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Reasoning and delusions

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Background Delusions are assumed to reflect disordered reasoning, but with little empirical support. We attempted to study this in 16 relatively intelligent deluded patients and 16 normal volunteers.

Method Standard tests were used which required subjects to choose between logically fallacious and valid responses, both of which were plausible. The tests were: (a) conditional statements (if . . . then), (b) syllogisms (e.g. no A are C, some B are C, some C are not A), and (c) judgements of probability. All three tasks incorporated neutral and emotive content.

Results Both normal and deluded subjects frequently made logical errors. With conditionals, deluded subjects tended to endorse fallacies more often than normal controls and this was accentuated when the content was emotive. Similarly, with syllogisms, the effect of emotional content on the endorsement of unbelievable responses was increased slightly in the deluded group. Finally, the deluded patients showed a trend to be less prone to the conjunction fallacy than normals, suggesting less reliance on existing schema.

Conclusions Differences in reasoning between deluded patients and controls are surprisingly small. Patients are somewhat more prone to endorse invalid or fallacious responses, especially when emotive themes are involved.

Delusions are the *sine qua non* of psychosis. A delusion may be defined as a relatively fixed, unfounded belief, not amenable to reason or to evidence to the contrary or shared by others in the same culture. Delusions may be explained in cognitive terms, broadly, as a deficit in reasoning ability. However, attempts to characterise such a deficit in deluded subjects have met with limited success (see below). The main alternative explanation is identified with Maher (1992) who argued that delusions result from the patient's impaired or anomalous perceptual experiences, but that reasoning processes themselves are basically intact. There is circumstantial evidence for this view, apart from phenomenological descriptions given by deluded subjects, such as the association linking sensory impairment to persecutory delusions (Cooper, 1976) and schizophrenia (David *et al* 1994), or the presence of specific facial processing deficits in patients with delusional misidentification (Phillips & David, 1995). However, such experiences do not invariably accompany the development of delusional beliefs: the so-called 'primary delusions' of phenomenologists (see Sims, 1988 for discussion). Even patients with 'ordinary' delusions fail to mention such experiences in 20% of cases (Jorgensen & Jensen, 1994). Another weakness in the perceptual account arises when we ask why subjects should reject naturalistic explanations of unusual perceptual experiences, suggesting some combination of perceptual and rational aberration. Furthermore, David & Howard (1994) argued that a brand of primary delusion, delusional memory, may occur through the vividness of the perceptual qualities of the *memory* as it is replayed. Hence it appears that the perceptual–rational distinction may be overly simplistic (Fleminger, 1992).

Syllogistic reasoning

Von Domarus (1944) proposed a defect in deductive reasoning with syllogisms in schizophrenic patients: the principle of identity which entails a false assumption of the identity of two subjects made on the basis of identical predicates (e.g. Diana is a princess; my initial is D; therefore I am a princess). Maher (1992) claimed that such errors are made as frequently by normal controls, deluded and non-deluded patients, when matched for education and IQ. Also, Williams (1964) compared syllogistic reasoning in schizophrenic patients and normals and found no major differences. Gottesman & Chapman (1960) found significantly more total errors on syllogisms in a study of schizophrenic patients compared with normal controls (although no difference in von Domarus errors), but the schizophrenic group's significantly lower verbal intelligence may have confounded the results.

Judgement of probability

Another aspect of reasoning which has been scrutinised in this context is probability theory. Garety & Hemsley (1994) have proposed that patients with delusions come to conclusions at levels of probability that are too low for acceptance by normal persons. Based on an experiment by Huq *et al* (1988), the authors claim that the deluded patients' problem lies in their tendency to "jump to conclusions", although it was the normal controls who were "less logical", in the sense of being overcautious. Indeed, this difficulty in interpretation arises frequently: the more the reasoning of normal subjects is studied, the more irrational it seems to be (Newstead *et al*, 1992; Evans *et al*, 1993).

A recent study by John & Dodgson (1994) employed a 'twenty-questions' game, a contextually relevant inductive reasoning task, and found that subjects with delusions requested less constraint-locating information and made guesses more readily than did both normal and non-deluded psychiatric controls. Young & Bentall (1995) have examined hypothesis-testing in deluded subjects using a series of visual discrimination problems, requiring them to narrow down hypotheses successively in response to feedback ("focusing"). Their results were somewhat different to those found by Huq *et al* (1988) and summarised in Garety & Hemsley (1994), in that there were no differences between the deluded subjects and controls with respect to the hypotheses generated, although the deluded group were

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less ready to change following negative (but not positive) feedback.

Conditional reasoning

One area of reasoning research which is beginning to find application in psychopathology is reasoning with conditional statements (*if . . . then*; Ho, 1974; Krasucki *et al*, 1995). It has been demonstrated that normals habitually make systematic errors or fallacies, and in certain contexts both valid inferences and fallacies may be suppressed (Byrne, 1989; Evans *et al*, 1993). Such reasoning tasks have been employed in a single case study of a young woman with a somatic delusion (Krasucki *et al*, 1995) where the findings suggested some deviancy from the normal pattern, with a ready acceptance of propositions regardless of validity.

The results reviewed above do not point to marked abnormalities in reasoning, and where present they seem to be inconsistent. In trying to understand these mixed results, it may be worth noting the clinical observation that abnormal beliefs tend to coalesce around certain predominant themes, especially persecution. Patients are not deluded about everything or apparently at random. Hence attempts to show an underlying global deficit in reasoning may be expected to be inconclusive. Bentall (1995) claims instead that apparent lack of reason is in fact due to biases in favour of certain attitudes. However, such biases must be extreme in order to explain some of the more bizarre delusions. Furthermore, it could be argued that these biases or schemata are in effect underlying beliefs which determine the appraisal of situations and events, so leading to circularity in the explanation.

The present study attempts to examine syllogistic, conditional and probabilistic reasoning in a group of relatively intelligent deluded patients diagnosed according to standardised operational criteria. A number of innovations have been introduced in an effort to address the questions raised by previous research. First, the content of these tasks has been modified to include emotive and threatening topics, those which commonly attract delusions. Lefford (1946) showed that emotionally toned syllogisms produced bias and more inaccurate responses in normal subjects. It is not yet clear whether or not manipulating the emotional content of syllogisms will produce a different or more marked bias in deluded patients. Second, context is manipulated in an attempt to increase both invalid and valid inferences in the case of conditional inferences, and believability in the case of syllogisms. Tests of probability were also used to examine the propensity of patients to draw on previous knowledge or schemata which commonly mislead subjects into committing the conjunction fallacy (Kahneman *et al*, 1982). Hence the influence of context and prior expectation on current thinking can be examined – a central element in several theories of psychosis (see Gray *et al*, 1991). Finally, the tasks used are framed in everyday language and are based around easily understood, naturalistic scenarios.

The following specific hypotheses were tested. In comparison with normal controls, deluded subjects:

(a) make more fallacious and fewer valid inferences on conditional reasoning tasks;

(b) select fewer valid responses to syllogisms;

(c) make more reasoning errors when problems have an emotive content;

(d) are more influenced by believability when attempting syllogisms; and

(e) are *less* influenced by context in:
(i) conditionals where alternative and additional premises may be expected to lead to a decrease in fallacies and valid responses respectively, and (ii) the probability task, rendering them *less* liable to the conjunction fallacy.

SAMPLE AND METHODS

The sample consisted of 16 patients with chronic psychotic illness, who were selected because of the prominence of their delusions combined with relatively good overall functioning. Using DSM–III–R criteria (American Psychiatric Association, 1987), 14 were diagnosed with chronic schizophrenia, one with delusional disorder, and one with atypical psychosis; 10 out of 16 were in-patients and currently delusional, and six were out-patients, all of whom had encapsulated delusions. The content of the delusions is given in Appendix I.

There were four women and 12 men, with a mean age of 41 years (s.d. 11.7) and a mean duration of illness of 15 years. A control sample (n=16) was obtained, comprising students and secretarial staff who had no formal training in psychology. They were seven women and nine men with a mean age of 26 years (s.d. 7.2).

Assessments

The following neuropsychological tests were carried out on patients (see Table 1):

(a) National Adult Reading Test (NART; Nelson & O'Connell, 1978): estimated IQ of 108.7;

(b) Mini-Mental State Examination (Folstein *et al*, 1975): cut-off for impairment <26;

(c) Cognitive Estimates (n=14) (Shallice & Evans, 1978), a test of common-sense reasoning (normal score <3); and

(d) Verbal fluency (n=13): the mean number of words/min generated beginning with a given letter (Lezak, 1983).

The last two may be viewed as tests of frontal lobe functioning.

Reasoning tests

Conditionals

These consisted of a series of 40 reasoning problems of the form 'If p then q', framed in everyday language adapted from Evans *et al* (1993), for example, 'If she meets her friend, then she will go to a play. She does not meet her friend – what follows?' Manipulations include provision of alternative premises: if she meets her family then she will go to the play . . . (If p *or* r then q) which normally reduces endorsement of fallacies, known as denial of the antecedent (DA: *If not p then not q*), and affirmation of the consequent (AC: *If q then p*), while having no effect on the valid inferences – modus pollens (MP: *If p then q*) and the less obvious modus tollens (MT: *If not q then not p*). Furthermore, provision of additional premises (If she has enough money, she will go to a play. . . . (If p *and* r then q)) normally suppresses the valid inferences (MP and MT), while having no effect on AC or DA fallacies.

Finally, emotional content of the conditionals was manipulated as in the following example (given in full):

If she is raped then she will go to the police.
She is raped: (MP)
She will go to the police (True)
She will not go to the police
Can't say

Example with alternative premise:

If she is raped then she will go to the police.
If she is mugged then she will go to the police.
She is raped: (MP)
She will go to the police (True)
She will not go to the police
Can't say

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Table I Clinical and neuropsychological characteristics of subjects with delusions

Patient no.	Years of illness	Age	IQ (NART[1])	MMSE[2]	Cognitive estimates[3]	Verbal fluency[4]
1	2	23	105	28	8	10
2	9	34	115	27	11	8
3*	25	54	122	29	1	
4**	3	46	110	28	2	19
5	2	29	99	29	11	13
6	9	33	119	30	2	16
7	25	52	111	30	1	19
8	16	41	108	26	10	13
9	30	57	91	28	4	19
10	5	24	113	29	7	14
11	13	38	107	28	4	9
12	30	51	97	26	9	9
13	17	40				
14	41	63	117	30	2	
15	8	41	115	29	7	22
16	13	36	102	25	9	22
Mean (s.d.)	15, range 2–41	41 (11.7)	108.7 (8.7)	27.9 (1.6)	6.1 (3.7)	14.8 (5.0)

All patients with DSM – III – R schizophrenia except *psychotic disorder not otherwise specified; **delusional disorder.
1. National Adult Reading Test.
2. Mini-Mental State Examination.
3. Higher score=more impaired.
4. Higher score=less impaired.

Example with additional:

If she is raped then she will go to the police.
If she is able to walk then she will go to the police.
She is raped: (MP)
She will go to the police (True)
She will not go to the police
Can't say

The other statements from the above example are:

She goes to the police (AC), was she raped? (can't say)
She is not raped (DA), does she go to the police? (can't say)
She does not go to the police (MT) she was not raped? (True)

Each item offers a choice of responses: true, false and can't say (the correct response to DA and AC statements), and subjects are asked to tick the correct one. The proportion of total true responses for each subject was taken as the dependent variable (see Appendix II).

Syllogisms

Forty of these were administered (see Appendix III). All were of the form: no A are C, some B are C, some C are not A/some A are not C.

The example below is adapted from Evans *et al* (1983):

People may be attracted to religion for many reasons including upbringing and life experiences.
No religious people are criminals
Becoming a priest requires dedication but some may find the demands too much to live up to.
Some priests are criminals
Let us agree that what has just been said is true.
Does it follow that:
Some religious people are not priests?
True/False (ib)

The same arguments may also end with:
Some priests are not religious people?
True/False (vu)

People may be attracted to religion for many reasons including upbringing and life experiences.
No priests are criminals
Becoming a priest requires dedication but some may find the demands too much to live up to.
Some religious people are criminals
Let us agree that what has just been said is true.
Does it follow that:
Some religious people are not priests?
True/False (vb)

The same arguments may also end with:
Some priests are not religious people?
True/False (iu)

It can be seen from the example that minor alterations in the order of the arguments produce the following response categories: valid believable (vb); invalid believable (ib); valid unbelievable (vu); invalid unbelievable (iu). All four versions were presented in random order, and the subjects asked to indicate whether the final conclusion was true or false. Normal controls typically make errors on syllogisms by accepting conclusions on the basis of believability. Finally, as in the above example, the emotional content of the syllogisms was manipulated. The proportion of total true responses was taken to be the dependent variable.

Probabilities

Four questions were administered (after Kahneman *et al*, 1982; see Appendix IV). These consist of descriptions of the background of four persons, with several pieces of contextual information (vignettes). The subject is asked to choose the most likely of three scenarios, none of which can be chosen with certainty since none relates precisely to information contained in the vignette. In the example below, the second is possible although unlikely (the 'correct' choice), the third combines this with a likely description, and the first is improbable. All responses are logically possible. Normals tend to choose the response that contains contextual information which accords with the schema they have created based on the vignette (response 3). However, this entails proposing that two events are more likely than one of the events alone – a logical impossibility known as the conjunction fallacy. The content of the first two questions was considered to be relatively neutral, and the last two questions, as in example below (no. 4), contained material that could be relevant to subjects with delusions. Example:

Sally is 29 years old. She ran away from home at the age of 15 because she got pregnant. She is sexually attractive and has had many partners. Recently, she has lost a lot of weight and has had to go into hospital for tests.

Sally. . .

(a) is a famous high court judge

(b) is a teacher in a primary school

(c) is a teacher in a primary school and has AIDS.

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RESULTS

The profile of the subjects is of a relatively chronic group with average or above average intelligence with minor frontal dysfunction (Table 1).

Correlations with age and cognitive function

An index of totals correct was calculated for conditionals and syllogisms. There were no significant correlations between IQ of subjects with delusions as estimated by the NART, and total correct scores in either syllogisms or conditionals or other errors on conditionals (an estimate of guess). However, there was a significant negative correlation between totals correct on syllogisms and score on cognitive estimates ($r=-0.55$, $P<0.05$). No such relationship was found for totals correct on conditionals or for other errors. In the patients only, there was a significant relationship of age with performance on syllogisms ($r=0.53$, $P<0.03$) but none of the other reasoning tests.

Conditionals

The results of the conditional reasoning task are shown in Figs 1 and 2. Grossly, both subjects and controls show high rates of endorsement of fallacies, with rates similar to those described by Evans *et al* (1993). Notably, performance on the valid MT response category was worse than that reported by Evans and colleagues in normal controls. In the analysis, response categories were combined: valid inferences (comprising MP and MT inferences) and fallacies (comprising DA and AC inferences).

A MANOVA was performed using SPSS:PC software, with presence of delusions as a between-group factor, and within-group factors of response category (valid/fallacy), premise presentation (simple, alternative, additional), and emotional content (emotional/neutral). There were significant main effects of response category, emotional content, and the presentation of additional and alternative premises, in the subjects as a whole, indicating that these manipulations were successful. *P* values were derived from Wilks' lambda (Table 2).

Diagnosis

There was no significant overall effect of group; that is deluded patients did not differ overall from normal controls. There was, however, a significant diagnosis × category interaction. The distribution of scores indicates that deluded patients tend to endorse fallacies more often than valid inferences. The effect of premise presentation had the expected interaction with response category on the group as a whole, but the effect of diagnosis on this was borderline ($P=0.09$).

Emotional content

Overall, the deluded subjects were not affected differently by emotional content than the comparison group. Emotion affected the category of response by increasing fallacies and reducing valid inferences, with and without extra premises, and also the interaction between such premises and category, but the four-way interaction with diagnosis was not significant. However, the diagnosis × category × emotion interaction was significant, indicating that the tendency for the deluded group to endorse fallacies is accentuated when the content is emotive, over and above that seen in the normal individuals.

Figures 1 and 2 show higher rates of fallacies in the deluded subjects in the alternative and additional conditions. Fallacies were suppressed to a greater extent by the controls than the deluded subjects in the alternative condition, as anticipated. Contrary to expectation (Byrne, 1989), the same trend was also observed in the additional condition where only valid inferences should have been suppressed. The raw data suggest that emotional content accentuates the relative failure to suppress DA fallacies with conditionals with alternative premises in the patients, but not in the controls.

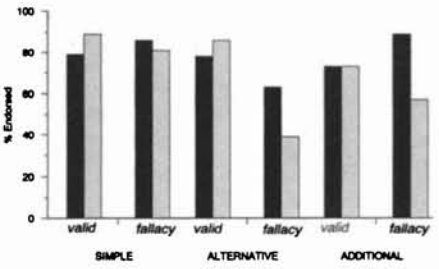


Fig. 1 Results of the standard-content conditional reasoning tests. ■, cases; ▨, controls.

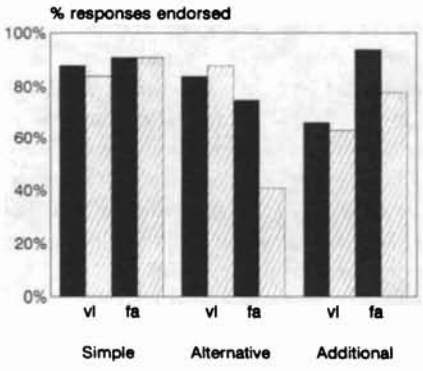


Fig. 2 Results of the conditional reasoning tests with emotional content. ■, cases; ▨, controls; vl, valid inferences; fa, fallacious inferences.

Table 2 MANOVA results for conditional reasoning task (two groups with three covariates)

	F	d.f.	*P*
Group (deluded *v.* normals)	1.28	1	0.26
Response category	5.52	1	0.03
Condition	9.47	2	0.001
Emotion	514.8	1	0.0001
CAT[1] × GROUP	9.69	1	0.004
COND[2] × GROUP	2.06	2	0.16
EMOT[3] × GROUP	1.26	1	0.27
CAT × COND	11.6	2	0.0001
CAT × COND × GROUP	2.51	2	0.098
CAT × EMOT	5.63	1	0.024
CAT × EMOT × GROUP	9.68	1	0.004
COND × EMOT	9.24	2	0.001
COND × EMOT × GROUP	2.09	2	0.14
CAT × COND × EMOT	11.4	2	0.0001
CAT × COND × EMOT × GROUP	2.43	2	0.11

1. Response category (valid inferences; fallacies).
2. Condition of presentation of premises (simple, alternative, and additional premises).
3. Emotional content.

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Syllogisms

The results on the syllogisms task are shown in Table 3 and Fig. 3. A MANOVA was performed with presence of delusions as a between-group factor, and within-group factors of response category (valid/invalid), believability (yes/no), and emotional content (emotional/neutral). There were significant main effects of validity, believability and emotional content in the subjects as a whole, indicating that these manipulations were successful.

Diagnosis

There was no significant overall effect of diagnostic group. Both groups endorsed more valid than invalid, and more believable than unbelievable responses, with the expected pattern of highest rates of endorsement for valid believable responses, and lowest rates for invalid unbelievable responses (validity × believability interaction, $P<0.0001$). This pattern was essentially the same in the deluded group. The deluded group showed a trend to endorse fewer valid and more invalid responses ($P=0.075$), but were equally influenced by believability of the syllogism.

Emotion

As noted above, there was a significant main effect of emotional content of increasing positive responses to syllogisms for the subjects as a whole, but this was accentuated in the deluded group. Emotional content appears to exert a slight effect on the endorsement of the unbelievable responses overall, marginally more so in the deluded group (diagnosis × believability × emotion interaction, $P=0.059$). There was no effect of emotional content on validity or the validity–belief interaction, in the group as a whole or among the deluded patients.

Table 3 Results of MANOVA for syllogisms (two groups with three covariates, each with two levels)

	F	*P*
Group (deluded *v.* normals)	1.09	0.30
Valid	26.5	0.0001
Believe	65.0	0.0001
Emotion	6.63	0.015
Valid × Group	3.41	0.075
Believe × Group	1.94	0.17
Emotion × Group	4.43	0.044
Valid × Believe	20.0	0.0001
Valid × Believe × Group	0.74	0.39
Valid × Emotion	0.18	0.67
Valid × Emotion × Group	0.18	0.67
Believe × Emotion	3.66	0.065
Believe × Emotion × Group	3.87	0.059
Valid × Believe × Emotion	0.01	0.92
Valid × Believe × Emotion × Group	0.02	0.89

Valid, validity of syllogism; Believe, believability of syllogism; Emotion, emotional content.

Probabilities

Both patients and controls endorsed the conjunction fallacy as being the most likely of the three possible answers. For each individual probability question, the responses were cross-tabulated. On question 1 (neutral content) all the controls chose the conjunction fallacy, four out of 16 deluded subjects had the correct response, while one subject chose the unusual response (Fisher's exact test, $P=0.02$).

On questions 2 and 3 the majority in each group chose the conjunction fallacy (>12). On question 4 (threatening content), 15/16 controls selected the conjunction fallacy, versus 11/16 in the deluded subjects (four of the deluded subjects chose the correct response, versus one of the controls; $P=0.08$).

Therefore we cannot reject the hypothesis that subjects with delusions may be somewhat less influenced by context overall than normal controls, and we are unable to say whether the context bias increases when the content of the material becomes more emotive.

DISCUSSION

These results do not reveal marked differences between deluded patients and normal subjects with respect to performance on tests of logical reasoning, namely conditionals and syllogisms, with no overall significant group differences. In fact, all subjects displayed considerable irrationality and a propensity to go with prior beliefs rather than reasoning through a problem. However, higher rates of endorsement of fallacies in conditional reasoning are found in the subjects with delusions.

Reason and emotion

The manipulation of emotional content appears to make the normals behave more like the deluded subjects – suppressing more valid inferences and fewer fallacies (alternatively, neutral material may be potentially emotive to a person with delusions). There is some indication of a tendency for emotion to make deluded subjects less responsive to extra contextual information which would normally enable them to draw a valid inference.

On the syllogisms, deluded patients show a similar pattern of responses to normal subjects, although with a trend to endorse fewer valid conclusions. This result is reminiscent of that found in the conditionals (i.e. higher rate of fallacies in the deluded subjects). Emotional content again appeared to have a significantly greater effect in the deluded group, making them tend to endorse more unbelievable responses.

Thus while emotional content affects the performance in both groups, there are pointers that reasoning is more adversely

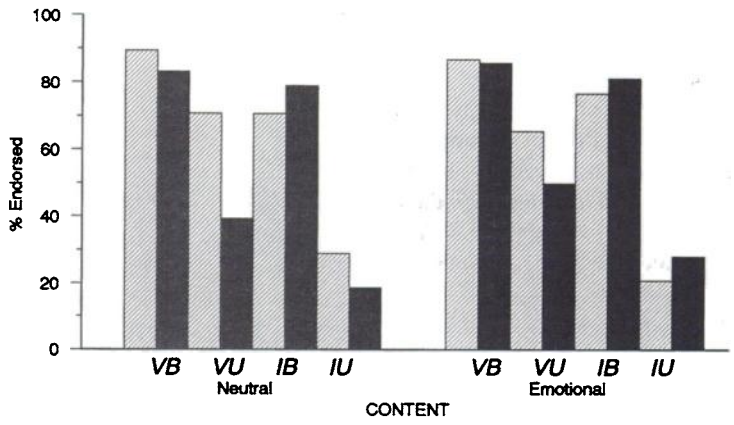


Fig. 3 Results of the syllogisms task. ■, cases; ▨, controls. *VB*, valid believable; *VU*, valid unbelievable; *IB*, invalid believable; *IU*, invalid unbelievable.

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affected in the subjects with delusions. An examination of the results with conditionals suggests that even in the controls there is an effect of the emotional content, with less suppression of fallacies and more suppression of valid inferences when the respective conditions are manipulated. The effect also occurs in the deluded subjects to a marginally greater extent, but serves to highlight the difference especially in rates of fallacies in the condition of alternative premises. Relating this issue of additional or alternative premises to the wider question of the influence of context in psychotic thinking, it was predicted that the extra premises would neither improve nor impair performance, that is, there should be no presentation × category × diagnosis interaction. The result was somewhat equivocal. The effects of emotional content in the syllogisms was also subtle, resulting in a tendency in the subjects with delusions to endorse more unbelievable responses regardless of validity.

The term 'emotional' may not best describe the content of some of the reasoning problems. Some touched on political themes, others were threatening, but all were intended to raise levels of arousal and affect.

The results on the probabilities reveal a slightly higher rate of conjunction fallacies in the controls, which may reflect overuse of certain judgemental heuristics, in this case "representativeness" (for review, see Kahneman *et al*, 1982). The results suggest that *normals* are prone to "jump to conclusions" and may possibly be more influenced by context or existing schemata than patients with delusions (cf. Gray *et al*, 1991).

This study has investigated logical reasoning on fairly demanding problems, in a group of patients with persistent and entrenched delusions, who had normal premorbid IQs as estimated by the NART, no gross deficits on the Mini-Mental State Examination, and generally mild to moderate impairment on a range of tests thought to assess frontal lobe functioning (the latter being in keeping with expected results in patients with chronic psychotic disorders). Nevertheless, these patients showed only subtle differences in their logical reasoning when compared with normal controls. These differences may be confounded by a general, although slight, impairment of cognitive functioning. However, if 'totals correct' can be taken as an overall index of reasoning ability, no significant correlations were observed between this and IQ in the patients, and no main effects for diagnosis were found in either conditional or syllogistic reasoning tasks. Hence the lack of a psychiatric control group (e.g. non-deluded psychotics) is not crucial since, despite the imperfect matching of our patients with normals, few differences emerged. What emerged unequivocally is that emotional content disrupts logical reasoning in both normals *and* deluded patients.

Abnormal beliefs or perceptions?

We are left with the impression of a subtle malfunction in reasoning processes in patients with delusions. The possible 'perceptual' basis for delusions could be neither confirmed nor refuted in this study, although the absence of an overwhelming reasoning deficit means that it must be considered seriously. A preliminary attempt was made to separate on purely phenomenological grounds those delusions which seemed to have a more or less perceptual origin (cases 1, 3, 9, 11, 13; see Appendix I). There were no group differences between these and the remainder on any of the reasoning tests, although we may have missed small differences because of low statistical power.

However, as argued in the introduction, the separation of perception and reasoning is artificial, and a more integrated account of mutual influence can be advanced (see Fleminger, 1992). Instead of proposing a fixed causal chain where anomalous experiences determine the development of delusions, Chapman & Chapman (1988) proposed that aberrant beliefs, cognitive deviancies and anomalous experiences are probably all direct expressions of some underlying (cognitive?) deficit in psychosis, and mutually augment each other. Therefore the mild relative weakness in formal reasoning that is suggested by our results may represent one link in the chain towards development of delusions.

Further research may elucidate the kinds of emotional cues that most reliably elicit the proposed reasoning abnormalities, cues that in at least some cases may in fact be related to anomalous perceptions. Another line for research would be to focus on specific abnormal beliefs, to formulate reasoning problems on such beliefs, and compare them with other non-delusional beliefs. While our 'emotive' material was typical of the content of many delusions, it was not tailored individually to the patients. One note of caution should be sounded at this point: an individual strategy could lead to a *reductio ad absurdum*. If, for example, a person believed that he was being followed by alien beings, he is likely to endorse the response to a reasoning problem "do you think people are followed by aliens?". This would not constitute a test of his reasoning, but merely the elicitation of a belief.

Another potential weakness in the approach taken here is that we have not distinguished formation from maintenance with respect to delusions. Clinical histories often contain descriptions of a period of uncertainty (sometimes called delusional mood) which is resolved by a delusion (see Sims, 1988). It could be that the usual (somewhat limited) capacity for rationality is temporarily suspended in such cases, a situation mimicked in normal subjects when highly emotive topics are considered. However, in deluded subjects, the belief, once formed, seems impervious to (intact) reason.

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APPENDIX I

Description of subjects' main delusions

1. Grandiose and persecutory delusions that he is an angel sent from God, involved in a great struggle against dark forces.*
2. Delusions of reference, thought broadcasting and passivity. Grandiose belief that he is Lord Harlech and has a lot of supporters trying to get him elected to Parliament.
3. Persecutory delusion that there is a plot against her by the CIA or the IRA, who are pumping electricity into her room.*
4. Bizarre belief in the identity of a Siamese twin sister from whom she was separated at birth – the Queen Mother arranged for her to have an operation in Russia.
5. Grandiose delusion that he is the Archangel Michael, and has developed grand scientific theories.
6. Grandiose belief that he is a prophet with special powers, Einstein or Jimmy Hendrix.
7. Grandiose belief that he is of royal lineage, and that he runs China which is doing well because of him.
8. Believes he is a special person, to whom miracles happen. Has seen a spaceman who is in regular communication with him.
9. Believes that he is the Antichrist, and that the media regularly make reference to his importance in world affairs.*

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10. Delusional memory of men coming to her workplace to abuse her, commenting on her genitalia. Believes that her genitalia are abnormal.
11. Believes he is being persecuted by a white energy, which affects people causing them to be antagonistic to him.*
12. Persecutory and grandiose beliefs that he is highly regarded for his talents, so that others become jealous and try to thwart him; he finds references to himself in various rap songs.
13. Believes that evil spirits persecute him for past misdemeanours.*
14. Persecutory beliefs that neighbours are harassing him, breaking into his flat and interfering with his food and belongings.
15. Persecutory belief that there is a conspiracy involving a famous businessman who is trying to discredit and malign him, in which his wife and family are involved.
16. Somatic delusion that various parts of her brain become hard and frozen. Believes she absorbs the personalities of those around her who then take control of her.

*Patients whose delusion was considered to be closely related to perceptual disturbance.

APPENDIX II

The four different versions of the following conditionals with simple, alternative, and additional premises were given, with subjects asked to indicate whether each of the four inferences were 'true', 'false' or 'can't say'.

1. If she meets her friend then she will go to a play.
   alternative: If she meets her family
   additional: If she has enough money.
2. If he plays football then he will go to the gym.
   alternative: If he wants to keep fit
   additional: If he catches the bus.
3. If it is raining then she will get wet.
   alternative: If it is snowing
   additional: If she goes out for a walk.
4. If she is raped then she will go to the police. [emotional content]
   alternative: If she is mugged
   additional: If she is able to walk.

APPENDIX III

The four different versions of the following syllogisms were given, with subjects asked to indicate whether they were true or false.

1. No highly trained/police dogs are vicious [emotional].
2. No nutritional things/vitamins taste nice.
3. No drugs/addictive things are inexpensive.
4. No millionnaires/rich people are careless with money.
5. No religious people/priests are criminals [emotional].
6. No healthy people/astronauts are over 50 years old.
7. No deep sea divers/good swimmers are afraid of sharks.
8. No judges/well educated people are fashionable.
9. No members of the IRA/Irish people respect the government [emotional].
10. No Nazi war criminals/Germans are innocent [emotional].

APPENDIX IV

PROBABILITY

Bill is 34 years old. He is intelligent but unimaginative, compulsive, and generally lifeless. At school he was good at mathematics but weak in social studies and the arts. Bill . . .

(a) plays jazz for a hobby

(b) is a ballet dancer

(c) is an accountant who plays jazz for a hobby.

Linda is 31 years old, single, outspoken and very bright. She got a degree in philosophy. As a student she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Linda . . .

(a) is a bank clerk and is active in the feminist movement

(b) is a plumber

(c) is a bank clerk.

Mark is 28 years old. He has always been a practical joker and likes to make fun of other people. He is very good at electronics and builds his own hi-fi equipment. Mark . . .

(a) likes gardening

(b) likes gardening and likes to record private conversations

(c) likes tropical fish.

Answers:

1. a (conjunction fallacy c)
2. c (conjunction fallacy a)
3. a (conjunction fallacy b).

CLINICAL IMPLICATIONS

- Normal people and patients with delusions often make errors when asked to solve logical reasoning problems.
- Problems that contain emotive material induce less correct reasoning (especially in deluded patients).
- Cognitive impairment is not sufficient to explain delusional thinking.

LIMITATIONS

- A non-deluded psychiatric control group was not tested.
- Patients all had established delusions.
- The content of the reasoning problems was not tailored to individual patients' beliefs.

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REFERENCES

American Psychiatric Association (1987) *Diagnostic and Statistical Manual of Mental Disorders* (3rd edn, revised) (DSM-III-R). Washington, DC: APA.

Bentall, R. P. (1995) Brains, biases, deficits and disorders. *British Journal of Psychiatry*, **167**, 153–155.

Byrne, R. M. J. (1989) Suppressing valid inferences with conditionals. *Cognition*, **31**, 61–83.

Chapman, L. J. & Chapman, J. P. (1988) The genesis of delusions. In *Delusional Beliefs* (eds T. F. Oltmans & B. A. Maher), pp. 167–183. New York: Wiley.

https://doi.org/10.1192/bjp.170.5.398 Published online by Cambridge University Press

Cooper, A. F. (1976) Deafness and psychiatric illness. *British Journal of Psychiatry*, **129**, 216–226.

David, A. S. & Howard, R. (1994) An experimental phenomenological approach to delusional memory in schizophrenia and late paraphrenia. *Psychological Medicine*, **24**, 515–524.

___, Malmberg, A., Lewis, G., *et al* (1994) Are there neurological and sensory risk factors for schizophrenia? *Schizophrenia Research*, **14**, 247–251.

Evans, J. St B. T., Barston, J. L. & Byrne, R. M. J. (1983) On the conflict between logic and belief in syllogistic reasoning. *Memory and Cognition*, **11**, 295–306.

___, Newstead, S. E. & Byrne, R. M. J. (1993) *Human Reasoning*. Hove: Lawrence Erlbaum.

Flemínger, S. (1992) Seeing and believing: the role of preconscious processing in delusional misidentification. *British Journal of Psychiatry*, **160**, 293–303.

Folstein, M. F., Folstein, S. E. & McHugh, P. R. (1975) "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, **12**, 189–198.

Garety, P. & Hemsley, D. R. (1994) *Delusions: Investigations into the Psychology of Delusional Reasoning*. Oxford: Oxford University Press.

Gray, J. A., Rawlins, J. N. P., Hemsley, D. R., *et al* (1991) The neuropsychology of schizophrenia. *Behavioural and Brain Sciences*, **14**, 1–84.

Ho, D. Y. F. (1974) Modern logic and schizophrenic thinking. *Genetic Psychology Monographs*, **89**, 145–165.

Huq, S. F., Garety, P. & Hemsley, D. R. (1988) Probabilistic judgements in deluded and non-deluded subjects. *Quarterly Journal of Experimental Psychology*, **40A**, 801–812.

John, C. & Dodgson, G. (1994) Inductive reasoning in delusional thought. *Journal of Mental Health*, **3**, 31–49.

Jorgensen, P. & Jensen, J. (1994) How to understand the development of delusional beliefs: a proposal. *Psychopathology*, **27**, 64–72.

Kahneman, D., Slovic, P. & Tversky, A. (eds) (1982) *Judgement under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press.

Krasucki, C., Kemp, R. & David, A. S. (1995) A case study of female genital self-mutilation in schizophrenia. *British Journal of Medical Psychology*, **68**, 179–186.

Lefford, A. (1946) The influence of emotional subject matter on logical reasoning. *Journal of General Psychiatry*, **34**, 127–151.

Lezak, M. D. (1983) *Neuropsychological Assessment* (2nd edn). Oxford: Oxford University Press.

Maher, B. A. (1992) Delusions: contemporary etiological hypotheses. *Psychiatric Annals*, **22**, 260–268.

Nelson, H. E. & O'Connell, A. (1978) Dementia: the estimation of premorbid intelligence levels using the new adult reading test. *Cortex*, **14**, 234–244.

Newstead, S. E., Pollard, P., Evans, J. St. B. T., *et al* (1992) The source of belief bias effects in syllogistic reasoning. *Cognition*, **45**, 257–284.

Phillips, M. L. & David, A. S. (1995) Facial processing in schizophrenia and delusional misidentification: cognitive neuropsychiatric approaches. *Schizophrenia Research*, **17**, 109–114.

Shallice, T. & Evans, M. E. (1978) The involvement of frontal lobes in cognitive estimation. *Cortex*, **14**, 294–303.

Sims, A. (1988) *Symptoms in the Mind*. London: Baillière Tindall.

Von Domarus, E. (1944) The specific laws of logic in schizophrenia. In *Language and Thought in Schizophrenia* (ed. J. S. Kasanin), pp. 104–114. Berkeley, CA: University of California Press.

Williams, E. B. (1964) Deductive reasoning in schizophrenia. *Journal of Abnormal and Social Psychology*, **69**, 47–61.

Young, H. F. & Bentall, R. P. (1995) Hypothesis testing in patients with persecutory delusions: comparison with depressed and normal subjects. *British Journal of Clinical Psychology*, **34**, 353–369.

https://doi.org/10.1192/bjp.170.5.398 Published online by Cambridge University Press