Reasoning in people with obsessive–compulsive disorder

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Objectives. The aim of this study was to investigate the inductive and deductive reasoning abilities of people with obsessive–compulsive disorder (OCD). Following previous research, it was predicted that people with OCD would show different abilities on inductive reasoning tasks but similar abilities to controls on deductive reasoning tasks.

Design. A two-group comparison was used with both groups matched on a range of demographic variables. Where appropriate, unmatched variables were entered into the analyses as covariates.

Methods. Twenty-three people with OCD and 25 control participants were assessed on two tasks: an inductive reasoning task (the 20-questions task) and a deductive reasoning task (a syllogistic reasoning task with a content-neutral and content-emotional manipulation).

Results. While no group differences emerged on several of the parameters of the inductive reasoning task, the OCD group did differ on one, and arguably the most important, parameter by asking fewer correct direct-hypothesis questions. The syllogistic reasoning task results were analysed using both correct response and conclusion acceptance data. While no main effects of group were evident, significant interactions indicated important differences in the way the OCD group reasoned with content neutral and emotional syllogisms.

Conclusions. It was argued that the OCD group’s patterns of response on both tasks were characterized by the need for more information, states of uncertainty, and doubt and postponement of a final decision.

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DOI:10.1348/01446507X228438
Most research investigating reasoning in obsessive-compulsive disorder (OCD) has focused on decision-making and probabilistic inference, with the general conclusion being that people with OCD require more information and time before making a decision (e.g. Fear & Healy, 1997). Recent research, however, has suggested that different abilities in deductive and inductive reasoning may be crucial to our understanding of OCD symptomology (O'Connor & Robillard, 1995, 1999).

Deductive reasoning involves the generation or evaluation of conclusions on the basis of given assumptions or ‘premises’. A valid conclusion follows necessarily from such premises and does not require the addition of information beyond that presented. Inductive reasoning, in contrast, makes use of additional information (e.g. generalizations or prior associations) to reach an inferential solution. Inductive inferences are, therefore, only ‘possible’ as opposed to being logically necessary. Pélissier and O’Connor, basing their research on O’Connor and Robillard’s (1995) theoretical framework, found little difference between the people with OCD and controls on various deductive problems, but discrepant performance on inductive tasks (e.g. people with OCD took longer to make bridging inferences linking unrelated statements). Pélissier and O’Connor argue that people with OCD display a distinctive ‘inductive’ style of inference, whereby events (e.g. unpleasant outcomes) are reasoned to be probable on the basis of irrelevant associations – rather than being deemed as non-necessary on the basis of factual evidence or perceivable reality. In other words, ‘inductive inference seemed to replace deductive inference in the OCD situation’ (Pélissier & O’Connor, 2002, p. 16). Although we are unaware of other studies examining reasoning in OCD, Reed (1977), using participants with anankastic (or obsessional) personality disorder, also found a difference in inductive and deductive task performance. Interestingly, while worse than the comparative group (people with other personality disorders) on inductive tasks, these participants were better on deductive tasks.

Pélissier and O’Connor’s study, however, raises several issues of concern. First, one set of deductive problems used versions of Wason’s (1966) selection task. Although no overall group differences in confirmatory vs. disconfirmatory testing arose, the one task variant with the most discriminatory power to arbitrate between logical and non-logical responding actually revealed marginally more logical behaviour by the OCD group ($p = .07$). Second, another purportedly ‘deductive’ task used, Wason’s (1960) 2–4–6 task, while showing no differences across groups, is not well suited to eliciting deductive processes. Evans (1989), for example, argues that the task, being one of rule discovery, relies primarily on inductive reasoning. Consequently, Pélissier and O’Connor’s proposal that no distinctive deductive style exists in people with OCD could benefit from validation through additional research. Furthermore, the content of the deductive tasks used by Pélissier and O’Connor’s was neutral. Studies that have investigated reasoning with delusional individuals (e.g. Kemp, Chua, McKenna, & David, 1997; McGuire, Junginger, Adams, Burright, & Donovick, 2001) reveal that participants are often unimpaired when reasoning with content-neutral tasks, but impaired with emotionally salient materials. Consequently, if a deductive deficit is associated with people with OCD, it may only be apparent with materials that are specific to their obsessions and compulsions. Indeed, real-world reasoning is rarely divorced from meaningful content, so using only neutral materials reduces ecological validity. Deductive reasoning paradigms, unlike inductive ones, are especially vulnerable to such criticism, given their typical presentation in abstract or semantically impoverished forms.

Several criticisms could also be made about Pélissier and O’Connor’s three inductive tasks, two of which resulted in reliable between-group differences. The results from the
‘bridging task’, which showed that people with OCD were slower to initiate and complete a narrative, are argued to reflect the generation of more alternative possibilities, which causes doubt and slows performance. These results, however, as Pélassier and O’Connor also suggest, could also be accounted for by a general hesitancy in performing cognitive tasks, an aspect of OCD performance that has been detected in a wide range of situations (Foa, Amir, Gershuny, Molnar, & Kozak, 1997). On the ‘supporting an arbitrary statement’ task, the groups also differed significantly. Participants were required to generate reasons to support the experimenter’s claim that ‘This pen belongs to me’. People with OCD changed their conviction in the statement after generating reasons to support it, becoming less sure of its truth. The degree of change in conviction was also positively correlated with scores on an OCD symptom scale. Pélassier and O’Connor concluded that people with OCD show a distinctive style of inductive reasoning because their generation of supporting reasons had a different effect than for the two control groups. However, change of conviction in a statement is perhaps not the strongest measure of inductive reasoning, and would certainly need additional support. Generating reasons to support a statement does involve induction, but there were no differences in the number of reasons produced by the three groups. Consequently, the aspects of these tasks on which OCD people performed differently do need some replication before firm conclusions can be made about inductive ability.

We believe that there is clear scope for further examining deductive and inductive reasoning in OCD with well-established measures. In this study, we opted for syllogistic reasoning (Evans, Barston, & Pollard, 1983) as a deductive paradigm and manipulated the believability of problem contents (also incorporating some OCD-specific materials). Our inductive task was a 20-questions game (John & Dodgson, 1994), whose solution required the application of personal knowledge. It was hypothesized that group differences would emerge on deductive reasoning tasks, although the direction of difference is not specified in relation to the performance of the OCD group on content-specific materials. Given previous research suggesting hesitancy in OCD, we also examined solution time to complete the task. Furthermore, as Pélassier and O’Connor provide some evidence of difference on inductive style, it was also hypothesized that differences on the inductive reasoning task would emerge.

**Method**

**Participants**

Twenty-three people with OCD were recruited from an out-patient clinic at a UK hospital. Participants were diagnosed according to DSM-IV (APA, 1994) criteria, using a structured clinical interview, by an experienced consultant psychiatrist who also completed their Yale-Brown Obsessive–Compulsive Scale assessment (Y-BOCS; Goodman et al. 1989). Most participants ($N = 20$) had a score above 16 (the standard clinical cut-off for OCD) on the Y-BOCS. Exclusion criteria were presence of another Axis I disorder, presence of an Axis II disorder, history of drug or alcohol abuse, presence of an organic brain dysfunction, and psychosurgery. All those who fulfilled the inclusion/exclusion criteria and consented to take part were included. Three people had Y-BOCS scores of less than 16 (14, 11, and 10), but were considered suitable for inclusion due to the length of illness (18, 14, and 19 years, respectively) and because they still met diagnostic criteria for OCD. Non-psychiatric control participants were recruited from local contacts and excluded if they reported any previous or current mental health problems or scored highly on the clinical rating scales. Group demographics are displayed in Table 1.
The OCD group consisted of 11 men and 12 women, with the control group comprising 9 men and 16 women. The two groups were successfully matched on sex, $\chi^2(1) = 0.69, p = .406$, premorbid IQ, as measured by the National Adult Reading Test (NART: Nelson, 1982) and the number of years spent in full-time education (Table 1). The OCD group were older than the control group and not surprisingly displayed a significantly higher level of obsessive–compulsive behaviours, as measured by the Maudsley Obsessional Compulsive Inventory (MOCI: Hodgson & Rachman, 1977). They also displayed significantly higher levels of depression, as assessed by the Beck Depression Inventory (BDI: Beck & Steer, 1987), significantly higher levels of anxiety, as measured by the Spielberger Trait Anxiety Inventory (STAI-T: Spielberger, 1983), but levels of delusional thought, as measured by the Magical Ideation Scale (Eckblad & Chapman, 1983), were similar across groups. With the exception of MOCI scores, any variables that were significantly correlated with dependent variables were entered in inferential analyses as covariates.

### Materials and design

#### Experimental tasks

The tasks used to test inductive ability were versions of the 20-questions game which required participants to discover the object of the experimenter's thoughts by asking a maximum of 20 questions, answerable with only ‘yes’ or ‘no’ responses. Two types of questions could be asked: Constraint-locating questions permitted the narrowing of possible solutions, such as ‘Is it a woman?’; direct-hypothesis questions were ones such as ‘Is it Marilyn Monroe?’ The three tasks were the following: (1) Which famous person am I thinking of? (2) Which item that can be bought in a shop am I thinking of? and (3) Which type of job am I thinking of? Two of these tasks were randomly selected for each participant. Measures taken were:

1. Mean number of constraint-locating questions asked prior to the first direct-hypothesis question.
2. Mean number of incorrect direct-hypothesis questions and mean number of constraint-locating questions.

#### Table 1. Mean values for participant group demographics (standard errors of the mean are shown in brackets)

<table>
<thead>
<tr>
<th>Group</th>
<th>Measures</th>
<th>OCD</th>
<th>Control</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age</td>
<td>41.52 (2.34)</td>
<td>32.36 (2.78)</td>
<td>2.497</td>
<td>46</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>Premorbid IQ</td>
<td>110.83 (1.32)</td>
<td>112.92 (1.42)</td>
<td>1.075</td>
<td>46</td>
<td>.288</td>
</tr>
<tr>
<td></td>
<td>Years in education</td>
<td>14.89 (0.64)</td>
<td>15.56 (0.37)</td>
<td>0.907</td>
<td>35.60</td>
<td>.371</td>
</tr>
<tr>
<td></td>
<td>Length of illness</td>
<td>14.26 (2.19)</td>
<td>na</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y-BOCS score</td>
<td>20.54 (1.27)</td>
<td>na</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MOCI score</td>
<td>16.87 (1.25)</td>
<td>5.20 (0.95)</td>
<td>7.515</td>
<td>46</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Beck depression inventory score</td>
<td>15.39 (2.22)</td>
<td>4.72 (0.86)</td>
<td>4.476</td>
<td>28.49</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Spielberger trait inventory score</td>
<td>72.13 (6.81)</td>
<td>35.72 (2.04)</td>
<td>5.118</td>
<td>25.94</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Magical ideation score</td>
<td>5.61 (1.00)</td>
<td>3.44 (0.72)</td>
<td>1.778</td>
<td>47</td>
<td>.086</td>
</tr>
</tbody>
</table>
(3) Number of correct direct-hypothesis questions asked (correct direct-hypothesis questions indicate discovery of what the experimenter was thinking).

(4) Mean number of questions before giving the correct answer.

The deductive task used involved the evaluation of syllogistic conclusions. Syllogisms consist of two statements (premises) that have a common ‘middle term’ and a conclusion that links the premises but excludes the middle term. An example is: *No A are B* (premise 1), *Some C are B* (premise 2), *Therefore Some C are not A* (conclusion). This syllogism is valid because the conclusion is necessitated by the premises. If a conclusion is merely possible given the premises but not necessitated, then it is invalid. An example would be: *No A are B, Some C are B, Therefore Some A are not C*. As well as conclusions being valid or invalid, it is also possible to manipulate their believability (using meaningful terms rather than abstract letters) so as to produce conclusions that are either believable (e.g. *Some rich people are not millionaires*) or unbelievable (e.g. *Some millionaires are not rich people*). This manipulation allows for the systematic examination of the biasing effects of beliefs on reasoning as well as impact of logicality (i.e. validity judgements should be based on a syllogism’s logical form and not the conclusion’s believability).

Twenty ‘content-neutral’ syllogisms were used, some of which were adapted from Evans *et al.* (1983) and Kemp *et al.* (1997). All 20 syllogisms had *No A are C* and *Some C are B* premises; 10 had *Some C are not A* conclusions, which are valid, and 10 had *Some A are not C* conclusions, which are invalid. Syllogisms vary in their complexity (and therefore the ease with which they can be solved); these particular syllogisms are relatively difficult (Johnson-Laird & Byrne, 1991). Half of the valid and invalid syllogisms had believable conclusions and half had unbelievable ones. Thus there were four conclusion types: (1) valid–believable; (2) valid–unbelievable; (3) invalid–believable; and (4) invalid–unbelievable – as is conventional in research using this paradigm (Evans *et al.*, 1983). Twenty ‘content-emotional’ syllogisms were also constructed, identical to the content neutral ones in terms of the manipulations of conclusion validity and believability, but different in the specificity of their contents to OCD (with themes of checking, safety, contamination, controllability, and somatic worries).

In this study, an example of a content-neutral valid-believable syllogism would be:

- No judges are fashionable
- Some well-educated people are fashionable

Does it follow that ‘*Some well-educated people are not judges*’?

A content-specific valid-believable syllogism was:

- No cancers are detectable
- Some life-threatening diseases are detectable

Does it follow that ‘*Some life-threatening diseases are not cancers*’?

The presentation order for syllogisms was randomized at the start of the study. The participants’ task was to judge whether each conclusion was valid or invalid. We also measured the time taken by participants to complete all 40 syllogisms (participants were told there was no time limit).
Background measures

A number of background measures were administered:

- The Maudsley Obsessional Compulsive Inventory (MOCI, Hodgson & Rachman, 1977). This is used to assess the presence of obsessive-compulsive behaviours and consists of 30 items requiring true or false responses. The maximum score is 30. Scores of 10 and above demonstrate some degree of obsessive-compulsive symptomology; higher scores indicate more severe symptomology.
- The Beck Depression Inventory (BDI, Beck & Steer, 1987). This 21-item inventory is used to determine levels of depression. For each item, participants choose which of four statements best describes how they are feeling. The score range is 0–63; higher scores indicate higher depression levels.
- The Spielberger Trait Anxiety Inventory (STAI:T: Spielberger, 1983). The trait version of this inventory was used to determine anxiety levels. This form of the measure consists of 20 items rated on a scale of 1–4. The score range is 20–80; higher scores indicate higher levels of anxiety.
- The Magical Ideation Scale (Eckblad & Chapman, 1983). This consists of 30 true or false statements and is used to determine whether participants are experiencing delusional thoughts. The score range is 0–30; higher scores indicate higher levels of delusional-type thinking.
- The National Adult Reading Test (NART: Nelson, 1982). This tests premorbid IQ and consists of 50 irregular spelt words which participants read aloud. Their score (number of words correctly pronounced) is converted into an IQ score.

Procedure

Participants with OCD were approached by a consultant psychiatrist who, after checking that the inclusion criteria were met, gained initial verbal consent. As recruitment took place via a specialist OCD out-patient clinic, high participation rates were recorded with very few participants who met the inclusion criteria declining to take part. Participants were then given an information sheet, which briefly explained the study’s aim and procedure. The experimenter reiterated this information verbally and if the participant was willing to continue, they were asked to sign a consent form. Participants in the non-clinical control group were given a verbal description of the study and those willing to take part were given an information sheet after providing formal consent. During testing, participants completed background demographic questions, clinical rating scales, and the reasoning tasks. All participants were fully debriefed and given a contact e-mail address in case they had any future concerns. The study was subject to full NHS ethical committee review.

Results and discussion

Inductive reasoning task

On the 20-questions tasks participants completed six trials so that the maximum possible number of correct direct-hypothesis questions was six. As in other research using this paradigm (e.g. John & Dodgson, 1994), only trials where the correct answer was eventually given were analysed. Overall, the results demonstrate that both groups performed well, asking several constraint-locating questions before the first direct-hypothesis question, relatively few incorrect direct-hypothesis questions, and, overall, asking more constraint-locating questions than incorrect direct-hypothesis questions.
This represents the optimum approach for solving the task. Furthermore, both groups reached the correct solution for the majority of trials, and on average needed to use only about half of the 20 questions available.

Individual measures were analysed separately using analysis of variance (ANOVA) with diagnostic group as the between-groups factor. BDI scores were only included as a covariate if correlated with the dependent measure (e.g. number of constraint locating questions (i) before the first direct-hypothesis question and (ii) overall and mean number of questions before the correct answer). The control group asked significantly more correct direct-hypothesis questions (\( M = 5.08, SE = .20 \)) than the OCD group (\( M = 4.39, SE = .21 \)) (\( F(1, 46) = 5.52, p = .023, \eta^2_p = .107 \)). There were no between-group differences on the other three measures (all \( F_s < 1.13 \), all \( ps > .29 \)).

**Deductive reasoning**

**Correct judgements**

For each diagnostic group, we calculated the mean number of correct judgements for each syllogism type (valid–believable, valid–unbelievable, invalid–believable, and invalid–unbelievable). Syllogisms were also divided according to whether they were content-neutral or content-emotional (Table 2). Overall, the data suggest that validity and believability affected correct judgments. Performance was best with valid–believable syllogisms and worst with invalid–believable syllogisms, although the exact pattern depended on content and diagnostic group.

**Table 2.** Mean number of each type of syllogism judged correctly for content-neutral and content-emotional conditions

<table>
<thead>
<tr>
<th>Content</th>
<th>Validity</th>
<th>Believability</th>
<th>OCD</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>Valid</td>
<td>Believable</td>
<td>4.34 (0.28)</td>
<td>4.29 (0.27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unbelievable</td>
<td>2.10 (0.40)</td>
<td>3.35 (0.38)</td>
</tr>
<tr>
<td></td>
<td>Invalid</td>
<td>Believable</td>
<td>1.85 (0.35)</td>
<td>1.22 (0.33)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unbelievable</td>
<td>3.78 (0.30)</td>
<td>3.36 (0.29)</td>
</tr>
<tr>
<td>Emotional</td>
<td>Valid</td>
<td>Believable</td>
<td>4.15 (0.28)</td>
<td>3.62 (0.27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unbelievable</td>
<td>3.64 (0.32)</td>
<td>3.45 (0.31)</td>
</tr>
<tr>
<td></td>
<td>Invalid</td>
<td>Believable</td>
<td>1.49 (0.34)</td>
<td>1.95 (0.32)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unbelievable</td>
<td>2.72 (0.35)</td>
<td>2.46 (0.33)</td>
</tr>
</tbody>
</table>

Notes. All reported means are estimated marginal means calculated on the basis of covariates. Standard errors shown in brackets.

These data were analysed using a mixed factorial ANOVA; the repeated measures were those described above and the between-participants factor was diagnostic group (OCD vs. control). BDI was the only unmatched variable included in the analysis as a covariate as BDI scores were significantly correlated with the dependent variable, \( r(46) = -.38, p = .008 \). Significant effects and interactions are shown in Table 3; no others reached the level of significance.

Of particular importance are the two reliable effects associated with diagnostic group. The first was a three-way interaction involving content and validity (upper panel of Figure 1). Further examination indicated that the content \( \times \) validity interaction was
significant in the OCD group ($p < .001$) but not the control group ($F < 1$), where valid syllogisms were more likely to be judged correctly than invalid syllogisms ($F(1, 45) = 19.03, p < .001$). In the OCD group, the validity effect depended on syllogism content. For emotional syllogisms, the pattern in OCD was similar to that with controls; valid syllogisms were more likely to be judged correctly than invalid ($F(1, 45) = 15.59, p < .001, \eta^2 = .28$). However, neutral syllogisms did not produce the same validity effect in OCD, with valid syllogisms being judged correctly to a similar extent to invalid syllogisms ($p = .305$). In essence, it appears that the OCD group reason similarly to controls when materials are emotionally relevant, but differently when materials are neutral.

**Table 3.** Significant main effects and interactions arising from a mixed factorial ANOVA examining conclusion validity, conclusion believability, syllogism content, and diagnostic group. BDI scores were included in the analysis as a covariate.

<table>
<thead>
<tr>
<th>Source</th>
<th>$F$</th>
<th>$\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity</td>
<td>5.39</td>
<td>.11</td>
<td>.025</td>
</tr>
<tr>
<td>Content $\times$ validity</td>
<td>11.24</td>
<td>.20</td>
<td>.002</td>
</tr>
<tr>
<td>Content $\times$ validity $\times$ BDI score</td>
<td>5.72</td>
<td>.11</td>
<td>.021</td>
</tr>
<tr>
<td><strong>Content $\times$ validity $\times$ group</strong></td>
<td>7.31</td>
<td>.14</td>
<td>.010</td>
</tr>
<tr>
<td>Content $\times$ believability</td>
<td>5.88</td>
<td>.12</td>
<td>.019</td>
</tr>
<tr>
<td>Content $\times$ believability $\times$ BDI score</td>
<td>8.86</td>
<td>.16</td>
<td>.005</td>
</tr>
<tr>
<td><strong>Content $\times$ believability $\times$ group</strong></td>
<td>4.14</td>
<td>.08</td>
<td>.048</td>
</tr>
<tr>
<td>Validity $\times$ believability</td>
<td>29.92</td>
<td>.40</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Content $\times$ validity $\times$ believability</td>
<td>6.89</td>
<td>.13</td>
<td>.012</td>
</tr>
</tbody>
</table>

Note. Degrees of freedom were 1 and 45 in all cases.
The second important effect associated with diagnostic group was a three-way interaction involving content and believability (lower panel of Figure 1). Further analysis indicated that for the controls, neither the interaction between content and believability nor the effects of those variables alone were significant (all $F$s < 2.09, all $p$s > .16). The interaction between content and believability was significant for the OCD group ($p = .01$). However, as Figure 1 suggests, the interaction was weak and the believability effect was non-significant, either for neutral or emotional syllogisms (all $F$s < 2.05, all $p$s > .16). Still, the interaction pattern is consistent with the view that while emotionally relevant materials invoke reasoning in people with OCD that is similar to that of controls, it is again the neutral materials that elicit a more discrepant performance of reasoning across groups.

Two other three-way interactions were also of some interest. The interactions between content and validity and between content and believability (Table 2) depended on levels of depressed mood as measured by the BDI. To interpret these interactions, correlation coefficients were calculated. Participants who were more depressed were less likely to judge invalid-neutral and believable-neutral syllogisms correctly ($r(46) = -.29, p = .04$; $r(46) = -.39, p = .007$, respectively). The negative relation between response accuracy and BDI scores supports research (Channon & Baker, 1994), indicating that depressed mood is associated with worse performance on syllogistic tasks. These authors argue that difficulties with ‘effortful processing’ may underpin such performance effects. Invalid syllogisms are known to be more difficult than valid ones (Quayle & Ball, 2000), which supports our observation that responses to invalid-neutral problems may be adversely affected by depressed mood.

**Conclusion—endorsement rates**

An alternative way to examine syllogistic reasoning data is in terms of conclusion-endorsement rates (number of conclusions accepted as valid irrespective of correctness). This enables a theory-driven analysis of performance, as contemporary accounts of syllogistic inference are based on this measure. Endorsement rates generally reveal three key findings (Ball, Phillips, Wade, & Quayle, 2006). First, believable conclusions are accepted more than unbelievable ones (the so-called ‘belief bias’ effect). Second, valid conclusions are accepted more than invalid ones (people demonstrate some logicality). Third, there is often an interaction between validity and believability, such that the effects of belief bias are stronger with invalid than valid conclusions, although the emergence of this interaction is paradigm dependent (Klauer, Musch, & Naumer, 2000). Increased belief bias with invalid problems has been attributed to their greater difficulty compared with valid problems, suggesting that belief bias reflects a ‘response bias’ that arises when reasoning fails to produce a confident evaluation (Quayle & Ball, 2000).

A factorial ANOVA, as described in the previous section, was used to analyse endorsement data (Figure 2). There was a reliable four-way interaction between content, validity, believability, and diagnostic group ($F(1,45) = 4.53$, $p = .039$, $\eta^2_p = 0.9$). Further analysis showed that for the control group, valid conclusions were endorsed more than invalid ones ($p = .01$) and believable conclusions were endorsed more than unbelievable ones ($p = .005$). This endorsement pattern pertaining to validity ($p = .02$) and believability ($p = .006$) was similar in the OCD group. To understand the nature of the four-way interaction, we conducted a series of two-way ANOVAs to establish the presence or absence of a validity $\times$ believability interaction at
the level of each content type (emotional vs. neutral) for each group. These analyses revealed no presence of a validity × believability interaction for either neutral or emotional contents in the control group ($F$s < 1). For the OCD group, however, the validity × believability interaction was reliable for both neutral and emotional contents, but with a larger effect size emerging for the former ($F(1, 21) = 6.14, p = .02, \eta^2_p = .23$) than the latter ($F(1, 21) = 4.87, p = .039, \eta^2_p = .19$).

The significant validity × believability interactions for OCD participants arise because belief bias effects are stronger on invalid conclusions ($p < .001, \eta^2_p = .64$ for neutral content; $p < .001, \eta^2_p = .49$ for emotional content) and weaker - though still reliable - on valid conclusions ($p < .001, \eta^2_p = .50$ for neutral content; $p = .041, \eta^2_p = .19$ for emotional content). These conclusion-endorsement findings corroborate and extend our analysis of correct responses by showing that reasoning on neutral problems is particularly different in the OCD group compared with the control group. Figure 2 shows this reasoning discrepancy between groups on neutral problems very clearly, with striking levels of belief bias apparent in OCD.
**Solution times**

We calculated mean overall solution times (in minutes). Although the OCD group took more time to complete the task ($M = 29.80$, $SE = 2.92$) than controls ($M = 24.36$, $SE = 2.78$), the difference was not reliable ($F(1, 45) = 1.53$, $p = .22$, $\eta^2_p = .03$). We note that our timing measure was a gross one, based on the overall latency to complete all presented syllogisms. As such, important time-based differences in the processing of emotional and neutral problems by our diagnostic groups may have been obscured by the insensitivity of the measure.

**General discussion**

Research on the inferential performance of people with OCD (e.g. Pélassier & O’Connor, 2002) suggests they may reason like controls on deductive tasks, but have a distinctive reasoning style on inductive tasks. Our study aimed to contribute further to understanding inferential processes in OCD by using well-established inductive and deductive paradigms (20-questions games and syllogisms, respectively). The deductive task also included a problem-content manipulation, whereby some problems were emotionally relevant to people with OCD, whereas others were emotionally neutral. This manipulation afforded an opportunity to assess how deductive processes in OCD may be impacted by factors beyond conclusion validity and believability. In the case of reasoning by people with delusions, for example, evidence suggests that performance may be similar to controls with content-neutral tasks, but less effective with emotionally oriented materials (Kemp et al., 1997; McGuire et al., 2001).

Our results for the inductive task indicated that the OCD group performed similar to the controls, differing on only one of four parameters by asking significantly fewer correct direct-hypothesis questions. Arguably, however, this is the most important parameter and may suggest a specific reluctance by the OCD participants in forwarding definitive solution proposals. This doubt or hesitancy is likely to manifest itself only when faced with a more final response choice, which would explain why performance on the other inductive task parameters was not different from controls. On the deductive task, the most striking finding was the content × validity × group interaction on correct scores, where, for controls, emotional and neutral contents had a similar effect on performance across valid and invalid syllogisms, but where, for the OCD group, performance was very different in relation to problem contents. In particular, while the OCD group’s reasoning with emotionally relevant syllogisms was similar to that of controls (i.e. a strong logic effect emerged whereby more valid than invalid conclusions were judged correctly), the OCD group’s reasoning with neutral syllogisms showed no logic effect, unlike the controls where the logic effect persisted.

The unusual way in which the OCD group processed neutral syllogisms was also evident when results were collapsed across validity. In this case, the OCD group’s performance with neutral problems showed similar levels of correct responding for believable and unbelievable conclusions, whereas the control group showed better responding for unbelievable than believable conclusions, as is typically observed in belief bias research. Finally, the analysis of conclusion-endorsement rates confirmed that the OCD group’s reasoning approach with neutral problems was unusual compared with the control group, revealing very strong belief bias on valid conclusions and still stronger belief bias on invalid conclusions.
What, then, do our data tell us about inferential abilities in OCD? The hypothesis that people with OCD would show different reasoning on inductive tasks than controls (Pélassier & O’Connor, 2002) was partially supported since they asked fewer correct direct-hypothesis questions, perhaps reflecting a hesitancy to forward solution proposals. This observation links with performance patterns seen on other inductive and probabilistic tasks, in which OCD responding is characterized by the need for more information, states of uncertainty and doubt, and postponement of a final decision (e.g. Fear & Healy, 1997; Pélassier & O’Connor, 2002; Reed, 1985).

For our deductive data, we found no overall group difference between people with OCD and controls. While this observation seems to support the view (Pélassier & O’Connor, 2002) that the deductive performance of those with OCD is similar to controls, at a deeper level of analysis a more interesting picture emerges in which manipulations of content, validity and believability affected comparative performance between groups. The most salient group difference related to neutral syllogisms, with evidence for the OCD group responding in a primarily belief-biased manner, whereas the control group showed less dramatic belief bias. These observations challenge the notion that the deductive performance of people with OCD is uniformly equivalent to that of controls, and also raise the question of why neutral deductive tasks should invoke such a discrepant reasoning process in OCD.

To account for these deductive effects in OCD, we must first consider theories of belief bias in syllogism endorsement rates with non-psychiatric groups. Contemporary theories of belief bias are couched within ‘dual-process’ models of reasoning, which view belief bias as arising through the interplay between belief-oriented ‘heuristic’ processes and logic-based ‘analytic’ processes (Evans, 2007). Within this dual-process framework, a key notion is that syllogistic reasoning progresses in a conclusion-to-premise manner, with participants deploying analytic processes to construct mental models of premises (Johnson-Laird & Byrne, 1991) that either include believable conclusions or refute unbelievable conclusions (Ball et al., 2006; Klauer et al., 2000). Heuristic processes come to the fore primarily when people are unable to deduce a ‘confident’ evaluation (i.e. when analysis leads to a state of ‘uncertainty’). In this situation, a belief heuristic acts as a response bias, accepting believable conclusions and rejecting unbelievable ones (Quayle & Ball, 2000; Thompson, Striener, Reikoff, Gunter, & Campbell, 2003).

Within this framework, we can present an account of why people with OCD reveal a discrepant style of reasoning on neutral syllogisms compared with controls, but apparently similar reasoning with emotional syllogisms. First, we propose that people with OCD will lack confidence with neutral syllogisms because of the relative unfamiliarity of the problem contents in terms of these individuals’ everyday concerns. In particular, limitations with information ‘availability’ (Pollard, 1982; Tversky & Kahneman, 1973) would promote difficulties in the spontaneous organization and integration of presented information (Greisberg & McKay, 2003; Reed, 1985), which would lead to feelings of uncertainty. According to the dual-process model, such uncertainty would lead directly to a heuristic response (Quayle & Ball, 2000), thus accounting for increased belief bias with neutral problems in our OCD group. Second, we propose that emotional materials, because of the relative availability of their contents in relation to themes linked to OCD, provide a better semantic platform from which to reason analytically in OCD. Indeed, people with OCD have been shown to have superior memory for personally relevant information concerning threat-related items (Radomsky, Rachman, & Hammond, 2001), and it is generally accepted that effective inference
depends upon the accuracy of understanding premise information, such that content can increase or decrease deductive success (Evans, 1989).

One strength of this account is that it provides a unified interpretation of our OCD group’s reasoning performance with inductive and deductive tasks involving neutral contents; in both cases, the underlying processes that engender some aspects of the discrepant performance in this group relative to controls derive from greater uncertainty. This explanation also ties in with evidence that a range of cognitive tasks are associated with hesitancy and doubt in OCD (O’Connor, Aardema, & Pélassier, 2005; Summerfeldt, Huta, & Swinson, 1998).

As only the second study to test formally the deductive and inductive abilities of people with OCD, our research provides a useful addition to Pélassier and O’Connor’s (2002) work. We attempted to eliminate some confounds in their study, although limitations remain. The use of only single tests of deductive and inductive reasoning is problematic, although the test session (around 90 minutes) was extensive, and numerous measures were taken from both tasks. Our inductive task was not tailored to contain OCD-specific content, so it is uncertain to what extent more meaningful content may have affected performance in the OCD group. Our gross time-based measure on the deductive task limited what could be gleaned about latency differences between different problem contents, which is something that could profitably be explored in future research. It would also be advisable in future research to assess objectively the relevance of the ‘emotional’ syllogisms to participants by means of a rating scale. The relative purity of the OCD group in terms of lack of comorbidity may also have implications for the generalization of these results. Furthermore, the study lacked a second control group (e.g. with another anxiety disorder). However, we statistically controlled for the effects of anxiety, depression, and delusional ideation.

The general conclusion from our study is that people with OCD have elements of a distinctive performance of both inductive and deductive reasoning, although the latter only emerges with neutral problem contents that provide a limited semantic basis for analytic reasoning. At a broader explanatory level, we propose that the key to understanding OCD symptomology may hinge on mechanisms promoting doubt and uncertainty during reasoning. From a clinical perspective, a number of issues appear pertinent. First, in relation to the inductive tasks, given the importance of hesitancy in preventing people with OCD from putting forward definitive responses, the recognition of doubt as a key influence on the development of symptoms is emphasized. This already plays an important role in many cognitive-based therapeutic approaches (e.g. O’Connor et al., 2005), and while it needs to be emphasized as part of its function in the development of symptoms, it could also be usefully addressed by more general confidence-building techniques. In terms of the deductive task, a number of suggestions are possible. Building confidence in problem-solving ability is certainly a key, given that people with OCD do not show any sign of a clear deficit or lack of ability in deductive skills. Techniques such as those taught in mindfulness training (e.g. Hannon & Tolin, 2005) might also allow the individual with OCD to be able to remove the obsessions from constant focus. This could help to enrich the individual’s personal reference base by encouraging attention to the here-and-now. Still, it will clearly be a challenge to build confidence in problem-solving abilities while – as part of cognitive approaches at least – increasing the ability to recognize ‘errors’ in the context of domains that are related to symptoms.
References


Received 30 September 2005; revised version received 5 June 2007