of 3 questions in each of the four categories (vb, ib, vu, iu) in the simple form.
†Total of 7 questions in each of the four categories (vb, ib, vu, iu) in the overall emotive form.

### Table 3(b). Syllogistic reasoning in patients P1–3

<table>
<thead>
<tr>
<th>Response category</th>
<th>% endorsed</th>
<th>vb</th>
<th>ib</th>
<th>vu</th>
<th>iu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-emotive*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>100</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>100</td>
<td>100</td>
<td>33</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>100</td>
<td>100</td>
<td>67</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Emotive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>100</td>
<td>75</td>
<td>50</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>100</td>
<td>75</td>
<td>0</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>100</td>
<td>75</td>
<td>50</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>High-emotive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>100</td>
<td>67</td>
<td>100</td>
<td>33</td>
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<tr>
<td>P2</td>
<td>100</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>100</td>
<td>71</td>
<td>71</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Overall emotive†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>100</td>
<td>71</td>
<td>75</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>84</td>
<td>88</td>
<td>17</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>100</td>
<td>71</td>
<td>59</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

*Total of 3 questions in each of the four categories (vb, ib, vu, iu) in the simple form.
†Total of 7 questions in each of the four categories (vb, ib, vu, iu) in the overall emotive form.

and for the normal control group (chi-squared = 0.03; \( p > 0.5 \)), but resulted in a significant reduction in the number of responses endorsed in the patient group (one-tailed Fisher Exact Test \( p = 0.01 \)).

The overall significant effect of emotive content in reducing the number of responses endorsed in the patient group was found to be due to the highly significant effect of this in reducing the number of valid responses endorsed in the additional premise (two-tailed Fisher Exact Test \( p = 0.001 \)), ie an exaggeration of the normal response to the addition of an additional premise, in which the number of valid responses is reduced. There were no other significant effects of the addition of emotive content in the patient group.

In the syllogistic reasoning task, both normal elderly controls and patients had a similar pattern of response, in that invalid but believable (ib) statements were endorsed to a greater extent than valid but unbelievable (vu) statements, with the highest proportion of endorsed responses in the valid believable (vb) category and the lowest in the invalid unbelievable (iu) category.
Believable statements were endorsed to a highly significantly greater extent than unbelievable statements overall (chi-squared = 106.67; \( p < 0.0001 \)) and in each of the two subject groups (chi-squared = 72.49; \( p < 0.0001 \), and chi-squared = 32.00; \( p < 0.0001 \), for normal controls and patients respectively). Valid statements were not endorsed to a significantly greater extent than invalid statements overall, although the patients appeared to be influenced by validity to a greater extent than normal controls, especially for unbelievable statements without emotive content. The effect of addition of emotive content on the number of responses endorsed was non-significant for both normal controls and patients, although a tendency for all subjects to endorse unbelievable items with emotive content was observed. Thus, the tendency for patients in particular to be influenced by validity in the endorsement of unbelievable statements was reduced when such statements had emotive content.

**DISCUSSION**

The aim of the study was to determine the respective roles of sensory information processing and/or reasoning deficits in the formation of delusions. In order to investigate this, a detailed case-study approach was adopted. Three late-onset schizophrenic subjects, one subject with marked persecutory delusions, one subject with persecutory delusions and delusional misidentification and one subject currently asymptomatic were investigated. Only one was prescribed psychotropic medication, but was not taking any anticholinergic medication. It is unlikely, therefore, that that medication had a significant effect on performance. The results were compared with those of eight age-matched normal control subjects, of whom only one was taking psychotropic but not anticholinergic medication.

The study produced some interesting results. All three patients performed well in tests of visual and space perception, as predicted in hypothesis 2 above. There were, however, no specific facial processing deficits demonstrated for either of the deluded patients. The patient with delusional misidentification (P2) performed slightly less well in the test of famous face recognition compared with the other facial perceptual tasks. This suggests that delusional misidentification may be related to impaired facial familiarity recognition, as proposed in the first hypothesis, although the results are far from conclusive. It is possible that the tests were not sensitive enough to elicit the specific impairments in facial processing in the deluded patients. Young et al. (1990) suggested that the utilization of tests of more specific aspects of facial processing, such as the recognition of ‘disguised’ faces, would be appropriate in the investigation of delusional misidentification. Archer et al. (1992) have also attempted to standardize the different tests of various aspects of facial processing in order to control for different levels of difficulty. This is important, in view of the different levels of memory requirement for the individual face perceptual tasks. Such procedures could be employed in further investigation of visual perception and reasoning in deluded subjects.

Patients with a history of delusions had a similar pattern of response in both conditional and syllogistic reasoning tasks to that of the elderly normal controls, but appeared to be influenced to a greater extent than the latter in the conditional reasoning tasks by the presence of emotive content. The overall effect of increasing emotive content led to a significant reduction in number of responses endorsed, that is, a more conservative response bias, in the patients, with a large reduction in endorsement of valid responses in the additional premise. Increasing emotive content did not have a significant effect on the number of responses endorsed in either subject group in the syllogistic reasoning tasks.

The results suggest, therefore, that deluded subjects may be persuaded to alter previous, more ‘logical’ responses to a greater extent than normal controls in the context of emotive content. Early work investigating syllogistic reasoning in normal subjects demonstrated that logical reasoning could be influenced by beliefs concerning emotive topics (Leford, 1946). Indeed, the tendency of deluded subjects to be influenced by prior beliefs and assumptions in a conditional reasoning task has been demonstrated in a schizophrenic subject with a somatic delusion in a recent case study (Krasucki et al., 1995). It would be particularly interesting in future studies to investigate the effect of employing tasks with content similar to that of the delusion held by the patient. It might be hypothesized that in such tasks, deluded patients perform more ‘logically’ than normal controls, with the former endorsing logical but unbelievable statements while the latter fail to endorse such statements because of their unbelievable (ie delusion-congruent) content.
Are the impairments demonstrated in the deluded patients causal or maintaining factors with respect to delusion formation? In his model of belief acquisition, Bentall has indicated that inferences and beliefs arise following initial perceptual experiences, and that individuals may seek to corroborate or refute such beliefs at a later stage by searching for further information (Bentall, 1990). A similar model has been proposed by Garety and Hemsley (1995). On the other hand, the influence of prior beliefs on perceptual experiences has been emphasized by Fleminger (1992), and is incorporated into the model of Garety and Hemsley (1995), highlighting the difficulty in distinguishing causal and maintaining factors. Support for the hypothesis that perceptual impairments act primarily as causal and reasoning abnormalities as maintaining factors in delusion formation would be obtained if it could be demonstrated that the longer the duration of the delusion, then the greater the probability of such reasoning abnormalities existing.

The current study has demonstrated the presence of subtle abnormalities in visual perception and reasoning in deluded patients, in the face of floridly abnormal beliefs. Future research employing a cognitive neuropsychological approach in the investigation of deluded patients at various stages of belief acquisition, and investigating the relationship between brain structures and specific cognitive functions, will be important in providing further information as to the specific roles of perceptual and reasoning abnormalities in delusion formation, and the nature of the brain dysfunctions underlying these.

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REFERENCES


**APPENDIX**

*Faces in the famous faces test*

<table>
<thead>
<tr>
<th>Royals</th>
<th>TV/media/sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Queen Mother</td>
<td>Angela Rippon</td>
</tr>
<tr>
<td>The Princess of Wales</td>
<td>Cilla Black</td>
</tr>
<tr>
<td>The Duke of Edinburgh</td>
<td>Terry Wogan</td>
</tr>
<tr>
<td></td>
<td>Paul Gascoigne</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Politics</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edward Heath</td>
<td>Four unknown and unfamiliar male (2) and female (2) faces</td>
</tr>
<tr>
<td>John Smith</td>
<td>(relatives of one of the authors)</td>
</tr>
<tr>
<td>Margaret Thatcher</td>
<td></td>
</tr>
</tbody>
</table>

The faces were presented in a random order