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## Belief-bias reasoning in non-clinical delusion-prone individuals

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### ABSTRACT

**Background and Objectives:** It has been proposed that people with delusions have difficulty inhibiting beliefs (i.e., “doxastic inhibition”) so as to reason about them as if they might not be true. We used a continuity approach to test this proposal in non-clinical adults scoring high and low in psychometrically assessed delusion-proneness. High delusion-prone individuals were expected to show greater difficulty than low delusion-prone individuals on “conflict” items of a “belief-bias” reasoning task (i.e. when required to reason logically about statements that conflicted with reality), but not on “non-conflict” items.

**Methods:** Twenty high delusion-prone and twenty low delusion-prone participants (according to the Peters et al. Delusions Inventory) completed a belief-bias reasoning task and tests of IQ, working memory and general inhibition (Excluded Letter Fluency, Stroop and Hayling Sentence Completion).

**Results:** High delusion-prone individuals showed greater difficulty than low delusion-prone individuals on the Stroop and Excluded Letter Fluency tests of inhibition, but no greater difficulty on the conflict versus non-conflict items of the belief-bias task. They did, however, make significantly more errors overall on the belief-bias task, despite controlling for IQ, working memory and general inhibitory control.

**Limitations:** The study had a relatively small sample size and used non-clinical participants to test a theory of cognitive processing in individuals with clinically diagnosed delusions.

**Conclusions:** Results failed to support a role for doxastic inhibitory failure in non-clinical delusion-prone individuals. These individuals did, however, show difficulty with conditional reasoning about statements that may or may not conflict with reality, independent of any general cognitive or inhibitory deficits.

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## 1. Introduction

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V; American Psychiatric Association, 2013) defines delusions as “fixed beliefs that are not amenable to change in light of conflicting evidence. ... The distinction between a delusion and a strongly held idea ... depends in part on the degree of conviction with which the belief is held despite clear or reasonable contradictory evidence regarding its veracity” (p. 87). Few theories of delusion aim to account for all the core features of the phenomenon as expressed in this definition, specifically, their formation,

uncritical adoption and maintenance in the face of rational counter-argument, and manifestation across different delusional themes and range of delusional conditions. For this reason, the two-factor theory of delusions (Coltheart, 2010; Davies, Coltheart, Langdon, & Breen, 2001; Langdon & Coltheart, 2000) is used as an explanatory framework for the current study.

### 1.1. The two-factor approach to explaining delusions

Central to the two-factor approach is that the presence of any delusion, regardless of theme or medical context, must be accounted for by answering two distinct questions: 1) how did the unusual thought content first arise?; and 2) having once entertained the idea, why does the patient fail to reject it? The first factor answers the first question and is thought to involve neuropsychological impairment that disrupts sensory or affective processing and/or internal monitoring, which in turn associates with an anomalous experience. For example, Breen, Caine, and Coltheart

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(2001) described patient FE with mirrored-self misidentification delusion (i.e., the delusional belief that one's reflection in a mirror is a stranger). The content of his delusion could be reasonably explained by an impairment of his face perception abilities stemming from the early stages of dementia, which distorted his perception of his mirrored reflection. While a first factor that reasonably explains the origin of delusional content can be identified in many such cases, two-factor theorists argue that this is not sufficient to explain the persistence of the delusional belief. Supporting their position is evidence of dissociations. That is, there are individuals who have the same proposed factor-one deficits as seen in people with delusions (e.g. impaired face recognition), but who do not present with delusions (Coltheart, 2005). It is argued, therefore, that a second factor that compromises belief evaluation must also be present to explain why a delusion is adopted and persists.

### 1.2. Specifying the second factor

Attempts to explain the causal mechanisms of defective belief evaluation in individuals with delusions have typically looked towards the literature on reasoning. For example, research has shown that people with delusions, when compared to healthy controls, have a tendency to gather less evidence when arriving at a hypothesis (i.e., they show a jumping to conclusions bias) (Garety & Freeman, 2013) and a tendency to ignore or discount evidence that challenges their current beliefs (i.e., they show a bias against disconfirmatory evidence, BADE) (Woodward, Moritz, Cuttler, & Whitman, 2006). Some researchers, however, have raised doubt as to the role of these evidence-gathering biases specifically in the maintenance of delusional beliefs, once they have been adopted (e.g. Fine, Gardner, Craigie, & Gold, 2007).

In related research on conditional reasoning, Sellen, Oaksford, and Gray (2005) proposed that a diminished influence of prior knowledge when reasoning might also contribute to delusional thinking. Using a schizotypy measure to capture the degree of schizophrenia-like symptoms in healthy individuals, they found individuals scoring high on the dimension of "Impulsive Nonconformity" - though not on the "Unusual Experiences" dimension more closely related to delusional thinking - were less influenced by semantic knowledge when making causal inferences. Alternatively, Speechley, Murray, McKay, Munz, and Ngan (2010) proposed that dual-stream processing, which involves the interplay of intuitive ("system-1") and reflective ("system-2") processing, is compromised in people with delusions. They suggested that individuals with delusions fail to engage more reflective, logical reasoning processes when presented with evidence that conflicts with the delusional beliefs that arise initially via their intuitive processing. In a similar vein, Aimola Davies and Davies (2009) suggested that the second factor in the two-factor account may relate to impaired "system-2" processing. Specifically, their suggestion is that defective working memory and/or executive dysfunction in those with delusions, compromises the reflective process of evaluating different competing hypotheses. Related to the above suggestions, a number of researchers have proposed a more specific role of "doxastic" (or belief-related) inhibitory failure in delusion maintenance (e.g., Aimola Davies & Davies, 2009; Langdon, 2011). This is the idea that individuals with delusions have a difficulty with suppressing the default belief generated by their (mis)perception of reality resulting from their anomalous factor-one experience. As a consequence of being unable to suspend their default (incorrect) beliefs, they are unable to engage in healthy belief evaluation processes.

The current study focuses on the proposal that the factor-two impairment of belief evaluation in people with delusions involves

inhibition deficits. Harnishfeger (1995) distinguished between intentional inhibition, an executive process involving the deliberate suppression of dominant stimuli or responses, which seems more aligned with doxastic inhibition, and automatic inhibition, the unconscious susceptibility to interference during competition (e.g., when processing colour and word information during the presentation of words in dissonant coloured ink during the Stroop task). However, a caveat here is that intentional and automatic inhibition processes interact (e.g., faster reaction times on the Stroop task might reflect less automatic interference and/or better intentional suppression of word-reading). Of relevance here, Orem and Bedwell (2010) found that increased reaction time (RT) to name colours of incongruent words on a Stroop task correlated with higher levels of delusion-proneness in non-clinical adults. Little previous research, however, has used inhibition tasks related more specifically to belief suppression (or doxastic inhibition) in individuals with delusions.

### 1.3. Belief-bias reasoning

One such inhibition task examines the belief-bias effect, which refers to the influence of real-world believability when people are required to reason logically according to a set of premises (Evans & Curtis-Holmes, 2005) – for example, if statements "A" and "B" hold, does statement "C" follow? Beliefs about the world normally inhibit or facilitate reasoning on this classic three-statement version of the belief-bias reasoning task (i.e. syllogisms) such that healthy individuals perform worse when the logical conclusion conflicts with pre-existing beliefs and perform better when they coincide.

Few studies have investigated belief-bias reasoning in individuals with delusions, and at present, findings are mixed. For example, Owen, Cutting, and David (2007) found that a group of people with schizophrenia performed better than their healthy control group on a syllogistic belief-bias reasoning task, but, crucially, performance fell near chance for both groups (41% correct for controls and 59% correct for the schizophrenia group) across the 15 items used. The chance performance suggests that participants may have been responding randomly and that the group difference may have reflected other unknown biases, rather than belief suppression capacities. The study also lacked appropriate control conditions and used a relatively small sample size. In contrast to the Owen et al. findings, Speechley et al. (2010) tested a group of patients with schizophrenia and non-patient controls on a simpler belief-bias task involving only two conditional statements. Thirteen of their 14 patients had delusions or unrealistic beliefs bordering on delusions. Their task fully manipulated logicity by believability and was presented in the format - "if some talking creatures are dogs, then some dogs can talk – logical or illogical?". The control group's accuracy rate in Speechley et al.'s study was 94% compared to the far lower rates above. Using this simpler task, Speechley and colleagues found that their patient group performed significantly worse when judging logicity in the conflicting conditions, both compared to the non-conflicting conditions and the healthy controls. Some ambiguities remain about their findings, however. For example, Speechley and colleagues assessed current and premorbid IQ but no other cognitive abilities such as working memory, which might have compromised the patients' performances. Of greater concern, no association was found between delusional severity in the patients and task performance, albeit the authors suggest this may be attributable to the relatively small sample size.

### 1.4. The current study

Against this background, the current study adopts a "continuity" approach to study belief-bias reasoning in non-clinical individuals

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