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# Overconfidence in psychosis: The foundation of delusional conviction?

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**Abstract:** A number of recent studies have identified an "overconfidence effect" in psychosis, whereby people with schizophrenia are overconfident in errors while simultaneously slightly underconfident when accurate. This effect may have implications for why delusions, which are based on *inaccurate* inferences, perceptions and judgements, are typically held with high conviction. Given the importance the overconfidence effect may have in accounting for delusional conviction, the current narrative review aims to summarise and critique the recent evidence for the effect within schizophrenia. People with schizophrenia were consistently found to be overconfident in errors and slightly underconfident in correct appraisals, and this effect appears not to be an artefact of poor task performance. While the overconfidence effect has been linked to delusion-proneness in the general population, there was less direct evidence linking overconfidence to delusional symptoms in clinical populations. Future studies need to adopt longitudinal designs and include additional measures of overconfidence to investigate this association more appropriately, and to also investigate possible mediators of this postulated relationship, such as dopaminergic activity.

**Subjects: Cognitive Psychology; Psychiatry & Clinical Psychology - Adult; Schizophrenia**

**Keywords: overconfidence; cognitive bias; delusions; psychosis; schizophrenia**

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## ABOUT THE AUTHOR

Ryan P. Balzan is a Vice-Chancellor's Early Career Research Fellow at the School of Psychology, Flinders University. His area of research is within the field of cognitive neuropsychiatry, which applies the knowledge base of cognitive psychology to the study of psychiatric symptoms, such as delusional beliefs. Balzan's research has focussed on the role that cognitive biases (i.e. problematic thinking styles) play in the development and maintenance of delusions, both in individuals with schizophrenia and in those identified as "delusion-prone" (i.e. people with mild delusional beliefs or tendencies). The current manuscript reviews the evidence for the overconfidence bias, which may be heightened in people with schizophrenia, and whether this may also play a role in the formation and/or maintenance of delusions.

## PUBLIC INTEREST STATEMENT

Delusions are among the most debilitating symptoms of schizophrenia, an illness that directly affects nearly one in every 100 people worldwide. The *Schizophrenia Research Institute* estimates that the direct and indirect cost of schizophrenia in Australia alone exceeds $2.6 billion per annum, and will continue to rise unless our understanding of the disorder is improved and treatments can be made more effective. Having a better understanding of the psychological processes underlying the symptoms of schizophrenia, such as delusions, works towards reaching these goals. The current review paper examines whether *overconfidence in errors*, a problematic thinking style that has been shown to be particularly high in people with schizophrenia, may be, in part, responsible for the delusional beliefs they often experience. Reducing overconfidence in errors in this population may therefore be an important treatment outcome.

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## 1. Introduction

Overconfidence is broadly defined as when one's confidence in subjective judgements, inferences, or predictions is reliably greater than the objective accuracy should allow. It has been studied extensively within the general population (for a review see Hoffrage, 2004), which has also identified a number of conceptually similar effects. These include the "better-than-average" effect where, despite mathematical odds, the majority of people evaluate their skills and abilities as above average (Matlin, 2004) and the Dunning–Kruger effect, where overconfidence is at its most severe for those who are incompetent in the skills and abilities in question (Dunning, Johnson, Ehrlinger, & Kruger, 2003; Kruger & Dunning, 1999, 2002). While it has been suggested that overconfidence can sometimes lead to positive effects, for example, boosted self-esteem (Hoffrage, 2004), heightened overconfidence has also been linked to a number of undesirable outcomes including problem gambling (Goodie, 2005), inaccurate eyewitness testimonies (Brewer, 2006; Brewer & Wells, 2006), and even catastrophic accidents, such as the failed *Challenger* Space Shuttle launch (Plous, 1993).

More recently, the overconfidence effect has been examined in clinical populations, such as in people with psychotic disorders, particularly schizophrenia. Of note, it has been proposed that the bias may possibly account for the symptoms of schizophrenia, such as delusions, and specifically how such beliefs are maintained with such high conviction despite the presence of counter-evidence. This review will examine the evidence suggesting that overconfidence is heightened in schizophrenia, before addressing the issue of whether the bias can adequately account for delusional conviction.

## 2. Overconfidence in schizophrenia

### *2.1. Jumping to conclusions bias*

Some of the earliest evidence for heightened confidence in schizophrenia comes from the "jumping to conclusions" (JTC) bias literature, which suggests that people with schizophrenia accept partial or limited evidence as sufficient for making hasty, yet confident, decisions (Fine, Gardner, Craigie, & Gold, 2007). The bias is usually elicited using probabilistic reasoning tasks, such the "beads task". During this task, participants are presented with two containers each filled with coloured beads (e.g. 80:20 red to green and vice versa), and are asked to decide on the basis of an emerging bead sequence, which container beads are being drawn from. The typical finding is that people with schizophrenia reach a decision, and have a lower confidence threshold, on the basis of *less* evidence (e.g. making a definite decision after only one bead) than healthy controls (e.g. Garety & Freeman, 2013; Garety, Hemsley, & Wessely, 1991).

While the JTC bias is a robust effect and has been replicated multiple times, a number of studies also suggest that the beads task may be confounded by high levels of miscomprehension among clinical samples, which could limit the validity of the bias (Balzan, Delfabbro, Galletly, & Woodward, 2012; Moritz & Woodward, 2005). Moreover, it should be noted that JTC is, at best, only an indirect way of assessing overconfidence (e.g. hasty decision-making can still occur under low confidence). In fact, it has been suggested that heightened JTC among people with schizophrenia is a relative, not an absolute, effect, given that even highly delusional people are often still observed to respond conservatively on such tasks according to the optimal Bayes solution (Huq, Garety, & Hemsley, 1988; van der Leer & McKay, 2013). This questions whether the JTC effect actually represents *objective* overconfidence.

### *2.2. Beck cognitive insight scale (BCIS)*

More direct evidence for overconfidence in schizophrenia comes from the Beck Cognitive Insight Scale (BCIS). Distinct from the construct of "clinical insight", which is one's awareness of their mental illness, "cognitive insight" is the ability of people with schizophrenia to identify and correct their distorted beliefs and misinterpretations (Beck, Baruch, Balter, Steer, & Warman, 2004). The scale consists of two factors: (i) self-reflectiveness, which assesses how much the individual believes that they may be wrong at times and their willingness to admit this; and (ii) self-certainty, which assesses

how much the individual believes that they are definitely correct about their decisions and experiences (Beck et al., 2004; Warman & Martin, 2006). Lower self-reflectiveness and higher self-certainty scores therefore reflect a greater propensity to overconfidence. There is a growing body of literature which demonstrates that people with schizophrenia, and particularly those experiencing delusions, have lower cognitive insight than healthy controls, as evidenced by significantly lower levels of self-reflectivity and significantly inflated levels of self-certainty (Bora, Erkan, Kayahan, & Veznedaroglu, 2007; Bruno, Sachs, Demily, Franck, & Pacherie, 2012; Engh et al., 2010; Guerrero & Lysaker, 2013; Lysaker et al., 2011; Martin, Warman, & Lysaker, 2010).

However, not all the evidence regarding the BCIS is consistent; a number of studies have failed to show the same pattern of results regarding the direction of the subscales between clinical and non-clinical groups. Contrary to expectations, some studies have reported significantly higher levels of self-reflectiveness among people with schizophrenia compared to non-delusional healthy controls (e.g. Kimhy et al., 2014), while others have failed to find a significant difference between these groups on the self-certainty scale (Engh et al., 2007; Kao & Liu, 2010). One recent study even demonstrated that self-certainty was actually lower for people with schizophrenia (Köther et al., 2012). While low subjective confidence ratings on their own do not preclude the possibility of overconfidence (i.e. low subjective confidence ratings could still be greater than objective accuracy), these mixed findings suggest that "self-certainty" is not always inflated in schizophrenia.

### *2.3. The metamemory studies*

While the JTC and BCIS studies provide mixed evidence for a generalised overconfidence effect in schizophrenia, the most direct and extensive evidence has come from a series of experimental metamemory studies commencing in the early 2000s. These metacognitive studies were designed to gauge subjective memory functioning and confidence in people with schizophrenia (hence "metamemory"), and have employed two forms of task: source-monitoring tasks (Gawęda, Moritz, & Kokoszka, 2012; Moritz & Woodward, 2002, 2006a; Moritz, Woodward, & Chen, 2006; Moritz, Woodward, & Ruff, 2003; Moritz, Woodward, Whitman, & Cuttler, 2005), and tasks specifically designed to elicit false memories (Bhatt, Laws, & McKenna, 2010; Moritz, Woodward, Cuttler, Whitman, & Watson, 2004; Moritz, Woodward, Jelinek, & Klinge, 2008; Moritz, Woodward, & Rodriguez-Raecke, 2006; Peters et al., 2007).

In the former, participants are first presented with a list of words and asked to provide semantic associations for each word. Participants are subsequently presented with another list containing (a) their self-generated words; (b) the former experimenter-generated words; (c) and new words that were either related but not identical to the original stimulus list or had no associative relation to this list. For each of these words, participants are required to identify them as old or new, name the source (experimenter- or self-generated), and provide their degree of confidence for the source attribution.

The "false memory" tasks were designed to distinguish false-negative errors (i.e. previously presented information misjudged as new) from false-positive errors (i.e. new information misjudged as previously presented), and have usually employed the Deese–Roediger–McDermott (DRM) paradigm. This paradigm usually presents participants with word lists that converge on one word, the "critical lure", which is not contained in the study list (e.g. study list: hill, climb, valley, summit, top, molehill, peak, glacier, climber, range; critical lure: mountain). When presented with the critical lure during the test list, the common effect is that people will tend to falsely recall or recognise the lure (Moritz et al., 2004). The effect has also been elicited using visual stimuli via illustrated scenes or standardised videos; for example, a typical populated beach, but with various critical lures missing, such as towels, rubber boats, beach umbrella (Moritz, Woodward, & Rodriguez-Raecke, 2006; Peters, Hauschildt, Moritz, & Jelinek, 2013).

Consistent with the expansive literature observing heightened memory deficits in schizophrenia (for a recent meta-analysis see Fioravanti, Bianchi, & Cinti, 2012), the majority of these metamemory

studies demonstrate that people with schizophrenia produce more memory errors than healthy controls. However, by incorporating measures of *memory confidence*, the metamemory studies have revealed a heightened "overconfidence effect" among people with schizophrenia. Relative to healthy and non-schizophrenia psychiatric controls, patients with schizophrenia were found to be significantly *overconfident* in memory errors and slightly *underconfident* given correct responses (Bhatt et al., 2010; Gawęda et al., 2012; Moritz & Woodward, 2002, 2006a; Moritz et al., 2004, 2005, 2008; Moritz, Woodward, & Chen, 2006; Moritz, Woodward, & Rodriguez-Raecke, 2006; Peters et al., 2013). These studies suggest that patients with schizophrenia have a reduced *confidence gap*, where the difference between confidence in errors and confidence in correct responses is significantly reduced. By contrast, healthy and psychiatric controls typically exhibit a higher confidence in correct responses and lower confidence in errors (relative to people with schizophrenia), which leads to a larger confidence gap. The literature suggests that the overconfidence effect is also quantified by another parameter known as the *knowledge corruption* index. The index is computed as the number of errors held with high confidence over the total number of responses held with high confidence. As shown in Table 1, the metamemory studies have robustly shown a higher level of knowledge corruption among the patients with schizophrenia relative to controls, with consistently moderate to large effect sizes, regardless of methodological variations between studies. It is worth noting that a

**Table 1. Knowledge corruption across overconfidence studies**

| Studies | Knowledge corruption (%)[1] | | | Effect size (*d*) | |
|---|---|---|---|---|---|
| | Schizophrenia | | Healthy controls (HC) | | |
| Moritz and Woodward (2002) | 11.8* | | 4.9 | 0.72 | |
| Moritz et al. (2004) | 33.7** | | 21.2 | 1.01 | |
| Moritz et al. (2005) | 20.9** | | 8.6 | 0.77 | |
| Moritz and Woodward (2006a) | 21.9*** | | 12.6 | 0.87 | |
| Moritz, Woodward, and Chen (2006) | 20.9*** | | 9.4 | 1.45 | |
| Moritz, Woodward, and Rodriguez-Raecke (2006) | 24.2** | | 18.3 | 0.71 | |
| Moritz et al. (2008) | 23.4*** | | 6.2 | 0.92 | |
| Gawęda et al. (2012) | 40.7*** | | 22.7 | 1.24 | |
| Peters et al. (2013) | 17.8** | | 8.4 | 1.27 | |
| Moritz, Ramdani, et al. (2014) | 17.2*** | | 6.5 | 0.86 | |
| Bhatt et al. (2010) | *Experiencing delusions (ED)* | *Not experiencing delusions (ND)* | | ED vs. HC | ND vs. HC |
| *Total knowledge corruption* | 46.2** | 45.5** | 28.9 | 1.37 | 1.03 |
| *False-positive knowledge corruption* | 57.2 | 47.9 | 43.6 | 0.72 | 0.20 |
| *False-negative knowledge corruption* | 18.0** | 12.0 | 5.2 | 1.22 | 0.68 |
| | **High-delusion-proneness/paranoia** | | **Low -delusion-proneness/paranoia** | | |
| Laws and Bhatt (2005)[2] | 46*** | | 27 | 1.20 | |
| Moritz, Göritz, et al. (2014)[3] | 20.1*** | | 11.9 | 0.63 | |
| Moritz et al. (2015)[3] | 11.23*** | | 3.76 | 0.52 | |

[1]Knowledge corruption is the proportion of high-confidence errors on all high-confidence responses.

[2]Delusion-proneness determined by Peters et al. Delusions Inventory within healthy controls.

[3]Paranoia determined by the Paranoia Checklist within healthy controls; non-metamemory task.

*$p < .05$.

**$p < .01$.

***$p < .001$.

heightened overconfidence bias has been observed in patients with first episode psychosis and those with at-risk mental state (Eisenacher et al., 2015), but also in healthy non-clinical individuals who score highly on measures of "delusion-proneness" (Laws & Bhatt, 2005; Warman, 2008) or paranoia (Moritz, Göritz, et al., 2014), suggesting the effect may be particularly relevant to the delusional symptoms often observed in schizophrenia (again, with moderate to large effect sizes).

While acknowledging the apparent consistency of the effect across studies, it should also be noted that one recent study demonstrated that the heightened overconfidence effect typically observed in people with schizophrenia (or those identified as "delusion-prone") may only occur when people feel competent in the given task, or find the task subjectively easy (Moritz et al., 2015). That is, group differences usually observed between schizophrenia and control groups, and high- and low-delusion-prone groups, may diminish when tasks are perceived to be difficult.

### *2.4. Overconfidence: An artefact of performance deficits?*

Despite the evidence for a heightened overconfidence effect in schizophrenia, it is possible that the effect is confounded with the increased number of memory errors relative to healthy controls. That is, as people with schizophrenia make more errors, the potential frequency of making highly confident responses is increased. Moreover, a number of studies have shown that people with schizophrenia are unaware of, or at least underestimate, the extent of their memory deficits (Balzan, Neaves, Denson, Liu, & Galletly, 2014; Bowie et al., 2007; Keefe, Poe, Walker, Kang, & Harvey, 2006; Köther et al., 2012; Moritz, Ferahli, & Naber, 2004; Poletti et al., 2012). It would therefore seem plausible that people with schizophrenia may be overly confident in their impaired abilities simply because they are not aware that they are impaired in these domains, and inadvertently anchor their confidence ratings as if they are performing as well as healthy controls. This would also appear consistent with the Dunning–Kruger effect, which predicts that overconfidence is at its most extreme for those who are incompetent in the skills and abilities in question (Dunning et al., 2003; Kruger & Dunning, 1999, 2002).

However, not all of the metamemory studies have reported memory deficits among participants with schizophrenia. For example, Moritz and Woodward (2006a) reported no difference in the rate of false-negative errors between people with schizophrenia and psychiatric controls; yet the schizophrenia sample still demonstrated a significantly higher overconfidence in errors relative to the psychiatric controls. Similarly, a number of the metamemory studies observing false-positive errors have not found significant differences between the schizophrenia and *healthy* control groups on objective performance; yet they showed significant differences between these groups on overconfidence measures (Moritz et al., 2004; Moritz, Woodward, & Rodriguez-Raecke, 2006; Peters et al., 2007, 2013). Furthermore, the emerging evidence that overconfidence in errors in people with psychosis is particularly heightened when tasks are subjectively easy (Moritz et al., 2015), where objective error rates are likely to be diminished relative to more difficult tasks, suggests the effect is not merely a consequence of excessive memory errors.

Finally, the overconfidence effect has recently been replicated beyond the domain of memory errors, where this potential confound of memory performance deficits can effectively be ruled out. Using tasks designed to measure errors in social cognitive processes (e.g. assessing the intentions of others or the ability to identify emotions from facial expressions or prosody), Köther et al. (2012) and Moritz, Woznica, Andreou, and Köther (2012) demonstrated that people with schizophrenia were overconfident in errors relative to healthy controls. More recently, Moritz, Ramdani, et al. (2014) investigated the overconfidence effect using a visual perception task, where participants were shown a series of blurry pictures, half of which contained a "hidden object", while the others depicted random noise. For each picture, participants were asked to determine if an object was being depicted or not, and to indicate their level of confidence in their response choice. Participants with schizophrenia demonstrated significantly greater confidence in errors and inflated knowledge corruption, but no difference in accuracy, relative to non-clinical controls and participants with obsessive–compulsive

disorder. These results were replicated in non-clinical participants who had scored highly on core paranoid symptoms (Moritz, Göritz, et al., 2014).

Taken together, while poor memory task performance might be a contributing factor for a heightened overconfidence effect in people with schizophrenia, or those at increased risk of developing psychosis, it does not appear to be the main driver of the bias. In fact, the effect may even diminish for difficult tasks where performance is lower, and it has been demonstrated in tasks that do not assess memory errors.

## 3. Overconfidence and delusions

### *3.1. The basis of delusional conviction?*

Having established an evidence base for a heightened overconfidence effect within schizophrenia, Moritz and Woodward (e.g. 2006b) have suggested that the bias may play a role in the development and maintenance of the symptoms of schizophrenia, particularly delusions. Delusions are one of the defining characteristics of schizophrenia, and often lead to a disturbance in the construction of reality. Delusions are defined as fixed false beliefs that (i) are maintained despite counter-evidence and rational counter-argument; (ii) would be dismissed by members of the same social-cultural environment; and (iii) are held with great conviction (American Psychiatric Association, 2013). Hence, from the outset, the overconfidence effect would appear to be consistent with the very definition of a delusional belief; that is, high confidence and strong conviction in an *erroneous* belief.

More specifically, a simultaneous overconfidence in errors and underconfidence when correct may play a crucial role in raising the level of *conviction* necessary to form and maintain a delusional belief. This is particularly important, for despite recent advancements in our understanding of the cognitive biases and errors responsible for the formation and maintenance of delusions (for reviews see Bell, Halligan, & Ellis, 2006; Freeman, 2007; Garety & Freeman, 1999), the specific processes responsible for the high *conviction* associated with delusional beliefs are less clearly understood. Indeed, cognitive errors such as false-positive memories, where fact and fiction may be confused, could be important in accounting for how specific delusional themes may arise (e.g. a persecutory delusion may be partially based on the false memory that one's neighbours continually watch them). However, false memories are not unique to a diagnosis of schizophrenia (e.g. Elvevåg, Fisher, Weickert, Weinberger, & Goldberg, 2004; Lee, Iao, & Lin, 2006), so cannot be entirely responsible for the emergence of delusional beliefs, or why they are held with such high conviction.

Accordingly, Moritz and colleagues argue that it is not necessarily the inaccurate memories, cognitive decisions, perceptions or judgements that lead to the strong conviction characteristic of delusional beliefs; rather, it is the *overconfidence* in these errors that is important. For example, if a person travelling on a bus casually perceives that a fellow passenger might be looking angrily at him, this is unlikely to have a strong cognitive or behavioural impact, even if the appraisal is inaccurate. However, if the same person attaches *high confidence* to the accuracy of their erroneous perception, this may trigger a strong conviction in a fixed false belief (e.g. "I am under surveillance and my life is in danger"), which can also lead to behavioural consequences and emotional distress (Moritz et al., 2012).

This is not to suggest that people without schizophrenia are immune to such errors. Rather it appears that people without schizophrenia are more likely to attach "not trustworthy" tags to cognitive errors, and therefore are more likely to dismiss erroneous memories, perceptions and judgements as trivial or implausible (Moritz & Woodward, 2006b). Even if people without schizophrenia were to hold onto particular beliefs substantiated by cognitive errors, it follows that these beliefs would typically be held with lower conviction than by people with schizophrenia. Greater social interaction and more established social networks among people without schizophrenia can also be helpful in slowing the progression of erroneous conclusions into erroneous fixed beliefs. Finally, the relative *underconfidence* associated with accurate memories, decisions, perceptions and judgements in people with

schizophrenia may also reinforce conviction in delusional beliefs, as such appraisals would otherwise help to buffer against the formation of erroneous conclusions (e.g. "my neighbour works fulltime so could not possibly be watching me").

### *3.2. Delusional ideation or diagnosis of schizophrenia?*

Despite the explanatory potential for the overconfidence effect in accounting for the strong conviction in delusional beliefs, one limitation in this interpretation is that relatively few studies thus far have actually linked the bias to delusional/paranoid symptoms in people with schizophrenia (i.e. Bhatt et al., 2010; Eisenacher et al., 2015; Moritz, Ramdani, et al., 2014). Although there is a consensus that overconfidence is heightened in schizophrenia (Table 1), no additional study reviewed here has found a significant association between the effect and delusional severity in schizophrenia. Recent work even suggests that overconfidence in errors may be more closely linked to the neurocognitive deficits observed in schizophrenia, rather than delusional ideation (Eifler et al., 2015). This is in contrast to other cognitive biases associated with schizophrenia, including the JTC bias and the "bias against disconfirmatory evidence" (BADE), which have both been found to correlate significantly with delusional severity (Sanford, Lecomte, Leclerc, Wykes, & Woodward, 2013; So, Garety, Peters, & Kapur, 2010; Speechley, Moritz, Ngan, & Woodward, 2012). This suggests that while other cognitive biases may play a role in the development and maintenance of delusions, overconfidence may be better viewed as a consequence of the disorder itself rather than a mediator of delusional conviction.

However, despite the limited evidence of a direct association between overconfidence and delusional ideation in schizophrenia, it would be premature to conclude that overconfidence is not linked to the formation or maintenance of delusional conviction. Importantly, while only three studies have reported statistically significant associations in overconfidence between delusional states (Bhatt et al., 2010), paranoia (Moritz, Ramdani, et al., 2014), or delusional conviction (Eisenacher et al., 2015), the effect sizes were moderate to large ($d$ = .43, 68, 1.10, respectively), and are also comparable to those which reported heightened overconfidence among healthy non-clinical individuals who scored highly on measures of "delusion-proneness" (Laws & Bhatt, 2005; $d$ = 1.20) or delusional paranoia (Moritz et al., 2015; $d$ =.52; Moritz, Göritz, et al., 2014; $d$ =.63). This not only suggests that there may be a predisposition to the overconfidence bias that is distinct from the onset of schizophrenia, but that the bias is consistent across samples of varying levels of delusional propensity. Moreover, there is also evidence that the overconfidence effect can be attenuated under the influence of dopaminergic agonists (Andreou, Moritz, Veith, Veckenstedt, & Naber, 2014; Moritz et al., 2003, 2008), which suggests that the effect, like delusions, may be modulated by dopaminergic activity. Whether this finding coincides with a simultaneous reduction in delusional severity is yet to be determined by future research, but it reiterates the possible association between overconfidence and delusional ideation.

There are also a number of methodological issues in the overconfidence in errors literature that may have contributed to the lack of association between the bias and delusional ideation. First, all of the studies observing the overconfidence effect in schizophrenia have been cross sectional in design, rather than monitoring whether longitudinal changes in delusional severity are linked to the overconfidence effect. One of the issues with cross-sectional studies in this context is that the between-group comparisons (e.g. delusional vs. non-delusional) are not as sensitive or powerful as within-group comparisons, which reduce sources of error that could be influencing results, as each participant serves as their own control (Woodward, Munz, LeClerc, & Lecomte, 2009). Furthermore, cross-sectional studies do not control for pre-existing differences between delusional and non-delusional groups, which would remain stable independent of delusional status, and that could otherwise account for apparent similarities in overconfidence between these groups (e.g. genetic or environmental predisposition that affects a cognitive style prompting overconfidence). Again, longitudinal studies are more powerful and interpretable as these potential pre-existing differences between delusional and non-delusional conditions are held constant as delusional severity changes (Woodward et al., 2009). To better understand the overconfidence effect between delusional states,

future replications could adopt a longitudinal design. Such longitudinal designs could also employ particularly easy tasks, as this appears to heighten the overconfidence effect in schizophrenia and delusion-prone groups (Moritz et al., 2015), which may therefore also help distinguish delusional from non-delusional groups.

It is also apparent that the majority of the overconfidence studies reviewed here (even those that have recently gone beyond using metamemory tasks), have all been conducted by the same research team (Table 1), which calls into question the generalisability of the findings, and the need for independent replication. Moreover, most of these studies have typically employed the same two measures of overconfidence: the confidence gap and knowledge corruption. While these measures are able to adequately distinguish clinical from non-clinical groups (Table 1), they may not be as sensitive at detecting more subtle differences between delusional and/or "delusion-proneness" states. This may stem from the descriptive, often dichotomous, measures these studies employ to assess confidence; for example, in the DRM false-memory tasks, participants typically only have the option of selecting "high" or "low" confidence for any given response. While such responses are good at capturing the nature of a person's confidence, the relative lack of specificity might make it difficult to detect the potentially subtle cognitive differences between high and low delusional states in clinical samples. This descriptive approach may also lead to ambiguity regarding what actually constitutes "overconfidence". For example, if a participant indicated "low confidence" for an incorrect answer, this could still technically represent overconfidence, as *subjective* confidence (e.g. 20%) might actually be greater than *objective* accuracy (i.e. 0%). Without the option of accurately calibrating overall confidence and objective accuracy, differences in "overconfidence in errors" between high- and low-delusional groups may technically be present but not be detectable (e.g. both groups might indicate a similar proportion of "high-confidence" errors, yet might differ on the specific miscalibration between overall confidence and accuracy). The "confidence gap" and "knowledge corruption" metrics may further be underestimating overconfidence, as they are typically based only on high-confidence errors, and do not account for any "low-confidence" errors, which might actually represent objective "overconfidence".

While these issues do not call into question the robustness of the overconfidence effect within schizophrenia, they do suggest the direction future research in the area could take. At the very least, independent replication of the overconfidence effect is warranted to ensure greater generalisability. Non-descriptive measures of confidence could also be utilised in addition to current measures, which may improve the specificity of the overconfidence effect within clinical samples. The majority of studies observing overconfidence in the general non-clinical population have either used probability estimates of the correctness of general knowledge questions (e.g. "which city is located further north: Rome or New York?"), or estimates of confidence ranges (e.g. "provide a low and high guess for the length of the Amazon river such that you are 80% sure the correct answer falls between the two") (Hoffrage, 2004). In the former, overconfidence refers to a miscalibration between subjective confidence and objective accuracy; for the latter, overconfidence is a confidence–accuracy miscalibration characterised by subjective confidence ranges that are too narrow for the observed level of accuracy (i.e. providing a range that does not include the correct answer). Using such measures would bring our understanding of overconfidence in schizophrenia in line with majority of studies that have examined the effect in the general population, but they might also represent a more sensitive approach in assessing overconfidence (i.e. use of calibration curves; specific confidence ranges vs. self-reported confidence levels), that may be able to better distinguish between delusional and non-delusional subsamples. Interestingly, while the overconfidence in errors effect seems to diminish when tasks are subjectively more difficult (Moritz et al., 2015), the miscalibration literature suggests that overconfidence is actually *heightened* by task difficulty (Hoffrage, 2004). Therefore, on the one hand, using objectively easier tasks that encourage participants to feel competent could elevate overconfidence in errors sufficiently to distinguish between delusional and non-delusional groups; yet using more difficult tasks may achieve the same outcome. Future research would need to investigate this apparent paradox.

## 4. Conclusions

The present paper has provided an overview of the overconfidence effect within schizophrenia, characterised by overconfidence in errors and slight underconfidence when correct. Despite gaps in the current literature linking the effect to delusional severity, this bias may offer an important theoretical account for how inaccurate decisions, perceptions or judgements can lead to the formation and maintenance of fixed false beliefs that are held with high conviction. To validate these theoretical assumptions, future studies on the overconfidence effect in schizophrenia need to adopt longitudinal designs and include additional measures of overconfidence that will determine if the effect is related to delusional severity, or if it is a consequence of the disorder itself. Only then can we be confident that overconfidence is the foundation of delusional conviction.

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