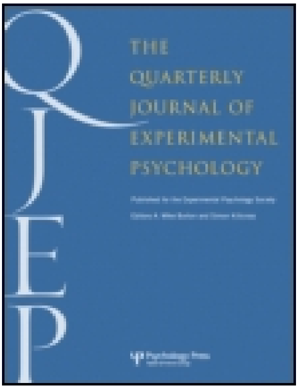

The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/pqja20

Probabilistic judgements in deluded and non-deluded subjects

S. F. Huq [a] , P. A. Garety [a] & D. R. Hemsley [a]
[a] Institute of Psychiatry, De Crespigny Park, London, U.K.
Published online: 29 May 2007.

THE QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY, 1988 *40A* (4) 801–812

Probabilistic Judgements in Deluded and Non-Deluded Subjects

S. F. Huq, P. A. Garety, and D. R. Hemsley
Institute of Psychiatry, De Crespigny Park, London, U.K.

An experiment is described in which deluded subjects were compared with a non-deluded psychiatric control group and a normal control group on a probabilistic inference task. Deluded subjects were found to request less information before reaching a decision and to express higher certainty levels than either control group. They also exhibited over-confidence on estimates of the probability of a future event.

Delusion. A false personal belief based on incorrect inference about external reality and firmly sustained in spite of what almost everyone else believes and in spite of what constitutes incontrovertible and obvious proof or evidence to the contrary. The belief is not one ordinarily accepted by other members of the person's subculture. [American Psychiatric Association, 1980]

The extent to which the deluded individual's reasoning is abnormal has been little explored. Whereas some assert that the reasoning of the deluded individual may remain intact (e.g. Mayer-Gross, Slater, & Roth, 1969, p. 272: "it is not a disturbance of intelligent grasp . . . the disturbance is one of symbolic meaning"), others suggest that the fault lies in the judgement processing of the individual (e.g. Jaspers, 1913, p. 95, refers to "pathologically falsified judgements", and the DSM III definition above points to "incorrect inference".) Assertions such as those of Jaspers were based upon phenomenological studies of delusions, and the fruits of such studies have been embodied in current definitions (see Garety, 1985).

However, there have been remarkably few experimental studies of the reasoning of deluded individuals, despite the fact that there is now a growing literature on inference in other clinical populations (e.g. depressed subjects, Alloy & Abramson, 1979). Many years ago, von Domarius (1944) saw delusions as the result of a failure of syllogistic reasoning; in an experimental study, however, in which schizophrenics were compared with normals,

Requests for reprints should be sent to P. A. Garety, Department of Psychology, Institute of Psychiatry, De Crespigny Park, London SE5 8AF, U.K.

Chapman and Chapman (1959) found that their *normal* subjects made many errors in solving syllogisms. Maher (1974) argued that when studies on the susceptibility of schizophrenic patients to logical errors of the von Domarius type are adequately controlled for education and verbal knowledge, there is no basis to support the claim that such patients differ from normals in vulnerability to these errors. It is furthermore now well established, in the experimental literature, that normals do not invariably follow the laws of logic in forming inferences. On the contrary, a number of "non-motivational" or "informational" biases in reasoning are reliably elicited, experimentally (Johnson-Laird, 1982; Kahneman, Slovic, & Tversky, 1982). Winters and Neale (1983), in a review of the literature on inference in deluded subjects, found the position inconclusive and noted that hypotheses that do not propose any reasoning abnormality, such as that of Maher (1974), may be equally plausible. He proposes that a deluded individual suffers from primary perceptual anomalies for which an explanation is sought through normal cognitive mechanisms. Thus the deluded patient is not viewed as suffering from impaired reality testing or judgement but is seen as a "reasonable" person reacting to an abnormal sensory experience (see also Frith, 1979, for a similar proposition).

One recent study (Brennan & Hemsley, 1984), which did find an inferential distortion, compared paranoid and non-paranoid schizophrenics and normals on their formation of "illusory correlations" (Chapman, 1967). An "illusory correlation" is the report by an observer of a correlation between two events that in reality are not correlated, or not to the extent reported. Brennan and Hemsley found that their paranoid group reported particularly strong illusory correlations, compared with the non-paranoid and normal groups, on a task involving stimuli relevant to subjects with paranoid delusions.

The above study employed material relevant to the content of paranoid delusions, and an effect did appear, suggesting an inferential bias in this group, with this material. However very few, if any, studies have been conducted of the reasoning of deluded subjects with tasks in which the material is not apparently relevant to the content of their abnormal beliefs, a "neutral content" task. One difficulty with exploring the reasoning of deluded individuals resides in the problem of setting a norm for "correct" or "normal" reasoning (as has been the case with the study of syllogistic reasoning, quoted above). Fischhoff and Beyth-Marom (1983) argue that Bayesian inference provides a general framework for evaluating beliefs and that it may be used to describe a person's consistency with, or departure from, the model. They identify a set of logically possible forms of non-Bayesian behaviour and review research to see whether these possibilities are realised in the normal population. Hemsley and Garety (1986) have argued that this approach may usefully be applied to the study of the inferences of deluded individuals. Bayesian procedures provide a model of different stages of the formation and evaluation of a hypothesis (belief):

1. the identification of the data sources that are most useful for discriminating between competing hypotheses;
2. the assessment of the implications of an observed datum vis-à-vis the truth of competing hypotheses;
3. an aggregation of the implications of different data with an overall appraisal of the relative likelihood of the truth of the hypothesis;
4. the selection, based on that appraisal, of the appropriate course of action.

A Bayesian framework has been used for the experimental study of the inferential style of one clinical population, obsessional patients, by Volans (1976). She reported that obsessional subjects, when compared with phobic and normal groups, and after partialling out neuroticism, differed with respect to the amount of evidence they required prior to making a decision: the obsessional group required more information at this stage.

Although there is no accumulation of experimental findings to guide the formation of hypotheses about the nature of the inferential distortion deluded subjects may show, the clinical phenomena of note are intensity of conviction and fixity of belief (Garety, 1985). Thus it is possible that if deluded subjects do deviate from a "norm", it will be in terms of these variables. Furthermore it may be hypothesized that deluded subjects, unlike obsessionals, will require less evidence to reach a decision than that which would be required following Bayesian norms. Thus the study presented below describes an investigation into the reasoning of deluded individuals, to examine whether these subjects demonstrate any characteristic distortions in decision-making using "neutral" material, deviating not only from a "Bayesian" norm but also from a normal control group and a control group of psychiatric patients. The present study follows the procedure devised by Volans (1976).

The Basic Paradigm

In a typical experiment on probability judgements (Phillips & Edwards, 1966) subjects are shown containers holding a large number of poker chips of two different colours, such as red and green. Containers labelled A and B have red and green chips in a particular ratio, e.g. 70 green/30 red, or the reverse. Subjects are informed of the proportions, and containers are removed from view. Subjects are then told about the prior probabilities, i.e. that either of the containers is equally likely to be chosen. The initial prior probabilities are thus always 50A:50B. One of the containers is then chosen, and a sample is drawn from the chosen container. The experiment is continued, with samples of one being drawn sequentially and sampling with replacement. The subject's task is to work out whether the experimenter is drawing from Container A or Container B. S/he may also have the additional task of indicating at each stage in the sequence estimates of the probabilities that each container had been chosen. Under different conditions, the numbers of draws will vary, according to predetermined criteria. There is an optimal "rational" strategy for performance on these tasks. At each stage, Bayes' theorem can be used to compute the likelihood of a given container having been selected, given the data presented.

The aim of the present study was to examine the formation and evaluation of hypotheses in deluded subjects.

Method

Materials and Measures

In order to test their hypothesis formation and evaluation, subjects were administered a series of probabilistic tasks based on the basic paradigm outlined by Phillips and Edwards (1966). Eight jam jars, each containing 100 coloured beads, constituted the stimulus material. There were four pairs of jars; in every pair there were, in each jar, two sets of coloured beads in equal and opposite proportions; for example, in Set W:

Jar A contained pink and green beads, in the ratio 85 pink and 15 green beads;
Jar B contained green and pink beads, in the ratio 85 green and 15 pink beads.

The other sets were identical, except that they contained beads of different colours. The proportions were always 85:15.

In order to register probabilities of hypothesis and event predictions, subjects were provided with a response board. The response board was clamped to a desk so that to some extent it formed a screen between the subject and the experimenter. Two thin rods joined together by a chain were supported on two cogwheels on the 2 sides of the response board facing the subject. A scale with fifty equal divisions was attached to the board beside each rod, on the experimenter's side of the board. The subject's side of the board was not calibrated. To ensure correct representation of hypotheses, the rods were labelled A and B. Relevant marker cards were used to indicate the colour predominant in the relevant jar in a particular condition. For example, when Set Y (Condition 3) was in use, Rod A would have a marker card reading "Rod A, Mainly White". For the YES–NO response mode subjects were presented with 2 cards—a continue card and a stop card. The continue card bore the message, "More items please"; the stop card bore the message, "No more items, I have decided".

There were four experimental conditions:

Condition 1: A YES–NO response mode was used in this condition. Subjects were asked to indicate whether or not they required more draws before they came to a decision by pointing to the relevant card. When subjects pointed to the stop card, they were asked to say which jar they thought the draw/draws came from.

Condition 2: In this condition subjects were required to use a YES—NO response mode in a similar way to that in Condition 1. In addition, before each draw they were required to indicate their estimates of the probability of a given colour coming up on that particular draw by using the response board (event estimation).

Condition 3: A probabilistic response mode was used in this condition. After each draw, subjects were required to indicate the relative probabilities that they attached to the draw having come from each of the two jars, using the response board. No estimations about individual colours (events) were required.

Condition 4: This condition required the subject to give event estimations prior to each draw, as in Condition 2, and then following each draw subjects were asked to indicate the relative probability of the draw having come from each of the two jars, as in Condition 3.

Subjects

The experimental subjects were 15 deluded (D) schizophrenics. The criteria for selection were:

1. a clear diagnosis of schizophrenia, as determined by the psychiatrist responsible for the patient's care;
2. present delusional symptoms at a high level of intensity—based on a structured interview carried out by the second author (P.A.G.) for a separate study (Garety & Hemsley, 1987);
3. absence of formal thought disorder (again assessed by the psychiatrist).

The 10 patients forming the psychiatric control group (ND) were of various diagnoses—depression (2), manic depression (4), phobia (2), anxiety state (1), eating disorder (1)—but were required to show no evidence of delusions. In addition, in view of Volans' (1976) results, obsessional subjects were also excluded. Subjects, who were all volunteers, were told that they were being invited to take part in a test of the way that people reason, and that the outcome would have no bearing on their psychiatric care. The normal (N) comparison group consisted of 15 volunteers who were asked to confirm that they had no psychiatric history. Each subject completed the Mill Hill Vocabularly Scale (synonyms). For all groups, any scoring below the 10th percentile were excluded from the experiment; a total of 7 were excluded in this way, 2 from the Deluded group, 2 from the psychiatric control group and 3 from the normal control group.

Subjects' characteristics are represented in Table 1.

Analyses of variance indicated no significant group effect for either age or Mill Hill score (the Mill Hill score is the total of synonyms plus expected definitions).

Design

Following Volans, data lists were prepared in advance, using her random number tables. This pre-arrangement of presentation of colours ensured that every subject would be shown the same sequence of colours in any particular condition. All subjects were run under all the four conditions, and hence four different lists were prepared. A given data list was assigned to one colour only. The sequence of draws in the four conditions (where A represents a bead of one colour of a given pair, and B the other colour) were as follows:

Condition 1: A A A A B A A A A A A A A A A B A A B A
Condition 2: A A A B A A A A A B B A A A A A A A A B
Condition 3: A A A A A A B A A B A A A B A A A B A B
Condition 4: A A B A A B A A A A A A A A A A A A A B

A Graeco-Latin square design was used to ensure that all four conditions occurred in all sequential positions. The distribution of subjects in the three groups across order conditions is presented in Table 2.

TABLE 1
Subject Characteristics

Group		N	Age (years) Mean	Age (years) SD	Sex F	Sex M	Mill Hill Vocabulary Scale Mean	Mill Hill Vocabulary Scale SD
Deluded	(D)	15	41.3	15.5	8	7	53	8
Non-deluded	(ND)	10	42.2	12.7	6	4	55	6
Normals	(N)	15	31.7	13.0	11	4	55	7

TABLE 2
Allocation of Subjects to Order Conditions

Groups		*Order i (1,2,3,4)*	*Order ii (3,4,1,2)*	*Order iii (2,1,4,3)*	*Order iv (4,3,2,1)*
Deluded	(D)	4	4	4	3
Non-deluded	(ND)	2	2	3	3
Normals	(N)	4	4	3	4

Procedure

The administration of the synonyms part of the Mill Hill Vocabulary Scale was followed by the experimental tasks. Before beginning each condition, subjects were asked to read the relevant written instructions. These were clarified with the subject, who then practised use of the rods. Emphasis was placed on three points:

1. draws would be taken from the same jar for all trials to be given with the same set;
2. beads would be replaced in the same jar after each draw;
3. subjects were allowed as many trials as they needed to be completely sure as to which jar had been chosen.

Beads were drawn from the chosen jar one at a time.
Criteria for stopping: Each condition was brought to an end

1. when the subject reported complete certainty at a 100% probability; and/or
2. when the subject said she/he had come to a decision about which jar the particular draw came from or
3. when the subject held his/her certainty level at 80–85% for more than 2 trials and reported that she/he could not be more sure than that; or
4. when a subject's response remained unchanged for more than 5 consecutive trials.

Dependent Variables

1. *Draws to decision.* This is the average of draws taken on Conditions 1, 2, 3, and 4, excluding the initial draw.
2. *Initial certainty level,* following first draw of Conditions 3 and 4. The subject's probability estimate was subtracted from that predicted by the Bayesian model, using a 50% prior. Deviations resulting from

subjects' underestimation with respect to the model were scored as positive values and indicate conservative responding, as has been found in the normal population (Phillips & Edwards, 1966).

3. *Event probability estimations.* These were calculated as deviations in subjects' estimations of the likelihood of a given colour bead appearing in the first draw from the "rational" estimate. As subjects had no evidence on which to base their first estimations, the rational estimate would be 50% for any set of 2 beads. The average of Conditions 2 and 4 was taken.
4. *Errors in decision making.*

Results

Very few decision errors were made (D = 6, ND = 1, N = 3). These will not be considered further.

The findings on the other dependent variables are presented in Table 3.

Two-way analyses of variance were carried out to examine group differences on draws to decision and initial certainty level. In neither case was the order effect or group by order effect significant. A significant group effect on both draws to decision, $F(2, 28) = 3.35$, $p < 0.05$, and initial certainty level, $F(2, 28) = 4.87$, $p < 0.05$, was found. The difference between the normal and deluded group on the former was significant $t(28) = 1.7$, $p < 0.05$, one-tailed). Because of the large variance in the deluded group on the latter variable, the results were checked by means of Fisher's Exact Test. The non-deluded and normal controls were grouped together, and the deluded patients were divided according to whether the deviation scores were negative or positive, i.e. expressing over- or under-confidence. There was a highly significant association between group membership and the likelihood of a negative (over-confident) deviation score ($p < 0.005$). For event estimation, the tendency for the deluded group to express higher probability estimates than the other two groups was not statistically significant (Kruskal-Wallis test, $\chi^2(2) = 2.56$, $p = 0.28$).

For the total group of subjects, the correlation between draws to decision and initial certainty level was highly significant, $r = 0.58$, $p < 0.0001$, and was also significant for the deluded sample, $r = 0.53$, $p < 0.05$.

TABLE 3
Mean Scores on Dependent Variables for the Three Groups

	Draws to Decision		*Initial Certainty*		*Event Estimation*	
Groups	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
D	1.22	1.57	6.40	17.37	67.79	21.22
ND	3.58	3.51	20.58	12.38	55.36	13.12
N	2.60	1.17	19.87	9.37	59.30	13.99

Discussion

The results of this study suggest that on a neutral task deluded subjects require less evidence than normals or non-deluded psychiatric patients before reaching a decision. They also express higher levels of certainty after the first item of information is presented than either of the two control groups. Indeed, this is understandable, as these two measures are strongly correlated. These results are not simply characteristic of psychiatric patienthood: the non-deluded psychiatric sample requested more information (mean 3.58 draws) than the normal sample (mean 2.6 draws), in contrast to the average 1.22 additional draws requested, after the first item was presented, by the deluded sample. It is noteworthy here that the two psychiatric patient groups fall on either side of the normal group: there is not, as is commonly the case, a continuum, with "normality" placed at one end and psychiatric groups at different points along it from the normal group, but in the same direction. Hence it does not represent solely a severity of psychopathology dimension.

Interpreting these, and the other results, presents some difficulties. In the case of "draws to decision", the deluded sample's average decision point was after the presentation of 2.22 items of information (i.e. after the first draw, which all subjects received, plus the mean 1.22 draws additionally requested). Under all conditions the first two draws selected beads of the same colour, and at this point the objective probability that the jar containing predominantly beads of that colour had been chosen was 97%. Thus it may be argued that the deluded sample reached a decision at an objectively "rational" point. It may further be argued that the two control groups were somewhat over-cautious, the normal sample reaching a decision at between on average 99.5% certainty in Conditions 1 and 3 and 97% certainty on Conditions 2 and 4, and the psychiatric control group at between on average 99.9% and 97% certainty. Even more cautious were Volans' (1976) obsessional patients, who required on average 8.86 additional draws to decisions. There was, however, considerable variability within the experimental group. Seven of the deluded sample (47%) made the decision on *all* conditions, after the very first draw, at the point of 85% probability, something that occurred in only one of the 25 controls.

It is not possible, at this stage, to argue for distinct sub-groups within the deluded sample. No a priori hypotheses were made in this respect: a post hoc analysis of the data does not point to any very clear differences between the "extreme" responders and the rest. However, one interesting characteristic of the group is the high proportion (5/7) of subjects with a diagnosis of paranoid schizophrenia.

The related measure, "initial certainty", yields a consistent picture. Here, again, a group effect was found, the deluded group expressing higher levels of conviction from the outset than the other two groups. In this respect, again, the deluded subjects are more "rational", according to the Bayesian model, than the other two groups—whereas all groups are over-cautious in their estimates, this is more marked in the two control groups. This "conservatism" is consistent with Phillips and Edwards' (1966) original finding, and also with a wealth of subsequent studies reported by Edwards (1982), and is particularly marked when, as in this case, the task is easy (Lichtenstein, Fischhoff, & Phillips, 1982). It should, however, again be noted that within the experimental group there were marked differences: 6 of the deluded group were over- not under-confident in their certainty levels. Over-confidence did not occur in any of the 25 controls.

The deluded subjects exhibited over-confidence in "event estimation", estimates of the likelihood of a given colour bead appearing on the first draw. Hence the correct probability was always 50%; the normal group averaged 59%, the non-deluded controls 55%, and the deluded group 68%. Even though the difference between groups was not statistically significant ($p = 0.28$), the deluded group again expressed higher levels of conviction. In this case, the deluded group's performance appears less normative than that of the control groups, in contrast to their performance on draws to decision and initial certainty. The direction of effect is, however, consistent with these other measures.

It is worth noting perhaps that the initial certainty level was calculated assuming a prior estimate of 50% (the objective probability); however, the subjective prior estimates given in event estimation (although regarding the likelihood of a particular colour bead being drawn, not the likelihood of a particular jar having been chosen) are, particularly for the deluded group, somewhat higher. Thus the deluded group's certainty level and draws to decision, if based on these priors, could be regarded as quite reasonable, given the (however over-confident) level of the prior estimates. Relevant here is the fact that the prior estimates did not deviate either side of 50% but were nearly all higher than or equal to 50% estimates of the probability of the same coloured bead being chosen, as was in fact the dominant colour of the chosen jar. Thus a particular characteristic of the procedure was that subjects' over-confidence appeared to be vindicated.

It would be hasty to draw any firm conclusions from this study. To the authors' knowledge, there have been few, if any, published reports of probabilistic reasoning in deluded subjects, and none that shows results such as these.

Although the deluded sample's responses on two of the measures appears more "Bayesian", being less subject to the "conservatism" bias than normals, it is not possible to conclude that deluded people are better reasoners. One could argue that here an abnormal bias—a tendency to draw on little evidence and to be over-confident—is cancelling out a normal bias—towards conservatism in this type of (easy) probabilistic reasoning task. Conservatism of this type may, in certain circumstances, be ecologically valid (Johnston,

1981) serving as a useful general strategy under conditions of uncertainty. Furthermore, there is a hint in these data that there may be sub-groups of deluded people, some of whom could clearly not be described as better Bayesians, being incautious and overconfident in decision making. If that were so, the data of the deluded group itself could be misleading, one sub-group's abnormal bias cancelled out by a more normative set of responses from the other deluded subjects. Clearly this requires further investigation. Furthermore, these tasks were undertaken by deluded subjects when they were symptomatic: it is not known whether in asymptomatic states they would yield similar results. It would also be instructive to study the performance of deluded subjects both on tasks where less conservatism is typically demonstrated by normals and also when normals actually demonstrate incaution.

Even at this stage, however, there may be some clinical implications of this work. Rachman (1983) points to the value of identifying biases in thinking as a prelude to intervention: such an approach has proved its value with depressed subjects (Rush, Beck, Kovacs, & Hollon, 1977). There is some evidence that the techniques of "belief modification" are helpful with deluded subjects (Milton, Patwa, & Hafner, 1978; Watts, Powell, & Austin, 1973). A detailed analysis of reasoning biases, using a Bayesian framework (Hemsley & Garety, 1986) could, in the individual case, prove a fruitful starting point for therapeutic intervention.

REFERENCES

Alloy, L. B. & Abramson, L. Y. (1979). Judgment of contingency in depressed and non-depressed students: Sadder but wiser? *Journal of Experimental Psychology: General, 108*, 441–485.

American Psychiatric Association (1980). *Diagnostic and statistical manual of mental disorders* (3rd edition). Washington, DC: A.P.A.

Brennan, J. H. & Hemsley, D. R. (1984). Illusory correlations in paranoid and non paranoid schizophrenia. *British Journal of Clinical Psychology, 23*, 225–226.

Chapman, L. J. (1967). Illusory correlations in observation report. *Journal of Verbal Learning and Verbal Behavior, 6*, 151–155.

Chapman, L. J. & Chapman, J. P. (1959). Atmosphere effect re-examined. *Journal of Experimental Psychology, 58*, 220–226.

Domarius, E. von (1944). The specific laws of logic in schizophrenia. In J. Kasanin (Ed.), *Language and thought in schizophrenia*. Berkeley, CA: University of California Press.

Edwards, W. (1982). Conservatism in human information processing. Chapter 25 in *Judgment under uncertainty: Heuristics and biases*. D. Kahneman, P. Slovic, & A. Tversky (Eds.). Cambridge: Cambridge University Press.

Fischhoff, B. & Beyth-Marom, R. (1983). Hypothesis evaluation from a Bayesian perspective. *Psychological Review, 90*, 239–260.

Frith, C. D. (1979). Consciousness, information processing and schizophrenia. *British Journal of Psychiatry, 134*, 225–235.

Garety, P. A. (1985). Delusions: Problems in definition and measurement. *British Journal of Medical Psychology, 58*, 25–34.

Garety, P. A. & Hemsley, D. R. (1987). Characteristics of delusional experience. *European Archives of Psychiatry and Neurological Sciences, 236*, 294–298.

Hemsley, D. R. & Garety, P. A. (1986). The formation and maintenance of delusions: A Bayesian analysis. *British Journal of Psychiatry, 149*, 51–56.

Jaspers, K. (1913). *General psychopathology* (Translated by J. Hoenig & M. W. Hamilton, 1959). Manchester: Manchester University Press.

Johnson-Laird, P. N. (1982). Thinking as a skill. *Quarterly Journal of Experimental Psychology, 34A*, 1–29.

Johnston, T. D. (1981). Contrasting approaches to a theory of learning. *Behavioral and Brain Sciences, 4*, 125–173.

Kahneman, D., Slovic, P., & Tversky, A. (Eds.). (1982). *Judgment under uncertainty: Heuristics and biases.* Cambridge: Cambridge University Press.

Lichtenstein, S., Fischhoff, B., & Phillips, L. D. (1982). Calibration of probabilities: The state of the art to 1980. Chapter 22 in *Judgment under uncertainty: Heuristics and biases.* D. Kahneman, P. Slovic, & A. Tversky (Eds.). Cambridge: Cambridge University Press.

Maher, B. A. (1974). Delusional thinking and perceptual disorder. *Journal of Individual Psychology, 30*, 98–113.

Mayer-Gross, W., Slater, E., & Roth, M. (1969). *Clinical psychiatry.* London: Balliere.

Milton, F., Patwa, V. K., & Hafner, R. J. (1978). Confrontation vs. belief modification in persistently deluded patients. *British Journal of Medical Psychology, 51*, 127–130.

Phillips, L. D. & Edwards, W. (1966). Conservatism in a simple probabilistic inference task. *Journal of Experimental Psychology, 72*, 346–354.

Rachman, S. J. (1983). Irrational thinking, with special reference to cognitive therapy. *Advances in Behaviour Therapy, 5*, 63–88.

Rush, A. J., Beck, A. T., Kovacs, M., & Hollon, S. D. (1977). Comparative efficacy of cognitive therapy versus pharmacotherapy in out-patient depressives. *Cognitive Therapy and Research, 1*, 17–37.

Volans, P. J. (1976). Styles of decision making and probability appraisal in selected obsessional and phobic patients. *British Journal of Social and Clinical Psychology, 15*, 305–317.

Watts, F. N., Powell, G. E., & Austin, S. V. (1973). The modification of abnormal beliefs. *British Journal of Medical Psychology, 46*, 359–363.

Winters, K. C. & Neale, J. M. (1983). Delusions and delusional thinking in psychotics: A review of the literature. *Clinical Psychology Review, 3*, 227–253.

Revised manuscript received 16 February 1988