# THE RELATIONSHIP BETWEEN COGNITIVE BIASES AND PSYCHOSIS: SEARCHING FOR MECHANISMS

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# THE RELATIONSHIP BETWEEN COGNITIVE BIASES AND PSYCHOSIS: SEARCHING FOR MECHANISMS


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EDITORIAL
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# Editorial: The Relationship Between Cognitive Biases and Psychosis: Searching for Mechanisms

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**Keywords: psychosis, cognition, cognitive bias, mechanisms, risk of psychosis**

**Editorial on the Research Topic**

**The Relationship Between Cognitive Biases and Psychosis: Searching for Mechanisms**

The development of cognitive psychology and the influence of its principles on other branches of psychology has revolutionized our understanding and treatment of psychiatric disorders. From the very beginning, the cognitive perspective on psychopathology was in opposition to the psychoanalytical model by offering scientifically falsifiable models and shortly after its introduction clinical interventions. Cognitive models of psychopathology have evolved in different directions and have been successfully adapted to very different psychiatric disorders, suggesting that it may be a transdiagnostic approach (1). Despite the variations in specific cognitive models of mental disorders, dysfunctional information processing, i.e. cognitive biases, are placed in the central focus in this approach. Biased information processing has been implicated in the development and maintenance of psychopathological symptoms across very different psychiatric disorders. What is even more important, studies have successfully demonstrated that the cognitive approach is clinically useful showing that cognitive interventions ameliorate cognitive biases and that these changes often transfer to symptom reduction (2, 3).

Unfortunately, psychosis and more notably schizophrenia spectrum psychoses have long been viewed as being beyond psychological understanding and treatment. It should be noted that as early as 1952 Beck (4) presented successful cognitive strategies that he used in working with a patient with paranoia around the time that chlorpromazine was introduced as the very first antipsychotic agent. However, the development of new medications and the negation of a psychological understanding of psychotic symptoms have prolonged the development of cognitive approaches to psychosis to the mid-'90s (5).

In the last three decades, we have been witnessing the systematic development of cognitive approaches to psychosis in general or its different specific symptoms like delusions, hallucinations, and negative symptoms. Again, all these models have placed biased information in the very center of their interest. In the late '80s, Frith and Done (6) followed later by Bentall (7) have proposed that dysfunctions in distinguishing between internal and external sources of information may constitute a cognitive background for the development and maintenance of some of the positive symptoms of schizophrenia (e.g., auditory hallucinations). Other researchers have focused their attention on biased tendencies in information processing that may give rise to delusional thinking (8). First studies in the late'80s and early'90s have provided the first empirical evidence that patients with schizophrenia exhibit cognitive biases to a much larger extent than healthy controls. Both evidence for source monitoring problems [e.g., (9)] and jumping to conclusions [e.g., (10)]

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have been confirmed several times in meta-analyses. These studies were the beginning of "madness [being] explained" (11) by psychological models. Recently, there are hundreds of studies on the role of different cognitive biases in psychosis, its risk states, and specific psychotic symptoms. This line of research has stimulated the development of different cognitive-behavioral therapies proven to be effective in psychosis.

Nevertheless, despite a growing number of studies on cognitive biases in psychosis, the mechanisms of how cognitive biases increase the risk of psychosis is still not clear. What is more, how cognitive biases that are important for psychosis arise is also relatively unknown. Hence, within the scope of the recent Research Topic, we intended to gather different studies addressing the mechanisms of the relationships between dysfunctional information processing and psychosis as well as its risk states.

In line with existing knowledge, current studies (this issue) have confirmed that exaggerated cognitive biases are observed along the continuum of psychosis from psychotic-like experiences to full-blown psychosis. The importance of assessment is relevant, in this way one of the manuscripts is centered on the validation of a tool for the assessment of cognitive biases in schizophrenia (Corral et al.). Importantly, studies published in the current Research Topic extended our understanding of the relationships between different cognitive biases and psychosis. Prochwicz et al. explained the mechanisms of the relationship between attention to threat and the non-clinical risk of psychosis, showing that the linkage is mediated by emotional stress. Intriguingly, the authors offered a further explanation by showing that the indirect effect of attention to threat via stress on psychotic-like symptoms was significantly moderated by higher levels of distraction-seeking coping strategies. In another study, Pytlik et al. aimed at a better understanding of the relationship between data gathering strategies and preclinical risk of psychosis. The authors have found that a tendency to jump to conclusions is related to conspiracy theories, which may be conceptualized on a continuum with paranoia as one extreme pole. Interestingly, Pytlik et al. have found that a higher tendency to engage in intuitive thinking, which is followed by data gathering biases, may constitute a risk for stronger belief in conspiracy theories. Data gathering and weighing biases as a cognitive underpinning of psychosis have also been investigated by Scheunemann et al. The authors found that individuals with more frequent psychotic-like experiences tend to not only overestimate their initial decision but also weigh currently available advice given in a decision-making task more strongly. García-Mieres et al. showed that a higher level of cognitive rigidity in an interpersonal context may be a marker of worse functioning for patients across a wide range of different domains (e.g., executive functions, higher self-certainty, earlier age of the onset). Zhu et al. also found that reduced cognitive flexibility is related to the severity of delusions. Interestingly, a tendency for a biased response to contradiction was higher among patients with delusion as compared to patients with depression. Taken together, these studies suggest that the preclinical risk of psychosis may be related to biases in different aspects of data gathering and weighting. Hence, published studies suggest that patients with psychotic symptoms, especially those with delusions, might be less cognitively flexible and may react in a biased way to contradiction, which may be a cognitive factor in maintaining the symptoms (this issue).

In Seo et al. another aspect of cognitive biases, i.e., facial recognition, was investigated among patients fulfilling clinical risk states for psychosis. They found that inaccuracy in emotion recognition may be an early marker for the risk of psychosis. Interestingly, a disgust response to neutral faces was related to the severity of paranoia. Furthermore, in another study investigating social cognition, Dorn et al. found that deficits in cognitive Theory of Mind may be specifically linked to general delusion severity, while emotional Theory of Mind was more closely related to negative and disorganized symptoms. These studies confirmed our prior knowledge on the important role of deficits in social cognition as a risk factor for psychosis (12).

Extending prior studies, Rodriguez's et al. narrative review discussed the interaction between exposure to life adversities, cognition, and social cognition, in contributing to psychosis. This review was based on the recent theoretical account of the risk of psychosis (13) as a dynamic interaction between social genetic predisposition, social adversities, and cognition. An interesting study was presented by Pionke-Ubych et al. in which cognitive biases were examined together with exposure to life-adversities and self-disturbances in a non-clinical sample with frequent psychotic-like experiences. Confirming prior studies [e.g., (14)], they found that indeed early childhood trauma may have an indirect effect on the risk of psychosis via biased information processing as well as self-disturbances. These findings provide an interesting contribution to the field by showing dynamic interactions between environmental factors, cognition, and self-disturbances that have all been shown to increase the risks of developing psychosis.

To sum up, we believe that the papers published in this Research Topic provide an interesting contribution to our understanding of the role of cognitive biases in psychosis and its risk states. Riding on the literature that focused on cognitive biases in schizophrenia over the last three decades, this Research Topic has further explored mechanisms of action and extended the investigation from patient samples through to the risk of psychosis. The presented articles also endeavored to address how different information processing biases may contribute to psychosis in the context of environmental factors, emotional processes, and interactions with other cognitive processes. Yet, our knowledge is still incomplete. The newest studies in the field have suggested the interaction between genetic, environmental factors, and cognitive biases in predicting the risk of psychosis [e.g., (15)]. Hence, further integration is warranted to gather new insights that may apply to clinical practice.

## AUTHOR CONTRIBUTIONS

ŁG wrote the first version of the editorial. All authors edited and contributed to the final version.

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# The Mediating Role of Stress in the Relationship Between Attention to Threat Bias and Psychotic-Like Experiences Depends on Coping Strategies

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**Aim:** Recent studies have provided evidence that enhanced stress level is associated with the increase of psychotic symptoms in both clinical and non-clinical populations. It has also been demonstrated that cognitive biases contribute to psychotic experiences. However, it remains unclear whether the effect of cognitive biases and perceived stress on psychotic-like experiences (PLEs) is influenced by coping methods. In the present study we examined whether the relationship linking cognitive biases with PLEs is mediated by the level of stress and whether particular coping methods modify the relationship between stress and PLEs.

**Methods:** The study sample consisted of 290 non-clinical subjects; study variables were assessed by questionnaires. Moderated mediation analyses were conducted.

**Results:** Perceived stress was found to serve as a partial mediator in the relationship linking attention to threat (ATB) and external attribution biases (ETB) with psychotic-like experiences. Also, moderated mediation analysis revealed that the indirect effect of attention to threat bias on positive and depressive symptoms of psychotic-like experiences *via* perceived stress was stronger at higher levels of distraction seeking coping. Moreover, the indirect effect of ATB on depressive symptoms was moderated by task-oriented coping and emotion-oriented coping. Task-oriented coping also moderated the indirect effect of ETB on depression.

**Conclusion:** The findings imply that both perceived stress and coping styles are important factors affecting the association between cognitive biases and psychotic-like experiences.

**Keywords: psychotic-like experiences, cognitive biases, stress, coping, mediation, moderation**

## INTRODUCTION

Cognitive biases have been recognized as important risk factors for various psychiatric conditions, including psychotic disorders. In line with the hypothesis of extended psychotic phenotype (1), the role of cognitive biases has been examined in samples of patients suffering from schizophrenia, individuals with ultra-high risk for psychosis (UHR), and community samples with subclinical psychotic experiences. These studies differentiated specific cognitive biases, i.e. attributional bias (2–4), attention to threat bias (5, 6), threat anticipation (7), and jumping to conclusions (8, 9) which are involved in the psychotic symptoms development. Importantly, the role of cognitive biases was confirmed not only in clinical groups, but also outside the boundaries of clinical psychosis.

Among psychological factors, heightened stress and elevated stress sensitivity have also been indicated as shaping the risk of psychosis (10–13). The central role of stress has been widely investigated and well-replicated in samples of patients with schizophrenia (13, 14), first episode psychosis (15), UHR individuals (10, 16, 17), and healthy subjects with psychosis-proneness (11, 18).

Particularly interesting, although there are only few, are studies concerning the relationship between stress and subclinical psychotic symptoms conducted on non-clinical groups. These studies to a greater extent, than research on patients with overt psychosis, give the opportunity to distinguish between the role of stress resulting from adverse life events and the role of stress being a consequence of psychotic symptoms (i.e., persecutory delusions or hallucinations). Thus, studies on non-clinical populations help to examine whether stressful life events contribute to psychosis development before its onset. Unfortunately, such studies are not only rare, but they also are focused primarily on positive symptoms (18–21). It is plausible, however, that adverse life events may be involved in the negative symptoms formation, e.g. through promoting social withdrawal or activity restriction.

A few studies have also considered the potential contribution of coping styles to the link between stress and psychosis. The majority of the research applied the distinction between adaptive and maladaptive coping. In general, task-oriented coping (focused on problem solving or cognitive reconceptualization) is viewed as adaptive, whereas emotion-oriented (focusing on emotional responses, e.g. worry, self-blame, self-preoccupation, or fantasizing) and avoidance-oriented (focusing on distraction-based activities or social diversion) coping methods are considered as less effective (19). A growing body of studies demonstrated that individuals reporting psychotic symptoms tend to use maladaptive coping methods to a greater extent than subjects denying psychotic experiences. Specifically, patients with schizophrenia are more likely to choose emotion-oriented strategies and less likely to engage in active problem solving when faced with stressful situations (16, 22). A similar coping pattern was observed in individuals at risk of psychosis (16, 17), and in adolescents and young adults with subclinical psychotic symptoms (18, 20). What is more, different types of non-adaptive coping were found to be associated with poor outcome in chronic schizophrenia patients (22) and UHR individuals (23), as well as with persistence of subclinical symptoms in a general population sample (18). In non-clinical adolescent a dose-response relationship was observed between emotionally driven coping and the development of subclinical symptoms (18). Contrarily, more adaptive, task-oriented coping was found to be associated with the decrease of attenuated psychotic experiences over a three-year period (18).

Among psychotic individuals stress experience is likely to be amplified by biased cognitive processes, such as oversensitivity to threat, threat anticipation, and tendency to perceive others as threatening. The relationship between cognitive biases and heightened stress has already been postulated in cognitive models of psychosis (24, 25). These models emphasize bi-directionality of this association; not only the presence of cognitive biases precedes stress, but the increased stress amplifies the tendency to search environment for threat. What is more, psychotic symptoms developed on the basis of cognitive biases and psychological distress may also be a source of further stress, threat sensitivity, and social withdrawal. However, it can be expected that enhanced stress may or may not exaggerate psychotic symptoms depending on which coping strategies are applied. Specifically, the use of task-oriented coping may break the vicious cycle linking cognitive biases, stress, and psychosis.

The aim of the current study was to explore the relationship between cognitive biases (attention to threat and external attribution biases), perceived stress, coping styles, and psychotic-like experiences in a non-clinical sample. Basing on the results of previous studies three hypotheses were formulated: 1) the relationship linking attention to threat bias (ATB) and external attribution bias (ETB) with psychotic-like experiences is mediated by the perceived stress; 2) the style of coping moderates the relationship between perceived stress and psychotic-like experiences; specifically, maladaptive emotion-oriented and avoidance-oriented coping increase the effect of stress on PLEs, whereas more adaptive task-oriented coping decreases the effect of stress on PLEs; 3) coping style moderates the positive indirect effect of ATB and ETB on psychotic-like experiences *via* perceived stress; in particular, this effect is stronger at higher levels of less adaptive styles of coping (emotion-oriented and avoidance oriented) and weaker at higher levels of more adaptive styles of coping (task-oriented).

The conceptual model tested in the study is presented in **Figure 1**.

## MATERIALS AND METHODS

### Participants

The initial study sample consisted of 376 participants; however, only the data obtained from participants with no history of psychiatric diagnosis (including substance abuse) and no history of clinical conditions in first and second degree relatives were included into the analyses (these data were collected with a self-report questionnaire). Therefore the final sample consisted of 290 individuals, 250 females and 39 males (one participant did

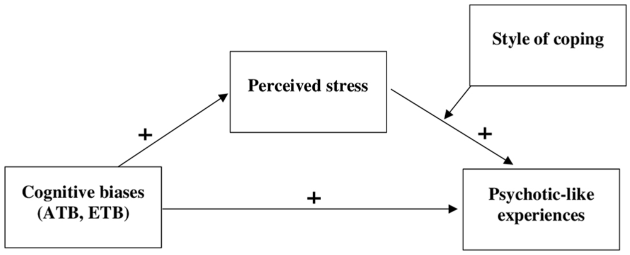


**FIGURE 1 |** Conceptual model of moderated mediation. Note: The model assumes that attention to threat bias and external attribution bias will be positively related to perceived stress, which will be positively related to psychotic-like experiences. However, the style of coping should moderate the link between perceived stress and psychotic-like experiences, so that less adaptive styles of coping increase the effect of stress on psychotic-like experiences.

not report sex) aged between 18 and 48 years (M=21.81, SD=2.72). All participants were recruited among students of the Pedagogical University of Krakow and were examined after giving the informed consent during regularly scheduled lectures. They were informed that they could refuse to participate at any time without consequences and that the study was anonymous. No form of compensation was offered as an incentive to participate. The studies were approved by the Local Ethics Committee.

## Measurements

### Perceived Stress Scale (PSS-10)

Perceived stress was measured using the 10-item Perceived Stress Scale (PSS-10) developed by Cohen et al. (26). The Polish adaptation of the PSS-10 by Juczyński and Ogińska-Bulik (27) was utilized in the study. The scale includes six negatively phrased items that assess levels of distress and negative affect and four items that are positively phrased and reflect the perception of one's ability to deal with stressors. Each item is rated on a five-point scale from 1 (never) to 5 (very often). Participants are asked to assess the frequency of thoughts and feelings in the last month. The total score ranges from 0 to 40, with higher scores representing higher perceived stress levels (positively phrased items are reverse coded before summing the responses). Cronbach's Alpha for the scale in our sample was 0.87.

### Coping Inventory for Stressful Situations (CISS)

Coping styles were assessed with the Coping Inventory for Stressful Situations (28). The Polish version of CISS translated and validated by Strelau et al. (29) was used in the present study. The CISS contains 48 items answered on a five-point Likert scale ranging from "never" to "very often." The scores for three main scales measuring: task-oriented coping (16 items), emotion-oriented coping (16 items), and avoidance-oriented coping (16 items) can be calculated. Furthermore, the last scale is divided into two subscales: distraction seeking (8 items) and social diversion (5 items). Cronbach's Alpha for the current sample were: 0.90 for the emotion-oriented coping subscale, 0.88 for the task-oriented coping subscale, 0.85 for the avoidance subscale, 0.81 for the distraction seeking subscale, 0.82 for the social diversion subscale.

### Davos Assessment of Cognitive Biases Scale (DACOBS)

DACOBS (30) is a 42-item self-report scale with seven subscales, each containing six items. Four of the subscales measure cognitive biases: jumping to conclusions (JTC), belief inflexibility (BIB), attention for threat bias (ATB), and external attribution bias (ETB). Additionally, two subscales measure cognitive limitations and one measures safety behaviors. Responses are given on a seven-point scale (1 = strongly disagree, 7 = strongly agree). Since the present study aimed at examining the role of attention to threat bias and external attribution bias in psychotic-like experiences only ATB and ETB scores were included in the analyses. The Polish translation was utilized; the Cronbach's Alpha for both ATB and ETB were 0.60 (31).

### Community Assessment of Psychic Experiences (CAPE)

The CAPE (32) consists of 42 items assessing on a four-point Likert scale the frequency (lifetime prevalence) of psychotic-like experiences and stress induced by specific experiences. In the current study only the frequency of PLEs was considered. The CAPE distinguishes three subscales measuring different dimensions of psychotic-like experiences: positive symptoms (CAPE positive: 20 items), negative symptoms (CAPE negative: 14 items), and depression (CAPE depression: 8 items). The CAPE provides scores for each subscale, as well as a total score calculated by summarizing all scores (CAPE total). We used the Polish version of the CAPE (31); in the current study the Cronbach's alpha calculated for the total score was 0.89, for the positive symptoms subscale 0, for the negative subscale score 0, and for depression subscale 0.

## RESULTS

## Data Analysis Plan

A correlation analysis was conducted among the variables prior to testing our hypotheses. Spearman's correlations were used to investigate the associations between the variables since some of the scores (PSS, CAPE, CISS social diversion subscale, age) deviated from normality. Point-biserial correlations were calculated to test the relationships with the "sex" variable. Proposed models were examined using the Process Macro for SPSS (33), applying models number 4 (simple mediation) and 14 (moderated mediation), with 5,000 bias corrected bootstrap samples. The variables in the models were mean centered to minimize multicollinearity. Each of the tested models examined the combination of different statistical predictors (ATB/ETB) of PLEs and different moderators (task-oriented style of coping/ emotion-oriented style of coping/avoidant style of coping/ distraction seeking/social diversion) of the relationship between perceived stress and PLEs. Sex and age were controlled for in the analyses. Missing data were handled with the listwise deletion (*n*=15). Bonferroni correction was not applied since it could not be assumed that the analyses were independent.

## Preliminary Analyses

**Table 1** presents the descriptive statistics of the variables and correlation matrix. Attention to threat bias and external attribution bias were positively related to psychotic-like experiences as well as to perceived stress, emotion-oriented coping style, and distraction seeking. Moreover, ETB was negatively related to coping by social diversion. Stress correlated positively with psychotic like experiences, emotion-oriented coping, and distraction seeking and negatively with task-oriented coping. Furthermore, there was a positive correlation between PLEs and emotion-oriented coping style as well as distraction seeking (with the exception of negative symptoms of PLEs which did not correlate significantly with distraction seeking). The analyses also yielded a negative, weak correlation between PLEs (with the exception of positive symptoms of PLEs) and task-oriented coping and social diversion.

## Test of Mediation Model

The results of the analyses examining mediating effects of perceived stress in the relationship between attention to threat bias and psychotic-like experiences as well as in the linkage between external attribution bias and PLEs are presented in **Table 2**. The total effect of ATB on psychotic-like experiences (CAPE total) was positive and significant (B=0.90 SE=0.14, $CI_{low}$=0.63; $CI_{high}$=1.18, p<0.001) similarly as the total effect of ETB on PLEs (B=1.18, SE=0.15, $CI_{low}$=0.89, $CI_{high}$=1.46, p < 0.001). Furthermore, both ATB and ETB were positively related to stress, which in turn correlated (also positively) with psychotic-like experiences. After controlling for perceived stress the relationships between ATB and PLEs (B=0.54, SE=0.14, $CI_{low}$=0.30, $CI_{high}$=0.79, p<0.001) and between ETB and PLEs (B=0.64, SE=0.14, $CI_{low}$=0.37, $CI_{high}$=0.92, p<0.001) were still positive and significant, however became weaker. As expected, the indirect effect of ATB on PLEs *via* perceived stress (B=0.36, SE=0.08, $CI_{low}$=0.22, $CI_{high}$=0.52) as well as the indirect effect of ETB on PLEs *via* stress (B=0.53, SE=0.08, $CI_{low}$=0.39, $CI_{high}$=0.71) were significant suggesting partial mediations.

A similar pattern of findings emerged when subscores of the CAPE scale were taken into account in the analyses: in each case perceived stress partially mediated the relation between cognitive bias and psychotic symptoms (see **Table 3**).

## Test of Moderated Mediation Models

### The Relationship Between Attention to Threat Bias, Stress, Coping, and PLEs

The interaction effect of perceived stress and coping on PLEs (CAPE total was significant (B=0.03, SE=0.01, $CI_{low}$=0.001, $CI_{high}$=0.05, p<0.05), however only in case of distraction seeking coping (**Table 4**).

Importantly, the conditional indirect effects of attention to threat bias on CAPE total *via* stress differed depending on the level of this particular coping style (Index of moderated mediation=0.01, SE=0.01, $CI_{low}$=0.001, $CI_{high}$=0.03). The indirect effect was weaker at the lower levels (Mean – 1 SD) of distraction seeking, and stronger at the higher levels of distraction seeking (Mean, Mean + 1 SD) (**Table 5**). Further analyses showed that the aforementioned effect was limited to positive symptoms

**TABLE 1** | Descriptive statistics and results of correlational analysis (Spearman's rho).

| | Min/ Max | S | K | M(SD) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSS-10 (1) | 1/37 | –.12 | –.64 | 18.78(7.23) | –.17** | .64*** | .11 | .17** | –.11 | .26** | .39*** | .55*** | .31*** | .45*** | .69*** | –.03 | .17** |
| CISS task (2) | 2/80 | –.13 | .54 | 55.39(8.90) | 1 | –.21*** | –.04 | –.14* | .15* | .08 | –.19** | –.12* | .05 | –.19** | –.21*** | .13* | .11 |
| CISS emotion (3) | 16/74 | .19 | –.19 | 43.91 (11.44) | | 1 | .25*** | .30*** | .00 | .30*** | .40*** | .52*** | .35*** | .45*** | .58*** | –.09 | –.17* |
| CISS avoidant (4) | 20/72 | –.24 | –.31 | 47.32 (10.12) | | | 1 | .88*** | .72*** | .08 | .04 | .06 | .12* | -.05 | .11 | –.29*** | –.19** |
| CISS distraction (5) | 8/39 | –.08 | –.37 | 20.80(6.23) | | | | 1 | .37*** | .13* | .14* | .17** | .16** | .09 | .20** | –.23*** | –.13* |
| CISS social diversion (6) | 6/25 | –.45 | –.10 | 17.88(4.15) | | | | | 1 | -.09 | -.20** | -.20** | -.05 | –.29*** | –.18** | –.24*** | –.25*** |
| DACOBS ATB (7) | 7/36 | –.06 | –.15 | 23.25(5.08) | | | | | | 1 | .46*** | .38*** | .36*** | .21*** | .38*** | –.13* | .02 |
| DACOBS ETB (8) | 7/34 | .45 | .30 | 18.58(4.67) | | | | | | | 1 | .44*** | .36*** | .33*** | .44*** | –.08 | .05 |
| CAPE total (9) | 46/120 | .72 | .49 | 72.11 (12.58) | | | | | | | | 1 | .81*** | .87*** | .84*** | .06 | 0.9 |
| CAPE positive (10) | 20/54 | 1.05 | 1.32 | 30.00(5.43) | | | | | | | | | 1 | .50*** | .55*** | .03 | .19** |
| CAPE negative (11) | 15/49 | .65 | .99 | 26.00(5.44) | | | | | | | | | | 1 | .65*** | .11 | .12** |
| CAPE depression (12) | 9/35 | 1.12 | 1.95 | 16.12(4.07) | | | | | | | | | | | 1 | –.00 | –.07 |
| Age (13) | 18/48 | 5.63 | 45.67 | 21.18(2.72) | | | | | | | | | | | | 1 | .21*** |
| Sex (14) | – | – | – | – | | | | | | | | | | | | | 1 |

*n = 275; *p < 0.05; **p < 0.01; ***p < 0.001. PSS-10, total score of the Perceived Stress Scale; CISS task, score of subscale of the Coping Inventory for Stressful Situations measuring task-oriented coping style; CISS emotion, score of subscale of the Coping Inventory for Stressful Situations measuring emotion-oriented coping style; CISS avoidant, score of subscale of the Coping Inventory for Stressful Situations measuring avoidance-oriented coping style; CISS distraction, score of subscale of the Coping Inventory for Stressful Situations measuring distraction seeking coping style; CISS social diversion, score of subscale of the Coping Inventory for Stressful Situations measuring social diversion coping style; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; DACOBS ETB, External Attribution Bias subscale score of DACOBS; CAPE, total score of the Community Assessment of Psychic Experiences (CAPE); women were coded as –1, men were coded as 1.*

**TABLE 2 |** Parameter estimates for the mediation model (dependent variable: CAPE total).

| | Estimate | *SE* | Bootstrap (*n*=5,000) | | |
|---|---|---|---|---|---|
| | | | 95%$CI_{low}$ | 95%$CI_{high}$ | *p* |
| | | Predictor: DACOBS ATB | | | |
| Total effect | | | | | |
| **DACOBS ATB→CAPE** | **0.90** | **0.14** | **0.63** | **1.18** | **<0.001** |
| Direct effects | | | | | |
| **DACOBS ATB → PSS-10** | **0.40** | **0.08** | **0.24** | **0.57** | **<0.001** |
| **PSS-10 → CAPE** | **0.90** | **0.09** | **0.73** | **1.07** | **<0.001** |
| **DACOBS ATB → CAPE** | **0.54** | **0.14** | **0.30** | **0.79** | **<0.001** |
| **Sex → PSS-10** | **−2.07** | **0.68** | **−3.41** | **−0.73** | **0.01** |
| Age → PSS-10 | 0.00 | 0.15 | −0.30 | 0.30 | 0.99 |
| **Sex → CAPE** | **4.17** | **0.98** | **2.24** | **6.11** | **<0.001** |
| Age → CAPE | −0.02 | 0.22 | −0.45 | 0.41 | 0.93 |
| | | Predictor: DACOBS ETB | | | |
| Total effect | | | | | |
| **DACOBS ETB-> CAPE** | **1.18** | **0.15** | **0.89** | **1.46** | **<0.001** |
| Direct effects | | | | | |
| **DACOBS ETB → PSS-10** | **0.65** | **0.09** | **0.48** | **0.82** | **<0.001** |
| **PSS-10 → CAPE** | **0.82** | **0.09** | **0.64** | **1.00** | **<0.001** |
| **DACOBS ETB → CAPE** | **0.64** | **0.14** | **0.37** | **0.92** | **<0.001** |
| **Sex → PSS-10** | **2.26** | **0.65** | **−3.53** | **−0.99** | **<0.001** |
| Age → PSS-10 | 0.03 | 0.14 | −0.26 | 0.31 | 0.86 |
| **Sex → CAPE** | **3.88** | **0.99** | **1.94** | **5.83** | **<0.001** |
| Age → CAPE | −0.03 | 0.22 | −0.46 | 0.39 | 0.88 |

*n = 275; $R^2$ when DACOBS ATB is the predictor = 0.27, p < 0.001; $R^2$ when DACOBS ETB is the predictor = 0.30, p < 0.001; PSS-10, total score of Perceived Stress Scale; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; DACOBS ETB, External Attribution Bias subscale score for DACOBS; CAPE total, total score of the Community Assessment of Psychic Experiences; women were coded as −1, men were coded as 1.*
*The statistically significant results were written in bold.*

**TABLE 3 |** Indirect effects of cognitive biases on different dimensions of CAPE.

| | Estimate | *SE* | Bootstrap (*n*=5,000) | |
|---|---|---|---|---|
| | | | 95%$CI_{low}$ | 95%$CI_{high}$ |
| DACOBS ATB→CAPE total | 0.36 | 0.08 | 0.22 | 0.52 |
| DACOBS ATB→CAPE positive | 0.08 | 0.02 | 0.04 | 0.14 |
| DACOBS ATB→CAPE negative | 0.14 | 0.03 | 0.09 | 0.21 |
| DACOBS ATB→CAPE depression | 0.14 | 0.03 | 0.08 | 0.19 |
| DACOBS ETB→CAPE total | 0.53 | 0.08 | 0.39 | 0.71 |
| DACOBS ETB→CAPE positive | 0.12 | 0.03 | 0.06 | 0.19 |
| DACOBS ETB→CAPE negative | 0.20 | 0.04 | 0.14 | 0.29 |
| DACOBS ETB→CAPE depression | 0.21 | 0.03 | 0.16 | 0.27 |

*n = 275; all indirect effects are statistically significant; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; DACOBS ETB, External Attribution Bias subscale score of the DACOBS; CAPE total, total score of the Community Assessment of Psychic Experiences; CAPE negative, negative symptoms subscale of the Community Assessment of Psychic Experiences; CAPE positive, positive symptoms subscale of the Community Assessment of Psychic Experiences; CAPE depression, depression subscale of the Community Assessment of Psychic Experiences.*

of PLEs (CAPE positive) and depression symptoms (CAPE depression); it was not present in the case of negative symptoms of PLEs (CAPE negative) (see **Tables 5** and **6** for details).

No other significant moderated mediation effects were detected when the total score of the CAPE scale was treated as a dependent variable. Nevertheless, when additional analyses were conducted

**TABLE 4 |** Parameter estimates for the moderated mediation model (dependent variable: CAPE total).

| | Estimate | *SE* | Bootstrap (*n*=5,000) | | |
|---|---|---|---|---|---|
| | | | 95%$CI_{low}$ | 95%$CI_{high}$ | *p* |
| | | Mediator Variable Model – outcome: PSS-10 | | | |
| **Constant** | **−10.83** | **4.12** | **−18.93** | **−2.72** | **<0.01** |
| **DACOBS ATB** | **0.40** | **0.09** | **0.23** | **0.56** | **<0.001** |
| **Sex** | **−2.04** | **0.68** | **−3.38** | **−0.70** | **<0.01** |
| Age | −0.00 | 0.15 | −0.30 | 0.30 | 0.99 |
| | | Dependent Variable Model – outcome: CAPE total | | | |
| **Constant** | **62.83** | **5.88** | **51.24** | **74.41** | **<0.001** |
| **PSS-10** | **0.89** | **0.09** | **0.71** | **1.06** | **<0.001** |
| **DACOBS ATB** | **0.53** | **0.13** | **0.28** | **0.78** | **<0.001** |
| CISS distraction | 0.17 | 0.10 | −0.03 | 0.36 | 0.09 |
| **Interaction** | **0.03** | **0.01** | **0.00** | **0.05** | **<0.05** |
| **Sex** | **4.06** | **0.98** | **2.13** | **6.00** | **<0.001** |
| Age | −0.02 | 0.23 | −0.44 | 0.40 | 0.96 |

*n = 275; $R^2$ for Mediator Model = 0.10, p < 0.001; $R^2$ for Dependent Variable Model = 0.40, p < 0.001; CAPE total, total score of the Community Assessment of Psychic Experiences; PSS-10, total score of Perceived Stress Scale; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; CAPE, total score of the Community Assessment of Psychic Experiences; CISS distraction, score of subscale of Coping Inventory for Stressful Situations measuring distraction seeking coping style; women were coded as −1, men were coded as 1.*
*The statistically significant results were written in bold.*

**TABLE 5 |** Conditional indirect effects of attention to threat bias on CAPE at values of the CISS distraction.

| Values of the CISS distraction | Effect | *SE* | Bootstrap (*n*=5,000) | |
|---|---|---|---|---|
| | | | 95% $CI_{low}$ | 95% $CI_{high}$ |
| Dependent variable: CAPE total | | | | |
| Mean − 1SD | 0.29 | 0.07 | 0.16 | 0.44 |
| Mean | 0.35 | 0.08 | 0.21 | 0.52 |
| Mean+1SD | 0.42 | 0.10 | 0.25 | 0.63 |
| Dependent variable: CAPE positive | | | | |
| Mean − 1SD | 0.05 | 0.02 | 0.01 | 0.10 |
| Mean | 0.08 | 0.02 | 0.04 | 0.13 |
| Mean+1SD | 0.11 | 0.03 | 0.05 | 0.18 |
| Dependent variable: CAPE depression | | | | |
| Mean − 1SD | 0.12 | 0.03 | 0.07 | 0.19 |
| Mean | 0.14 | 0.03 | 0.08 | 0.21 |
| Mean+1SD | 0.15 | 0.04 | 0.08 | 0.25 |

*n = 275; CAPE total, total score of the Community Assessment of Psychic Experiences; CAPE negative, negative symptoms subscale of the Community Assessment of Psychic Experiences; CAPE positive, positive symptoms subscale of the Community Assessment of Psychic Experiences; CAPE depression, depression subscale of the Community Assessment of Psychic Experiences; CISS distraction, score of subscale of Coping Inventory for Stressful Situations measuring distraction seeking coping style.*

separately for the CAPE subscales, a couple more interesting effects emerged concerning the depression symptoms subscale (**Table 6**). It turned out that conditional indirect effect of attention to threat bias *via* perceived stress differed depending on the level of emotion-oriented coping (Index of moderated mediation=0.002, SE=0.001, $CI_{low}$=0.0003, $CI_{high}$=0.004) and task-oriented coping (Index of moderated mediation=−0.002, SE=0.001, $CI_{low}$=−0.004, $CI_{high}$=−0.0003) in such a way that the effect was stronger at the higher level of emotional coping and at the lower level of task-oriented coping (**Table 7**).

**TABLE 6** | Conditional indirect effects of cognitive biases on different dimensions of CAPE.

| | Index of moderated mediation | *SE* | Bootstrap (*n*=5,000) | |
|---|---|---|---|---|
| | | | 95%$CI_{low}$ | 95%$CI_{high}$ |
| Moderator: task-oriented coping | | | | |
| DACOBS ATB→CAPE total | −0.005 | 0.004 | −0.013 | 0.003 |
| DACOBS ATB→CAPE positive | −0.001 | 0.002 | −0.003 | 0.003 |
| DACOBS ATB→CAPE negative | −0.003 | 0.002 | −0.007 | 0.001 |
| **DACOBS ATB→CAPE depression** | **−0.002** | **0.001** | **−0.004** | **−0.000** |
| DACOBS ETB→CAPE total | −0.008 | 0.006 | −0.020 | 0.003 |
| DACOBS ETB→CAPE positive | −0.000 | 0.002 | −0.005 | 0.004 |
| DACOBS ETB→CAPE negative | −0.005 | 0.003 | −0.012 | 0.001 |
| **DACOBS ETB→CAPE depression** | **−0.003** | **0.002** | **−0.006** | **−0.000** |
| Moderator: emotion-oriented coping | | | | |
| DACOBS ATB→CAPE total | 0.002 | 0.003 | −0.004 | 0.008 |
| DACOBS ATB→CAPE positive | 0.000 | 0.002 | −0.003 | 0.003 |
| DACOBS ATB→CAPE negative | −0.000 | 0.001 | −0.003 | 0.002 |
| **DACOBS ATB→CAPE depression** | **0.002** | **0.001** | **0.000** | **0.004** |
| DACOBS ETB→CAPE total | 0.001 | 0.005 | −0.007 | 0.011 |
| DACOBS ETB→CAPE positive | −0.000 | 0.002 | −0.005 | 0.004 |
| DACOBS ETB→CAPE negative | −0.001 | 0.002 | −0.005 | 0.004 |
| DACOBS ETB→CAPE depression | 0.002 | 0.001 | −0.000 | 0.005 |
| Moderator: distraction seeking | | | | |
| **DACOBS ATB→CAPE total** | **0.010** | **0.005** | **0.001** | **0.023** |
| **DACOBS ATB→CAPE positive** | **0.005** | **0.003** | **0.001** | **0.011** |
| DACOBS ATB→CAPE negative | 0.002 | 0.003 | −0.003 | 0.008 |
| **DACOBS ATB→CAPE depression** | **0.003** | **0.002** | **0.001** | **0.007** |
| DACOBS ETB→CAPE total | 0.014 | 0.008 | −0.001 | 0.031 |
| DACOBS ETB→CAPE positive | 0.006 | 0.004 | −0.001 | 0.015 |
| DACOBS ETB→CAPE negative | 0.003 | 0.005 | −0.006 | 0.013 |
| DACOBS ETB→CAPE depression | 0.004 | 0.003 | −0.000 | 0.010 |
| Moderator: social contacts | | | | |
| DACOBS ATB→CAPE total | 0.002 | 0.008 | −0.014 | 0.017 |
| DACOBS ATB→CAPE positive | 0.005 | 0.004 | −0.002 | 0.015 |
| DACOBS ATB→CAPE negative | −0.002 | 0.004 | −0.010 | 0.005 |
| DACOBS ATB→CAPE depression | −0.002 | 0.002 | −0.007 | 0.002 |
| DACOBS ETB→CAPE total | 0.000 | 0.012 | −0.024 | 0.023 |
| DACOBS ETB→CAPE positive | 0.007 | 0.006 | −0.006 | 0.020 |
| DACOBS ETB→CAPE negative | −0.002 | 0.006 | −0.014 | 0.010 |
| DACOBS ETB→CAPE depression | −0.005 | 0.004 | −0.012 | 0.020 |

*n = 275; since the presented effects are small, all values are shown to three decimal places; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; DACOBS ETB, External Attribution Bias subscale score of the DACOBS; CAPE total, total score of the Community Assessment of Psychic Experiences; CAPE negative, negative symptoms subscale of the Community Assessment of Psychic Experiences; CAPE positive, positive symptoms subscale of the Community Assessment of Psychic Experiences; CAPE depression, depression subscale of the Community Assessment of Psychic Experiences. The statistically significant results were written in bold.*

### The Relationship Between External Attribution Bias, Stress, Coping, and PLEs

When ETB was treated as predictor in the moderated mediation models, none of the examined interaction effects of stress and coping on total score of the CAPE reached the level of statistical significance: task-oriented coping × stress: B=−0.09, SE=0.06, $CI_{low}$=−0.20, $CI_{high}$=0.03, p=0.15; emotion-oriented coping × stress: B=−0.01, SE=0.04, $CI_{low}$=−0.09, $CI_{high}$=0.07, p=0.84; avoidant coping × stress: B=0.06, SE=0.06, $CI_{low}$=−0.05, $CI_{high}$=0.17, p=0.29; distraction seeking × stress: B=0.12, SE=0.09, $CI_{low}$=−0.05, $CI_{high}$=0.31; social diversion coping × stress: B=0.08, SE=0.13, $CI_{low}$=−0.18, $CI_{high}$=0.34, p=0.53. Interestingly, when the CAPE subscales were taken into consideration, the conditional indirect effect of external attribution bias on depression turned out to be stronger at the lower level of task-oriented coping (**Tables 6** and **7**).

**TABLE 7** | Conditional indirect effects of cognitive biases on CAPE depression at values of the moderators.

| | Values of the moderator | Effect | *SE* | Bootstrap (*n*=5,000) | |
|---|---|---|---|---|---|
| | | | | 95%$CI_{low}$ | 95%$CI_{high}$ |
| | Moderator: emotion-oriented coping | | | | |
| Predictor: DACOBS ATB | Mean − 1SD | 0.09 | 0.02 | 0.05 | 0.13 |
| | Mean | 0.11 | 0.02 | 0.06 | 0.16 |
| | Mean+1SD | 0.13 | 0.03 | 0.07 | 0.19 |
| | Moderator: task-oriented coping | | | | |
| | Mean − 1SD | 0.15 | 0.03 | 0.10 | 0.22 |
| | Mean | 0.13 | 0.03 | 0.08 | 0.19 |
| | Mean+1SD | 0.12 | 0.03 | 0.07 | 0.17 |
| Predictor: DACOBS ETB | Mean − 1SD | 0.24 | 0.04 | 0.18 | 0.32 |
| | Mean | 0.21 | 0.03 | 0.16 | 0.27 |
| | Mean+1SD | 0.18 | 0.03 | 0.13 | 0.24 |

*n = 275; CAPE depression, depression subscale of the Community Assessment of Psychic Experiences; DACOBS ATB, Attention to Threat Bias subscale score of the DACOBS; DACOBS ETB, External Attribution Bias subscale score of the DACOBS.*

## DISCUSSION

The current study examined the interrelationship between cognitive biases, perceived stress, and psychotic-like experiences in a sample of healthy young and middle adults (34). It also further explored whether the individual strategies applied to copy with stressful events moderate the link between stress and PLEs. The findings confirmed that a higher level of psychotic-like experiences is associated with oversensitivity to threat (ATB) as well as a tendency to blame others for negative events (ETB). The study also yielded a positive, correlational relationship between stress and biased cognitive processes, and demonstrated that individuals with higher psychological stress are more likely to endorse psychotic-like experiences. These results contribute to growing literature highlighting the importance of cognitive biases and stressful life events for psychotic symptoms within the psychosis continuum (4–6, 10, 11, 13, 15–18).

In the study, we also examined whether the relationship linking oversensitivity to threat and the tendency to blame others for failures with subclinical psychotic symptoms may be explained by the level of stress experienced by individuals. Indeed, the results showed that the relationship linking ATB and ETB with different dimensions of psychotic-like experiences is partially mediated by perceived stress. It suggests that searching environment for threat, social threat in particular, may exaggerate psychotic symptoms through increasing the stress level. This finding provides additional evidence in a non-clinical sample supporting the recent models of psychosis emphasizing the interplay between cognitive and emotional distortions in symptoms development (24, 25). However, it should be noted that the mediation effect yielded in the study was only partial, suggesting that there are some other factors through which cognitive biases may affect psychotic symptoms. For example, the tendency to attribute negative events to external, personal causes may trigger anger or result in social withdrawal and loss of social support, which may likewise lead to symptoms amplification.

In the study, we also considered the role of coping strategies on the relationship between stress and psychotic-like experiences. The link between coping and psychotic experiences has already been examined in a few studies concerning coping methods preferred by individuals with PLEs, UHR subjects, and patients with schizophrenia (16–18, 22). In general, it was demonstrated that individuals with psychotic symptoms reveal the tendency to apply non-adaptive, emotion-focused coping style. The current study also yielded the results suggesting that PLEs are positively related to emotion-oriented and distraction type of avoidance-oriented coping (with the exception of the negative symptoms of PLEs), however, not to social diversion coping. We also observed the weak, negative relationship between the negative symptoms of PLEs as well as depression and task-oriented coping. This coping fashion roughly mirrors the pattern previously found among individuals with clinical psychosis and UHR subjects (17, 22) providing future evidence that the tendency to overuse maladaptive coping may be observed in both subclinical and clinical areas of the psychosis continuum. Similarly, as previously stated in case of a clinical group (22), individuals reporting PLEs may perceive stressful events as uncontrollable and social support as unavailable due to their suspicious and persecutory beliefs. Therefore, they may consider emotion-oriented coping as more adequate than task-oriented one. Also, negative symptoms, such as amotivation, anhedonia and withdrawal, or depression-related hopelessness can be a source of participants' tendency to refrain from acting actively when facing stressful events. Individuals experiencing such symptoms may consider task-oriented coping as too demanding, which makes them willing to apply strategies focused on emotional responses, self-preoccupation, or fantasizing. Also avoidance-oriented coping, such as distraction seeking and social diversion may be difficult to apply for individuals with negative symptoms since these require engaging in new activities and maintaining social contacts.

Although on the basis of our study we cannot draw conclusion about the direction of the relationship linking emotion-oriented coping and PLEs, it is probable that the tendency to apply emotion-focused methods may amplify psychotic-like experiences, which in turn increase the use of emotion-oriented coping. This conclusion is consistent with the findings obtained by Lin et al. (18) in a longitudinal study on a non-clinical sample of adolescents, demonstrating that greater use of emotion-oriented coping is associated with an increase of subclinical psychotic symptoms over time, and that higher level of PLEs at baseline predicted greater use of emotion-focused coping three years later.

The current study also demonstrated that the association between perceived stress and psychotic-like experiences is modified by the coping styles. This finding is in line with previous studies considering the role of coping method in symptoms development and outcome (18, 23). However, contrary to prior research, the present study investigated the role of coping in a broad context of interrelationships between stress and cognitive biases. Particularly, we tested whether individual coping methods may moderate the associations linking cognitive biases (ATB and ETB), stress, and PLEs. We found that the stress-mediated indirect effect of ATB on positive and depressive symptoms of PLEs is stronger at the higher level of distraction seeking type of avoidance coping, and weakens when the tendency to engage in distraction-based activities is reduced. It is likely that in individuals characterized by enhanced threat sensitivity, the use of these strategies may increase psychotic symptoms, since for them distraction-based activities are the source of additional stress. It is also possible, that individuals seeking distraction to cope with stress originating from their increased sensitivity are especially susceptible to psychotic symptoms, since this coping method may prevent them from deeper processing of information they receive from the environment. As a result, they have fewer opportunities to correct their reasoning and are more prone to the harmful effect of cognitive biases. Furthermore, avoidant style of coping keeps them from dealing directly with demands created by the stressful events and as a result may lead to the escalation of a problem, which would start to impact them even more strongly—leading to depressive symptoms.

It should be noted, that the previous study of Chisholm et al. (35) did not find avoidant coping to be maladaptive in a group of non-clinical adolescents. However, Chisholm et al. (35) considered jointly the two types of avoidant styles, i.e. distraction seeking and social diversion, therefore, they were unable to capture the role of each of these styles in the relationship between stress and PLEs. Our findings indicate, that only the level of distraction seeking modifies the stress-PLEs relationship. What is more, in the Chisholm et al. (35) study the role of attention to threat bias was not considered. It is plausible, that distraction seeking increases the PLEs only among distressed individuals with heightened threat sensitivity. For these participants, engaging in distraction-biased activities may provide additional stress due to their tendency to examine the phenomena they encounter in terms of threat, whereas in adolescents without ATB undertaking additional activities may be even adaptive since in adolescents avoidance-oriented coping was found to be positively associated with social relationships (35).

Our study also yielded the moderation effect concerning emotion-oriented coping: the indirect effect of ATB *via* perceived stress on depressive symptoms was stronger at the higher level of emotion-oriented coping. The fact that this effect was not present in regard to positive and negative symptoms of PLEs is somewhat surprising in light of previous studies showing that patients with schizophrenia, UHR subjects and healthy people reporting PLEs are particularly likely to employ emotion-oriented strategies to cope with stressful events (16, 22). It suggests, that although focusing on one's own emotional responses is common among individuals with psychotic experiences, applying this coping method not necessarily shapes the relationship between stress and positive or negative psychotic symptoms. It seems plausible that emotion-oriented coping may be effective as far as individuals with PLEs perceive stress as uncontrollable, i.e. it may decrease the stress level, however, it does not necessarily reduce psychotic experiences. This finding seems to be inconsistent with the previous observation by Lin et al. (18) that emotion-oriented coping predicted PLEs over time. However, in our study we investigated the link between emotion-focused coping and PLEs at a single time point, therefore, our findings do not exclude the possibility that this type of coping is related to some changes in psychotic symptoms that occur over time.

It is noteworthy, that in the current study also task-oriented coping emerged as a moderator shaping the indirect effects of attention to threat bias and external attribution bias on depressive symptoms in such a way, that the effects of perceived stress on depression were weaker at the higher level of task-oriented coping. It is possible that active problem solving protects individuals from depression-related negative consequences of stress such as feeling of helplessness, negative self-esteem, or hopelessness by improving their well-being, perceived efficacy, and sense of control (36). On the other hand, surprisingly, a similar pattern was not found in the case of positive and negative symptoms of PLEs: this finding leaves open the question about the role played by task-oriented coping in reducing psychotic symptoms.

Researching possible factors and mechanisms underlying psychotic-like experiences in non-clinical groups is important for a few reasons. First of all, it has been demonstrated that providing help at a very early stage of disorder emergence and development may prevent, delay, reduce, or help to control later psychotic symptoms (37). Effective prevention needs to take into account not only early symptoms but also and foremost phenomena producing such symptoms and psychotic vulnerability (38). Moreover, studying very early phases of psychosis gives a clearer picture of factors and processes involved, before the development of illness, its consequences, and effects of treatment clouds this picture (38).

The results of our study provide implications for early interventions focused on decreasing subclinical psychotic symptoms through reducing perceived stress or modifying methods used to cope with stressful events. Given that PLEs have been linked to increased risk of psychosis development (1), such interventions should be effective when applied among healthy, at risk individuals in order to preclude or delay the psychosis onset. For example, programs focused on the modification of attention to threat bias as well as on teaching stress alleviation techniques may decrease PLEs by reducing stress. Also, interventions aimed at replacing distraction seeking coping and emotion-focused coping with more adaptive methods may be of assistance to people with heightened threat sensitivity.

The present findings should be interpreted in light of the study limitations. Firstly, variables assessment was based on self-reports and retrospection. It is particularly important in case of psychotic-like experiences which were suggested to be overestimated in self-reports (39). However, evidence also exists, that there is a good correlation between scores obtained on the CAPE questionnaire and interview-based assessment of PLEs (40). Nevertheless, due to the lack of more objective methods for measuring variables, the results obtained in the study should be treated as preliminary. Secondly, the study design was cross-sectional and therefore we cannot establish the causality or directionality of the observed relationships. Moreover, there was no clinical group to assess whether a similar pattern of findings would be found among patients suffering from psychosis or UHR individuals. Furthermore, it may be argued, that excluding participants with family history of psychiatric disorders from the study, although common practice in research concerning psychotic-like experiences, might have unnecessarily limited the variance of measured variables. Future studies with stronger methodologies, such as Experience Samples Methods, and with more heterogeneous as well as clinical groups are needed to confirm the obtained results. Also, the imbalance of the study sample in terms of gender and education level limits the generalizability to the general population. Finally, it is worth mentioning that apart from modifying the relationship between perceived stress and PLEs, it is also possible that coping styles change the way in which cognitive biases affect the subjective appraisal of stress. Although the additional analyses conducted by the authors did not yield significant interaction effects of cognitive biases and coping methods on perceived stress this model should be explored in further longitudinal studies.

In summary, despite its limitations, the study provided new data concerning the interplay between cognitive biases (widely recognized as contributing to psychotic symptoms), subjective experiences of stress, coping styles, and psychotic-like experiences. The results imply that addressing simple relations between cognitive biases and perceived stress may be insufficient to understand psychotic symptoms. The findings suggest that stress associated with the heightened threat sensitivity may aggravate the psychotic symptoms especially among individuals employing distraction seeking and emotion-oriented coping methods. Therefore, our study provided theoretical basis for early intervention strategies.

## DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Komisja ds Etyki Badań Naukowych przy Instytucie Psychologii Uniwersytetu Jagiellońskiego. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

KP and JK designed the study. AD gathered data. JK run and described the statistical analyses. KP and JK interpreted the data and wrote the manuscript. All authors approved the final version of the manuscript. All the authors edited the manuscript.

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# Impaired Facial Emotion Recognition in Individuals at Ultra-High Risk for Psychosis and Associations With Schizotypy and Paranoia Level

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**Background:** Patients with schizophrenia and individuals at ultra-high risk for psychosis (UHR) have been reported to exhibit impaired recognition of facial emotion expressions. This impairment has involved both inaccuracy and negative bias of facial emotion recognition. The present study aimed to investigate whether UHR individuals display both types of impaired facial emotion recognition and to explore correlations between these impairments and schizotypy, as well as paranoia levels, in these individuals.

**Methods:** A total of 43 UHR individuals and 57 healthy controls (HC) completed a facial emotion recognition task consisting of 60 standardized facial photographs. To explore correlations, we assessed schizotypy using the Revised Physical Anhedonia Scale and Magical Ideation Scale and paranoia level using the Paranoia Scale and persecution/suspicious item of the Positive and Negative Syndrome Scale in UHR individuals.

**Results:** Compared with HC, UHR individuals exhibited less accuracy for facial emotion recognition (70.6% vs. 75.6%, p=0.010) and a higher rate of "fear" responses for neutral faces (14.5% vs. 6.0%, p=0.003). In UHR individuals, inaccuracy was significantly correlated with schizotypy scores, but not with paranoia level. Conversely, "disgust" response for neutral faces was the only fear response correlated with paranoia level, and no threat-related emotion response correlated with schizotypy scores.

**Discussion:** UHR individuals exhibited inaccuracy and negative bias of facial emotion recognition. Furthermore, schizotypy scores were associated with inaccuracy but not with negative bias of facial emotion recognition. Paranoia level was correlated with "disgust" responses for neutral faces but not with inaccuracy. These findings suggest that inaccuracy and negative bias of facial emotion recognition reflect different underlying processes, and that inaccuracy may be a vulnerability marker for schizophrenia.

**Keywords: facial emotion recognition, inaccuracy, negative response bias, schizotypy, paranoia, ultra-high risk for psychosis, schizophrenia**

## INTRODUCTION

Patients with schizophrenia exhibit deficits in social cognition that produce difficulties in social interactions (1). Social cognition consists of various psychological processes involved with recognizing the mental state of other people (2, 3). Facial emotion recognition—the ability to evaluate another person's emotional state from their facial expressions—is one of the most studied social cognition processes in schizophrenia (3, 4). Impaired facial emotion recognition has been repeatedly observed in previous studies of patients with first-episode schizophrenia, as well as chronic schizophrenia (4–6). Thus, impaired facial emotion recognition could represent a trait marker of psychotic disorders. This premise is supported by findings of impaired facial emotion recognition in individuals at ultra-high risk for psychosis (UHR) (7–10).

Two types of impaired facial emotion recognition have been previously reported in patients with diagnosed schizophrenia, as well as in UHR individuals: inaccuracy and negative bias. Inaccuracy, which implies a lack of ability to accurately recognize facial emotions, was a consistent finding in most previous studies of schizophrenia (4, 11) and UHR (8, 12, 13). Negatively biased error patterns for neutral faces was also observed in previous studies of schizophrenia (14–16) and UHR (8). Although the specific emotion categories that were biased differed according to the characteristics of the research subjects and emotion recognition tasks, most studies showed bias toward negative emotions, such as "disgust" (14), "anger" (15, 16), and "fear" (16) in patients with schizophrenia and bias toward "anger" in UHR individuals (8). These emotions (fear, anger, disgust) are interrelated, threat-related emotions. Fear and anger are well known facial emotions associated with social threats (17, 18). With disgust, the type of threat is different, but it is similar to fear (warning others of the presence of danger) and anger (displaying anger toward others) in that it is a defensive emotion about a possible threat (with disgust toward others representing a type of contamination fear). Also, in the sense that disgust represents the rejection of a stimulus, disgust could appear as a rejection to others to avoid. In this respect, disgust could be thought of as a similar group of emotions that can be perceived as being hostile such as fear and anger in paranoia. (19–21). Although bias toward threat-related emotions seem to be consistent in schizophrenia (14–16), few studies have evaluated this bias in the UHR phase (8). Thus, it remains unclear whether negatively biased error patterns represent a trait marker that is already apparent during the putative "prodromal" UHR period.

The relationship between facial emotion recognition and psychometrically-identified schizotypy has also been studied because of the possibility of impaired facial emotion recognition as a vulnerability marker for psychosis. Relatively recent studies consistently showed lower accuracy of facial emotion recognition in individuals with high degrees of schizotypy (22–26). In addition, some studies have reported an association between negative bias of facial emotion recognition and schizotypal features in the general population. (23, 24) However, since most previous schizotypy studies have been conducted in general populations (23–25, 27, 28), the relationship between facial emotion recognition and schizotypy has not been studied sufficiently in clinical populations. Our previous study (10) of UHR individuals and patients with first-episode schizophrenia showed a significant correlation between inaccuracy of facial emotion recognition and schizotypy, but the relationship between negative bias of facial emotion recognition and schizotypy has not yet been examined. As the presence of schizotypy has been suggested to confer proneness to schizophrenia spectrum disorders (29), associations between schizotypy and facial emotion recognition suggest that impaired facial emotion recognition could be a vulnerability marker of psychosis. Therefore, exploration of the association between the two types of impaired facial emotion recognition (inaccuracy and negative bias) and schizotypy in clinical populations, such as UHR individuals, would be helpful for assessing whether each type of facial emotion recognition impairment is a potential vulnerability marker for schizophrenia spectrum disorders.

Furthermore, actively paranoid patients with schizophrenia were reported to exhibit no difference in accuracy of facial emotion recognition but tended to be more likely to judge a neutral face as "anger", when compared with non-paranoid patients (15). These findings suggest that paranoia level may be related to negative bias, but not inaccuracy, of facial emotion recognition. The association between paranoia and negative bias towards threat-related emotions is consistent with the existing hypothesis that paranoid patients tend to be more aware of threats in ambiguous situations (17, 18). This hypothesis was supported by recent studies showing that schizophrenia patients take longer to process ambiguous stimuli for some negative emotions (sad, anger) (30), and reduced visual scanning of salient features mediate paranoia and facial emotion recognition (31). These findings may be one of possible mechanisms explaining the correlation between paranoia and negative bias of facial emotion recognition that we expect. Together with the consistent prior reports of facial emotion recognition inaccuracy in patients with schizophrenia, it can be hypothesized that accuracy of facial emotion recognition is related to inherent traits of schizophrenia, whereas negative bias of facial emotion recognition is related to paranoia level, not to inherent traits of schizophrenia.

Based on these previously reported findings, we conducted a study of UHR individuals to test the following three hypotheses: 1) UHR individuals exhibit inaccuracy and negative bias of facial emotion recognition; 2) schizotypy in UHR individuals is associated with inaccuracy and negative bias of facial emotion recognition; and 3) paranoia level of UHR individuals is unrelated to inaccuracy of facial emotion recognition but does correlate with negative bias towards threat-related emotions (anger, fear, and disgust). In addition, it was explored whether there were emotion specific deficits in UHR individuals.

# METHODS

## Participants

A total of 43 UHR individuals and 57 healthy controls (HC) were enrolled in this study between April 2008 and December 2011. Some of the participants overlap with existing our prior study examining the accuracy of facial emotion recognition using different facial photos from Japanese and Caucasian Facial Expressions of Emotion and Neutral Faces (32). All participants were evaluated using the Structured Clinical Interview for DSM-IV (33, 34). According to the Criteria of the Prodromal Syndromes from the Structured Interview for Prodromal Syndromes (35), UHR individuals were defined as people who met the criteria for at least one of these three prodromal syndromes: (1) brief intermittent psychotic syndrome; (2) attenuated positive prodromal syndrome; and (3) genetic risk and deterioration syndrome. The study protocol was approved by the Institutional Review Board of Severance Hospital. Written informed consent was obtained from all participants after being provided with a full explanation of the study's procedures. For participants under the age of 18 years, we also obtained informed consent from their parents. Demographic and clinical profiles of the participants are summarized in **Table 1**.

## Procedures

The facial emotion recognition task consisted of 55 facial photographs selected from standardized photographs of the Ekman and Friesen series (41). We selected those photographs for which consensus was reached by more than 70% of observers in our previous study of 134 Korean youths (42). The photographs represented six different emotions, as well as neutral faces: 10 showed happiness, 6 showed disgust, 6 showed anger, 9 showed sadness, 10 showed surprise, 4 showed fear, and 10 showed neutral expressions. The study participants were shown each photograph in a pseudorandom order and asked to choose an emotion category that most appropriately described the emotional state of the person in the photograph. The category options were happiness, disgust, anger, sadness, surprise, or fear, which were typed below each facial photograph. While 9 photographs of neutral faces were included, neutral was not included as a response category. The accuracy rate for recognizing neutral faces is known to be very high, and we were concerned that if neutral were included as a response option, we would be unable to analyze tendencies to attribute each emotion to neutral faces because of a limited number of misattribution cases. The stimulus presentation time was 7 seconds on computer screen and then the labels of six emotional categories were displayed on the screen for another 7 seconds for response time. During the response time, participants were allowed for choosing the emotional category in response paper sheet.

Schizotypy was assessed using the Revised Physical Anhedonia Scale (38) and the Magical Ideation Scale (39). The Revised Physical Anhedonia Scale is a self-reported scale consisting of 61 items that assess deficits in the ability to derive pleasure from typically pleasurable physical stimuli, such as sex and food. It has been used widely in schizotypy research in both clinical and non-clinical settings (43) and has exhibited fair reliability and internal consistency (44). The internal consistency (Cronbach's alpha) of the Revised Physical Anhedonia Scale in the present study was 0.66. The Magical Ideation Scale is a self-reported questionnaire with 30 items that assess magical thinking. The developers of this scale defined magical thinking as "the tendency to accept forms of causality that are not viewed as valid in our culture" (45). This scale has demonstrated good reliability and internal consistency in previous studies (46, 47). The internal consistency (Cronbach's alpha) of the Magical Ideation Scale in the present study was 0.77.

**TABLE 1** | Demographic and clinical profiles of healthy controls and individuals at ultra-high risk for psychosis.

| | Healthy controls (n = 57) | UHR individuals (n = 43) | P-value |
|---|---|---|---|
| Age (years) | 20.9 (3.3) | 19.9 (3.6) | 0.937 |
| Education (years) | 13.3 (1.9) | 12.8 (2.0) | 0.819 |
| Sex (male/female) | 33/24 | 25/18 | 0.980 |
| SIPS-defined prodromal status (BIPS/APS/GRDS) | – | 8/39/7 | – |
| PANSS, positive scale[1] | – | 13.8 (3.9) | – |
| PANSS, negative scale[1] | – | 16.1 (5.1) | – |
| PANSS, general psychopathology scale[1] | – | 32.0 (7.9) | – |
| Revised Physical Anhedonia Scale | – | 23.7 (9.8) | – |
| Magical Ideation Scale | – | 10.6 (5.9) | – |
| Suspiciousness/persecution item of PANSS[1] | – | 2.83 (1.0) | – |
| Paranoia Scale[2] | – | 36.0 (18.2) | – |
| Antipsychotic medication Naïve/medicated | – | 27/16 | – |
| Chlorpromazine equivalent dose (mg/day)* | – | 133.6 (77.9) | – |

*Data are mean (standard deviation) or number.*
*[1]Data missing for one person.*
*[2]Data missing for three people.*
**Kroken et al. (36).*
*APS, Attenuated Positive Symptom Prodromal Syndrome; BIPS, Brief Intermittent Psychotic Symptom Prodromal Syndrome; GRDS, Genetic Risk and Deterioration Prodromal Syndrome; SIPS, Structured Interview for Prodromal Syndromes. (35); UHR, Ultra-High Risk for psychosis.*
*PANSS, Positive and Negative Syndrome Scale (37); Revised Physical Anhedonia scale (38); Magical Ideation Scale (39); Paranoia Scale (40).*

Paranoia level was assessed using the Paranoia Scale (40) and the persecution/suspicious item of the Positive and Negative Syndrome Scale [PANSS; (37)]. The Paranoia Scale is a self-reported assessment of paranoid ideation, which consists of 20 items. Both paranoia level scales have been reported to have good psychometric properties and have been widely used in research involving paranoia in clinical and non-clinical settings (48, 49). The Korean versions of the paranoia level scales have also shown acceptable validity and reliability and have been widely used in Korean research (50, 51). The internal consistency (Cronbach's alpha) of Paranoia scale in the present study was 0.95.

The clinical interviews and assessments of psychopathology, including PANSS, were administered by a psychiatrist on the day of enrollment in the study. Each participant then completed the Paranoia Scale, Revised Physical Anhedonia Scale, and Magical Ideation Scale. The facial emotion recognition task was conducted by a masters-level psychologist within 1 week of enrollment.

## Data Analysis

Performance during the facial emotion recognition task was quantified using two indices. First, total hit rate was used to measure accuracy. As previously mentioned, since "neutral" was not provided as the answer, the total hit rate was calculated excluding the response to the neutral stimuli. To compare the total accuracy rate of the facial emotion recognition task between UHR individuals and HC, we used the independent-sample t-test.

To measure negative bias, the response rate of specific emotions for neutral faces was calculated. If the proportion of negative emotions in the reaction to the neutral faces is high, there is a negative bias. To examine differences between response rates for neutral faces between groups, we performed multivariate analysis of variance.

For the exploratory analysis of specific deficits in emotion category in UHR individuals, the independent-sample t-test was performed to compare the accuracy of each specific emotion category between UHR individuals and HC.

Correlations between the total accuracy rate on the facial emotion recognition task and the values on both scales of paranoia level, as well as schizotypy, were examined using Pearson's correlation analysis. To examine the relationships between threat-related emotion response rates for neutral faces and the values on both scales of paranoia level, as well as schizotypy, we used Spearman's correlation analysis because we assumed that these threat-related emotion responses may not follow a normal distribution.

In all correlation analyses, we used the Bonferroni correction to adjust p-values. The significance level was set at 0.05 for all tests.

# RESULTS

## Facial Emotion Recognition Task Performance

With regards to accuracy, facial emotion recognition task performance was worse in UHR individuals (mean=80.0%, standard deviation [SD]=12.7) than in HC. (mean=85.7%, SD=8.8; t=2.65; p=0.009).

Regarding the negative bias, in emotion-specific responses to neutral faces, there was statistically significant difference between the NC and UHR individuals. (Wilks' Lambda=0.89, F (5,94)=2.32, p=0.049). Specifically, the "fear" response rate was significantly higher for UHR individuals (mean=14.2%, SD=14.2) than for HC (mean=6.1%, SD=12.1; p=0.003). Response rates for the other threat-related emotions ("anger" and "disgust") were not significantly different between UHR individuals and HC. Response rates for other emotions ("happiness", "sadness", and "surprise") also did not differ significantly between UHR individuals and HC. Details of these results are shown in **Table 2**. In exploratory analysis of the difference in accuracy for each emotion category, UHR individuals (mean=69.8%, SD=23.5) show significantly lower accuracy rate of sad emotion than HC (mean=83.6, SD=12.8; p<0.001). Details of each category are shown in **Supplementary Material**.

## Correlation Between Total Accuracy Rate and Schizotypy Scores, as Well as Paranoia Level, in UHR Individuals

Total accuracy rate was significantly correlated with schizotypy scores on both schizotypy scales: Revised Physical Anhedonia Scale: r = –0.396, corrected p<0.050, and Magical Ideation Scale: r = –0.417, corrected p=0.033 (**Figure 1**, **Table 3**). Total accuracy rate was not significantly correlated with paranoia level determined by either the Paranoia Scale or the suspiciousness/persecution item of the PANSS (p>0.129 for both).

## Correlation Between Threat-Related Emotion Response Rates and Schizotypy Scores, as Well as Paranoia Level, in UHR Individuals

The response rate for "disgust" was significantly correlated with paranoia level determined by both the Paranoia Scale (r=0.501, corrected p=0.012) and the suspicious/persecution item of the PANSS (r=0.449, corrected p=0.032). There were no other significant correlations between threat-related emotion response rates and paranoia level. There were also no significant correlations between threat-related emotion response rates and schizotypy scores on either schizotypy scale (p>0.470 for all comparisons) (**Figure 2**, **Table 3**).

**TABLE 2** | Response rates for neutral faces in healthy controls and individuals at ultra-high risk for psychosis.

| | Heathy controls (n=57) | UHR individuals (n=43) | P-value |
|---|---|---|---|
| Responses for neutral faces | | | |
| Happiness | 16.8 (23.2) | 14.2 (22.3) | 0.566 |
| Sadness | 38.9 (24.9) | 31.4 (22.4) | 0.121 |
| Surprise | 6.5 (9.5) | 7.4 (10.5) | 0.638 |
| Disgust | 4.9 (13.9) | 6.2 (12.9) | 0.617 |
| Anger | 26.7 (17.5) | 26.5 (20.0) | 0.967 |
| Fear | 6.1 (12.1) | 14.2 (14.2) | 0.003* |

**p < 0.05.*
*Data are number (percentage).*
*UHR, individuals at Ultra-High Risk for psychosis.*

**TABLE 3 |** Correlation coefficients for the associations between accuracy rate of facial emotion recognition/threat-related emotion response rates for neutral faces and schizotypy scores and paranoia level in individuals at ultra-high risk for psychosis.

| | | Schizotypy score | | Paranoid level | |
|---|---|---|---|---|---|
| | | Revised Physical Anhedonia Scale (n=39) | Magical Ideation Scale (n=39) | Paranoia Scale (n=40) | Suspiciousness/persecution item of PANSS (n=42) |
| Accuracy rate | | −0.396 (corrected P<0.050)* | −0.417 (corrected P=0.033)* | −0.344 (corrected P=0.129) | −0.135 (corrected P>0.999) |
| Response for neutral faces | "Disgust" response | 0.246 (corrected P>0.999) | 0.330 (corrected P=0.470) | 0.501 (corrected P=0.012)* | 0.449 (corrected P=0.032)* |
| | "Angry" response | 0.004 (corrected P>0.999) | 0.193 (corrected P>0.999) | −0.043 (corrected P>0.999) | −0.057 (corrected P>0.999) |
| | "Fear" response | 0.105 (corrected P>0.999) | −0.047 (corrected P>0.999) | 0.164 (corrected P>0.999 | 0.108 (corrected P>0.999) |

**Bonferroni-corrected P < 0.05 (for accuracy rate: uncorrected P<0.05/4; for response for neutral faces: uncorrected P<0.05/12).*
*PANSS, Positive and Negative Syndrome Scale (37); Revised Physical Anhedonia scale (38); Magical Ideation Scale (39); Paranoia Scale (40).*

# DISCUSSION

## Results and Comparisons to Previous Studies

To our knowledge, this is the first published study examining the associations between two types of impaired facial emotion recognition (inaccuracy and negative bias) and schizotypy, as well as paranoia level, in UHR individuals. In the present study, UHR individuals exhibited both types of impaired facial emotion recognition: inaccuracy and negative ("fear") bias. Moreover, inaccuracy of facial emotion recognition was correlated with schizotypy scores, whereas the "disgust" response rate for neutral faces was correlated with paranoia level.

In the present study, UHR individuals had lower total accuracy for facial emotion recognition (70.6% vs. 75.6%) and higher rates of "fear" responses to neutral faces (14.5% vs. 6.0%), when compared with HC. This inaccuracy was consistent with the results of previous studies in UHR individuals (10, 13, 52). The negative bias toward "fear" emotion was also generally consistent with the results of previously studies involving UHR people (8) and patients with schizophrenia (14–16, 21), although "anger" was the emotion that was biased in the previous UHR study. The difference between the specific biased emotion categories may arise from methodological differences between studies, such as differences in the types of facial emotional stimuli or the type or number of emotion categories. The effect of methodological differences has already been demonstrated in previous schizophrenia studies showing negative bias for different emotion categories, such as "disgust", "fear", and "anger" (14–16, 21). Considering methodological differences, the "fear" bias observed in the present study is consistent with the "anger" bias of the previous UHR study (8), as both represent biases for threat-related emotions. As with facial emotion recognition inaccuracy, threat-related emotion bias is observed in both UHR individuals and patients with schizophrenia, suggesting that threat-related emotion recognition bias may represent a marker of psychosis. To provide support for this suggestion, further studies addressing methodological issues would be helpful.

We also explored relationships between the two types of impaired facial emotion recognition and schizotypy, as well as paranoia level. Schizotypy scores correlated with inaccuracy of facial emotion recognition, but not with the response rates for any of the three threat-related emotions. The correlation between inaccuracy and schizotypy is consistent with the results of our previous study of UHR individuals and patients with first-episode schizophrenia (10), as well as previous general population studies (23, 25, 26). However, the lack of negative bias observed in this

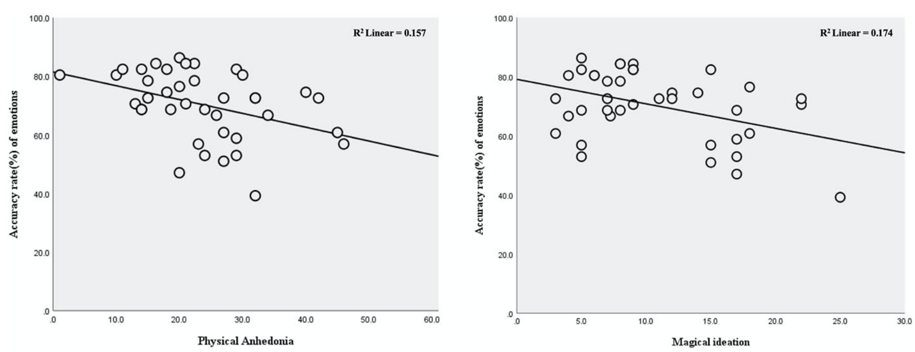


**FIGURE 1 |** Relationships between accuracy rate for facial emotion recognition and schizotypy scores in individuals at ultra-high risk for psychosis.

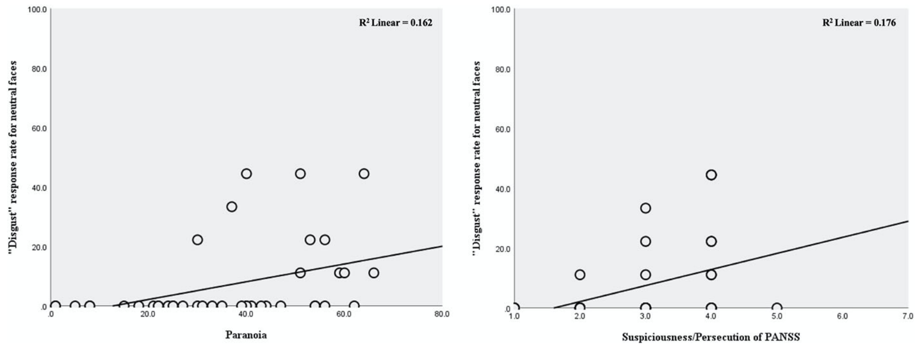


**FIGURE 2 |** Relationships between "disgust" response rate for neutral faces and paranoia level in individuals at ultra-high risk for psychosis.

study contrasted with the results of previous studies in the general population, which showed correlations between high schizotypy and negative bias (23, 24). This discrepancy suggests that although both inaccuracy and negative bias of facial emotion recognition exist in the putative "prodromal" UHR phase, the processes underlying these impairments may differ. Considering the characteristics of schizotypy, which reflects proneness to psychosis (29), the significant association between inaccuracy and schizotypy scores suggests that inaccuracy is likely a vulnerability factor for schizophrenia spectrum disorders.

When examining paranoia, we found that inaccuracy was not associated with paranoia level and that the "disgust" response was the only threat-related emotion correlated with paranoia level in UHR individuals. The lack of association between paranoia level and inaccuracy is consistent with the results of a previous study, which reported no difference in accuracy of facial emotion recognition between patients with paranoid or non-paranoid schizophrenia (15). Unlike schizotypy, paranoia does not appear to be an inherent trait of psychosis but a symptom that changes according to the severity of the psychotic disorder. Thus, our finding that inaccuracy correlates only with schizotypy scores and not with paranoia level further supports the possibility that inaccuracy of facial emotion recognition is a trait marker for psychosis.

Although the "disgust" response rate correlated with paranoia level, which may correspond with the previous finding of more "anger" bias in patients with paranoid schizophrenia than in those with non-paranoid schizophrenia (15), we cannot definitively conclude that negative bias of facial emotion recognition correlates with paranoia level based on these findings. Pinkham et al. examined differences between paranoid and non-paranoid patients but did not evaluate the correlation between paranoia level and negative bias. In the present study, correlation between paranoia level and threat-related emotion ("disgust") response was observed, but this emotion differed from the emotion that was biased in our UHR group ("fear"), compared with HC. One possible explanation for this discrepancy could be that paranoia is necessary for negative bias, but the level of paranoia is not directly proportional to negative bias. Alternatively, paranoia level may actually correlate with negative bias, but we were unable to detect this correlation because of the characteristics of UHR individuals. As these individuals exhibit less severe psychiatric symptoms, including paranoia levels, than those with schizophrenia, impaired facial emotion recognition is also likely to be less severe in UHR individuals. Thus, there is a possibility that the negative bias, paranoia level, or both were not of sufficient severity to permit detection of a significant correlation. In addition, UHR is an extremely heterogeneous group, with varying outcomes on follow-up: some individuals will proceed to develop a schizophrenia spectrum disorder, some will recover, and others will maintain their current status. If the negative bias is observed in only specific subgroups of patients with schizophrenia who have paranoid features, then any correlation effects would be further diluted by mixing paranoid-prone individuals with other people in the heterogeneous UHR group. Future studies examining subgroups of UHR individuals and patients with schizophrenia may help clarify these issues.

Regarding the exploration of specific deficits in emotion category in UHR individuals, there were lower accuracy rate of sad emotion significantly and those of happy and fear emotions in trend-level. These findings were globally compatible of the previous reports (9, 13). In near future, further study to clarify whether there is the emotion-specific deficits in UHR individuals under the application of the differential deficits design (53).

## Limitations

One limitation of the present study is that the ethnicity of people in the facial photographs differed from that of our Korean study participants. This difference could affect our results because racial and cultural differences may influence the interpretation of facial expressions. However, this effect was likely minimal because we used only those photographs with more than 70% consensus in our previous study of Koreans (42). Secondly, limitation may be that different numbers of stimuli were used for each emotion category to use only pictures with high inter-rater agreement. Thus, in the present study, the inaccuracy of facial emotion recognition was tested using the overall accuracy rates of facial photos across emotional categories. Since there was limitation of controlling the possible confounding effects due to different number of stimuli according the emotional category, it was only explored whether there were differential deficits according to the emotional category in UHR individuals. Meanwhile, in the case of negative bias, since we analyzed only the response to neutral stimuli, the effect of the difference in stimuli numbers would have been minimal. Thirdly, there may be at least partial relations of inaccuracy rates and negative bias of facial emotion recognition. In the presence of negative bias, the accuracy for positive or neutral stimuli may decrease, but the accuracy for negative stimuli may increase. Also, although the overall accuracy is not compromised, it may only show negative bias for stimuli that are generally difficult to match. In the opposite case, even if there is no bias, the ability to recognize facial emotions itself may be impaired. In this regard, possible relations of overall inaccuracy rate across emotional faces and negative bias to neutral ones may be small enough to be ignored in the present study. The difference in correlation with schizotypy and paranoid level, which shown in this study, also suggests that inaccuracy and negative bias are of different natures. Last potential limitation is that we used neutral face photographs as facial stimuli but excluded "neutral" as an emotion response option. We did this because we anticipated difficulties with measuring misattribution cases because of the very high accuracy for neutral faces observed in previous studies. However, this decision contributed to methodological differences between our current study and previous reports.

## CONCLUSIONS

In summary, UHR individuals exhibited impaired facial emotion recognition, including inaccuracy and negative bias. Schizotypy was associated with inaccuracy but not with negative bias of facial emotion recognition, whereas paranoia level was correlated with "disgust" response bias for neutral faces but not with inaccuracy. These findings suggest that there is a difference in the processes underlying the two types of facial emotion recognition impairments. Inaccuracy of facial emotion recognition may be a vulnerability marker for schizophrenia. To clarify the exact nature of negative bias of facial emotion recognition with respect to paranoia level, further investigations involving UHR individuals, as well as patients with schizophrenia, may be helpful.

## DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review boards at Severance Hospital. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

## AUTHOR CONTRIBUTIONS

SA designed the study. SA and EL recruited subjects. ES undertook the statistical analysis and wrote the first draft of the manuscript. ES, HP, KP, SK, SL, and JM interviewed patients and collected data. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.00577/full#supplementary-material

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# Thinking Preferences and Conspiracy Belief: Intuitive Thinking and the Jumping to Conclusions-Bias as a Basis for the Belief in Conspiracy Theories

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**Background:** The belief in conspiracy theories and paranoid ideation are often treated as almost synonymous. However, there is to date no research concerning shared underlying cognitive underpinnings of belief in conspiracy theories and paranoid ideation. One potential underlying factor could be the well-known jumping to conclusion (JTC) bias, the tendency of persons with delusions to perform hasty decisions that are sometimes based on little evidence. Furthermore, a preference for a more intuitive general thinking style, as opposed to an analytical thinking style, could be an additional underlying cognitive factor of both conspiracy theories and paranoia. Thus, the aim of the present study is to investigate in a large sample of non-clinical individuals whether the JTC-bias is more pronounced in individuals who display a stronger belief in conspiracy theories and whether both are related to a more intuitive thinking preference.

**Methods:** We assessed the data of 519 non-clinical individuals regarding their respective approval of 20 specific conspiracy theories in an online study. Further, we assessed the JTC-bias by using a computerized variant of the beads task (fish task). Thinking preferences were measured with the Rational-Experiential Interview.

**Results:** Subjects who displayed the JTC-bias presented a more pronounced belief in conspiracy theories. In addition, gathering little information in the fish task before performing a decision (less draws to decision) was related to a stronger endorsement of conspiracy theories and a more intuitive thinking style (and a less analytic thinking style). Finally, a preference for intuitive thinking predicted a stronger belief in conspiracy theories in a multiple regression analysis.

**Conclusions:** Our results demonstrate the implication of a preference for an intuitive thinking style accompanied by a propensity to faster decision-making (JTC-bias) as possible cognitive underpinnings of beliefs in conspiracy theories. Furthermore, our study is the first to confirm the notion of the JTC-bias as a reflection of the use of an intuitive thinking style.

**Keywords: conspiracy theories, paranoia, jumping to conclusions, delusions, intuitive thinking, analytical thinking**

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## INTRODUCTION

Conspiracy theories are typically unverified and sensationalistic interpretations of events that are "self-insulating against disconfirmation" and are "based on weak kinds of evidence" (1). Beliefs in conspiracy theories are associated with the rejection of generally accepted norms, assumptions, and behaviors, e.g., regarding vaccination (2), combating climate change (3) or political participation (4). However, many of these theories are widely disseminated and accepted (5). Despite growing research in this area, little is still known about the cognitive underpinnings of the belief in conspiracy theories.

A plethora of studies indicates that the individual agreement with various specific conspiracy theories is highly intercorrelated (6, 7), even if the specific conspiracy theories contradict each other. For example, people who believed that Princess Diana had been murdered were also more likely to agree that she had also faked her own death (8). This tendency to presume conspiracies as the primary cause of important societal events (8, 9) is defined as *conspiracy belief* (CB).

Numerous polls over the last decades found that conspiracy theories are a common phenomenon, with recent studies suggesting that 63% of the American public believed at least one political conspiracy theory and half of Americans believed at least one medical conspiracy theory (5, 6, 10). The wide prevalence and acceptance of conspiracy theories in the general population suggests that CB does not necessarily indicate a mental disorder (11, 12). Nevertheless, parallels to paranoia, defined as "a tendency on the part of an individual or group toward excessive or irrational suspiciousness and distrustfulness of others" (13) are evident. As Jovan Byford (14) puts it: "The link between conspiracy theories and paranoia has become so strong that the two terms are now treated as almost synonymous."

However, paranoia or persecutory ideation, as it is found in psychotic disorders, usually involves some form of personal and immediate threat, typically targeted on individual or closely related parties (15). In contrast, CB is less self-referential than paranoia, with broader groups of people or in many cases the whole world being the target of the assumed conspiracy (5). Aside from these important differences, both phenomena imply a deep mistrust in external factors and agents (14, 16). In line with this contention, two studies have demonstrated an association of CB and paranoia in non-clinical samples (17, 18).

Paranoia is a common symptom especially of psychotic disorders and a significant feature of persecutory delusions (19). However, it is notable that persecutory ideation is not solely a clinical phenomenon. As psychotic symptoms also commonly occur in the general population, many researchers argued that there is a continuum between everyday suspicions and clinically relevant delusions (20–23). In line with this contention, it is estimated that up to 15% of the general population regularly experience paranoid thoughts (19). Considering the wide prevalence of conspiracy theories and paranoid thoughts as well as the obvious parallels between both phenomena, it also seems plausible that "deficits and stressors that predispose an individual to conspiracy thinking are similar to, if less intense than, those involved in the etiology of paranoid psychosis" (24). However, despite of the two promising studies mentioned above that found preliminary evidence of an association between paranoia and CB (17, 18), to our knowledge there is no research concerning possible shared underlying cognitive mechanisms of both paranoia and CB.

With respect to said "deficits [ … ] involved in the etiology of paranoid psychosis" (24), important factors in the formation and maintenance of delusions are various cognitive biases or thinking errors (25, 26). Possibly the most commonly studied cognitive bias is the *jumping to conclusions* (JTC) bias (27), defined as the tendency of individuals to make quick decisions sometimes based on little evidence (28). There is converging meta-analytical evidence that people with psychosis tend to display a more extreme reasoning style with generally hastier decision making behavior in comparison to non-clinical controls (29–31). Typically, the JTC-bias is measured with the *beads task* (27). This task involves two jars containing two types of differently colored beads in an opposite ratio (e.g., 85% orange; 15% blue and vice versa). After the jars are presented to the subjects, they are hidden from view and subjects are consecutively presented beads from only one jar. After each round, the subjects are asked if they are able to decide from which jar the beads are drawn. A decision after one or two beads is considered as JTC-bias, while the total number of beads subjects require before deciding is called *draws to decision* (DTD). Given the considerable parallels between CB and paranoia mentioned above, it thus would be interesting to further assess a possible implication of the JTC-bias in CB.

In general, the JTC-bias seems to reflect a broader tendency of individuals to rely on a faster, heuristic thinking style in contrast to a slower, more analytical thinking style (32). These two thinking styles are postulated in several so-called dual process models of human reasoning and typically differ in several key characteristics (33–35). The faster and relatively effortless route of reasoning is typically regarded as independent of cognitive abilities, as well as working memory and relies on heuristics and intuition. The slower and effortful, analytical route relies heavily on the cognitive ability and is dependent on the working memory of the individual. However, although the claim that the JTC-bias might reflect the use of the intuitive thinking style has an intuitive appeal, to our knowledge an association of both constructs has yet to be empirically established.

Regarding the belief in conspiracy theories, as mentioned before, there is a broader tendency to presume conspiracies as the primary cause of important societal events (8, 9). This broader tendency (defined as CB), could in turn reflect a preference for one or the other thinking style described above. As "widespread irrational beliefs often have strong intuitive appeal" (36) and conspiracy theories tend to trigger a strong affective response (37), CB could reflect an individual's preference for the use of the intuitive thinking style. On the other hand, "[conspiracy] theorists do not see themselves as raconteurs of alluring stories, but as investigators and researchers," (14) which would consequently imply a preference for a more analytical thinking style. These contradicting considerations echo in current research regarding this topic, as preliminary findings suggest that CB seems to be associated with an increased use of an intuitive thinking style, while the evidence for the relationship with the use of the analytic thinking style remains equivocal (37, 38).

Taken together these findings provide preliminary evidence indicating that the preference for an intuitive, heuristic style of thinking is related to CB. However, in order to derive clear-cut evidence about the role of thinking styles in the formation and maintenance of CB, it is important to further scrutinize this association.

Overall, we consider it most relevant to further investigate the topic of CB regarding possible cognitive underpinnings. While preliminary evidence points at a preference for an intuitive thinking style as the foundation of CB, the role of specific mechanisms of the experiential system (e.g., the JTC-bias) has not been examined before. Consequently, as the JTC-bias is commonly found in subjects suffering from delusions and even in delusion-prone individuals (29–31), we predict first, in line with the notion of shared underlying cognitive mechanisms between paranoia and CB, that persons who display a more pronounced JTC-bias hold a stronger CB (hypothesis 1a) and that less *draws to decision* in a computerized variant of the beads task (fish-task) are negatively correlated with CB (hypothesis 1b).

Regarding the role of the two thinking styles, we first consider it important to validate the – intuitively appealing – idea, that the JTC-bias is a reflection of the use of the experiential system (32). Thus, we hypothesized that subjects who display the JTC-bias show a stronger preference for intuitive thinking as well as an aversion to analytic thinking in comparison to subjects who show a more cautious information gathering style (hypothesis 2a) and that a preference for intuitive thinking (in contrast to analytic thinking) is associated with less *draws to decision* in a computerized variant of the beads task (hypothesis 2b).

Third, our aim was to further elucidate the interplay of the different thinking styles and CB. Most conspiracy theories are intuitively appealing and therefore individuals who exhibit a stronger preference for an intuitive thinking style could, consequently, be more inclined to belief in said theories. As mentioned before, evidence regarding an association of analytical thinking and CB is equivocal, probably because conspiracy theorists see themselves "as investigators and researchers." (14). However, considering the promising results regarding the role of the use of intuitive thinking, we hypothesized that only the preference for intuitive thinking predicts a stronger CB (hypothesis 3).

# MATERIALS AND METHODS

## Recruitment and Procedure

Recruitment was accomplished via social media and a survey-sharing platform (surveycircle.com), which allows to disseminate one`s own study in return for participation in other online-studies. An additional incentive was a voluntary lottery with 15 Amazon-vouchers (20 € each). The study was described to potential participants as an investigation of the association between political attitudes and decision behavior (associations between political attitudes and CB will be reported elsewhere).

All participants were first informed about the assessment and gave informed consent, then they saw a 4-min video[1] explaining the *fish task* described below, as misunderstanding is a common phenomenon regarding the measurement of the JTC-bias (39). Subsequently, participants were directed to the measures described below. Finally, participants answered questions on sociodemographic data. They were then asked whether they had answered all questions conscientiously and truthfully and whether they considered their data as valid. Finally, participants received a summary of their results after the study was completed. More specifically, they received a short overview about the scientific background of the study. Applicable ethical standards of the German Psychological Society (DGPs) were followed, no experimental manipulation took place and anonymity was assured. The local ethics committee approved of the study. Participants provided informed consent and were debriefed after the completion of the study.

## Subjects

Subjects were included if they had access to social media and their age was above 16. From the originally 519 participants, 30 were excluded either because they declared their data to be invalid ($n$ = 7) or because they were considerably faster than the other participants ($z < -1.96$; n = 23). We also excluded one participant who declared to suffer from schizophrenia, as the tendency to jump to conclusions is influenced by the state of remission of the disorder (28, 40, 41).

## Measures

### Conspiracy Belief

The tendency to endorse conspiracy theories, defined as conspiracy belief (CB), was measured using the classical approach of asking participants to rate several specific conspiracy theories regarding their respective approval (42). The mean approval rate of said theories is then interpreted as a measure for the superordinate general CB. The different conspiracy theories derive from a previous study that examined the popularity and approval of several conspiracy theories in German-speaking countries (43). Thirty conspiracy theories with the most pronounced approval rating were used in a pilot study (44) and from these 30 conspiracy theories, 20 theories with the highest discriminability were selected for the updated assessment of CB The 20 different conspiracy theories are depicted in **Appendix A**. Participants had to read verbal descriptions of the 20 conspiracy theories and were then asked to rate their respective approval of said theories on a five-point Likert scale ranging from 1 (I do not agree at all) to 5 (I fully agree) or to choose "Not able to judge/theory not known" as an answer if they did not want or were able to decide about a specific conspiracy theory. The mean approval rate of all conspiracy theories was used as measure of CB (range, 1–5). The mean approval rate of the total sample was 2.63 ($SD$ = .76) and the final questionnaire had an excellent reliability with Cronbach's $\alpha$ = .94. An overview of all the theories used in the present study and their intercorrelations can be found in **Appendixes A1**, **B1**.

[1] https://youtu.be/YuJuCqdTBgs

### Analytic and Intuitive Reasoning

Analytic and intuitive reasoning was measured with the German version of the *Rational-Experimental Inventory* (45). The original version of Epstein, Pacini, Denes-Raj, and Heier (46) is theoretically based on the *Cognitive-Experiential Self-Theory of Personality* (33). The German version of the Rational-Experiential Inventory consists of 29 items measuring the individual's preferences regarding different types of information processing, subsumed to two subscales (the *Need for Cognition* scale and the *Faith in Intuition* scale). The *Need for Cognition* scale consists of 14 items measuring the preference for an analytical thinking style (derived from the 45-item *Need for Cognition* scale, originally developed by Cacioppo & Petty (47). The *Faith in Intuition* scale consists of 15 items measuring the preference for an intuitive thinking style (range, 15–105). The questions are answered on a seven-point Likert scale ranging from 1 (completely wrong) to 7 (completely true). The two subscales were confirmed factor-analytically, both in the original as well as the German version of the questionnaire (45, 46) The subscales of the German version feature a good reliability with Cronbach's $\alpha$ = .82 (*Need for Cognition* scale) and $\alpha$ = .86 (*Faith in Intuition* scale).

### Jumping to Conclusions (JTC)

The JTC-bias was measured with a modified version of the traditional *beads task* (27). The *fish task* uses a more easily understandable scenario of a fisherman who fishes differently colored fish from one of two ponds (48). Participants are first informed that two fish species (orange and blue fish) are located in two ponds (A and B) in reversed ratio, 60 orange and 40 blue fish in pond A and 40 orange and 60 blue fish in pond B. The subjects are furthermore made aware of being presented with fish from only one pond without knowing which pond the fish come from (prior probability of 50 percent). After each fish that is presented, the subjects are asked if they are ready to decide from which pond the fish is drawn. A decision after one or two fish is considered as a JTC-bias. The sequence of fish presented is orange-orange-orange-blue-orange-orange-orange-orange-blue-orange. In the present paradigm, the posterior probability for choosing pond A after the presentation of one orange fish is 60% and for choosing pond A after the presentation of two orange fish is 69%. As an additional JTC-measure, the number of *draws to decision* (DTD) (range, 1–10) is recorded: the number of fishes the subjects views until they decide that the fish stem from one pond.

### Demographic Form

Participants provided their demographic details, consisting of gender (*man, woman*, and *diverse*), age, mental disorders in the past/present, highest educational qualification, and political affiliation.

## Statistical Analyses

Following the *central limit theorem* (49), independent variables in samples of $n > 30$ can be viewed as sufficiently normally distributed. Thus, as all groups consisted of more than 30 participants, we assumed normal distribution of the variables.

The assumed group difference regarding CB between participants who showed the JTC-bias (indicated by a decision after one or two fishes fished in the fish task) and those who did not (hypothesis 1a) was analyzed by performing an independent-sample *t*-test, if the assumption of homoscedasticity was met, verified by the Levene's test. In case of heteroscedasticity, degrees of freedom were adjusted accordingly. Possible group differences regarding the two thinking styles (indicated by the *Faith in Intuition* score and the *Need for Cognition* score) between participants who showed the JTC-bias (indicated by a decision after one or two fishes fished in the fish task) and those who did not (hypothesis 2a) were also analyzed by performing two independent-sample *t*-tests, as both thinking styles are theoretically independent. Furthermore, we examined the association between *draws to decision* in the fish task and CB (hypothesis 1b) as well as both thinking styles (indicated by the *Faith in Intuition* score and the *Need for Cognition* score, hypothesis 2b) by using Pearson's two-tailed correlations.

Finally, a multiple regression analysis was performed using the SPSS-Enter method in order to test if a preference for intuitive thinking predicts CB (hypothesis 3). We included the preference of both an intuitive and an analytical thinking style (indicated by the *Faith in Intuition* score and *Need for Cognition* score respectively) as predictors and CB (mean score) as criterion. The required assumptions (independence of errors and absence of multicollinearity) were tested by calculating the *Durbin-Watson statistic* as well as the *variance inflation factor*.

We repeated all analyses controlling for age and gender by performing an ANCOVA for hypotheses 1a and 2a and a partial correlation analysis for hypotheses 1b and 2b. The multiple regression (hypothesis 3) was conducted by first calculating a regression model only with age and gender as predictor variables and CB (mean score) as criterion, we then included both thinking styles as predictors. Since the inclusion of the relatively small group of 5 "diverse" individuals led to a violation of some statistical assumptions, we performed the additional analyses for age and sex twice, once with and once without the five "diverse" individuals. Gender was dummy-coded in the analysis that included the five individuals. The results of the analyses can be taken from the **Supplement S1**.

# RESULTS

## Sample Characteristics

The final sample consisted of 488 non-clinical individuals of whom 295 identified as women and 198 identified as men and 5 identified as "diverse". An analysis of variance (ANOVA) yielded significant differences in both analytic thinking ($F(2,485) = 8.44$, $p < .001$) and intuitive thinking ($F(2,485) = 5.28$, $p = .005$) between genders. Post hoc Tukey tests showed men and women differed significantly regarding their thinking preferences, with men ($M = 73.52$, $SD = 14.15$) showing a stronger preference for analytic thinking than women ($M = 68.73$, $SD = 12.19$), $p < .001$. On the other hand, women ($M = 62.92$, $SD = 11.33$) showed a stronger preference for intuitive thinking than men ($M = 59.33$, $SD = 13.12$), $p = .004$. Age ranged between 17 and 70 ($M = 28.11$; $SD = 7.79$) and was significantly correlated (all $p < .05$) with CB

($r$ = .11), intuitive thinking ($r$ = −.10) and analytic thinking ($r$ = .12).

## JTC-Bias and Conspiracy Belief

### Differences in CB Between Participants With and Without a JTC-Bias (Hypothesis 1a)

Mean scores of agreements with the 20 specific conspiracy theories and their respective intercorrelations are depicted in **Appendix B1**. The level of agreement with the 20 specific conspiracy theories was quite large and intercorrelations between CB were mostly of medium effect size. Ranges of agreement to the individual theories varied considerably, range of the mean score lay between 1 and 5.

As depicted in **Table 1**, we found statistically significant differences between participants who did and did not display the JTC-bias with regard to CB. As *Levene's Test* indicated homogenous variances ($p$ = .39), the group comparison was performed as a $t$-test. In comparison to persons who did not jump to conclusions ($M$ = 2.58, $SD$ = .74), participants who jumped to conclusions ($M$ = 2.99, $SD$ = .81) showed a significantly higher CB score ($t(482)$ = 4.20, $p$ <.001, Cohen's $d$ = .53). Controlling for age and gender did not affect the significance of the results (see **S2** and **S8**).

### Analysis of the Association Between DTD and CB (Hypothesis 1b)

Results of Pearson's correlation coefficients suggested a significant correlation between less draws to decision in the fish task and a more pronounced CB, $r(384)$ = −.16, $p$ = .002, 95% CI [−.26 to −.05]. **Table 2** depicts intercorrelations between all other variables. Controlling for age and gender did not affect the significance of the results (see **S5** and **S11**).

## JTC-Bias and the Information Processing Systems

### Differences in the Use of Intuitive and Analytical Thinking Between Participants With and Without a JTC-Bias (Hypothesis 2a)

As Levene's tests indicated homogenous variances for the *Faith in Intuition* score ($p$ = .72), the group comparison was performed as a $t$-test for independent groups. Participants who presented a JTC-bias (defined as a decision after one or two fishes in the fish task, $n$ = 69) showed a significantly higher *Faith in Intuition* score ($M$ = 66.41, $SD$ = 12.48) than those who did not jump to conclusions ($n$ = 419, $M$ = 60.67, $SD$ = 11.97), with $t$ (486) = 3.67, $p$ <.001, Cohen's $d$ = .47). In case of the *Need for Cognition* score, Levene's test indicated heterogenous variances ($p$ <.001). Consequently, the degrees of freedom were adjusted accordingly. Participants who showed a more pronounced tendency to jump to conclusions showed a significantly lower *Need for Cognition* score ($M$ = 64.78, $SD$ = 16.27) than those who did not jump to conclusions ($M$ = 71.59, $SD$ = 12.43), $t(81.58)$ = 3.32, $p$ = .001, Cohen's $d$ = .47). Controlling for age and gender did not affect the significance of the results (see **S3**, **S4**, **S9** and **S10**).

### Analysis of the Association Between DTD and Intuitive and Analytical Thinking (Hypothesis 2b)

Results of the correlation analysis revealed a statistically significant correlation between a lower number of *draws to decision* (DTD) in the fish task and a more pronounced *Faith*

**TABLE 1** | Comparison of Participants Regarding Cognitive Measures (CB, Thinking Styles) and JTC Measures.

| | Total sample ($N$ = 488) | JTC yes ($n$ = 69) | JTC no ($n$ = 419) | Statistics |
|---|---|---|---|---|
| | *M (SD)* | *M (SD)* | *M (SD)* | |
| Conspiracy belief | 2.66 (*.73*) | 2.99 (*.81*) | 2.58 (*.74*) | $t(482)$ = 4.20, $p$ <.001 |
| *Cognitive measures* | | | | |
| Faith in Intuition Scale | 62.00 (*11.75*) | 66.41 (*12.48*) | 60.67 (*11.97*) | $t(486)$ = 3.67, $p$ <.001 |
| Need for Cognition Scale | 69.83 (*12.70*) | 64.78 (*16.27*) | 71.59 (*12.43*) | $t(81.58)$* = 3.32, $p$ <.001 |
| *JTC measures* | | | | |
| Draws to decision | 4.65 (*2.32*) | 1.45 (*.50*) | 5.24 (*2.03*) | $t(379.63)$* = 29.32, $p$ <.001 |

*JTC, jumping to conclusions.*
**as Levene's Test indicated inequal variances, degrees of freedom were adjusted accordingly.*

**TABLE 2** | Associations between Conspiracy Beliefs, Thinking Styles, and the JTC-bias.

| | | M | SD | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1 | Conspiracy belief | 2.64 | 0.77 | **0.363***** | **–0.190***** | **–0.160**** |
| 2 | Faith in Intuition Score | 61.44 | 12.17 | | **–0.359***** | **–0.200***** |
| 3 | Need for Cognition Score | 70.70 | 13.13 | | | **0.146*** |
| 4 | JTC draws to decision | 4.56 | 2.35 | | | |

*JTC, jumping to conclusions.*
*Significant correlations are written in bold.*
** p = 0.004.*
*** p = 0.002.*
**** p < 0.001.*

*in Intuition* score, ($r(384) = -.20$, $p < .001$, 95% CI [−.30, −.10]). In addition, results revealed a significant association between DTD and a more pronounced *Need for Cognition* score ($r(384) = .15$, $p = .004$, 95% CI [.05,.24]). Controlling for age and gender did not affect the significance of the results (see **S5** and **S11**).

### Intuitive Thinking as a Predictor of Conspiracy Belief (Hypothesis 3)

A standard multiple linear regression analysis using the enter method indicated that CB (criterion variable) was significantly predicted by the *Faith in Intuition* score ($\beta = 0.34$, $t(483) = 7.45$, $p < .001$), whereas the *Need for Cognition* score was not a statistically significant predictor of CB. ($\beta = -.07$, $t(483) = -1.51$, $p = .13$). The model explained 14% of the variance of the CB-variable, with $F(2, 481) = 37.79$; $p < .001$; $R^2 = .14$. When controlling for age and gender, we found that age was also a significant predictor of CB ($\beta = 0.16$, $t(478) = 3.71$, $p < .001$) (see S6 and S12).

## DISCUSSION

The present study yielded some interesting results. Participants who displayed the *jumping to conclusions* (JTC) bias were more likely to endorse conspiracy theories than subjects who did not jump to conclusions, thus presented a stronger generalized *conspiracy belief* (CB). In addition, subjects who required more *draws to decision* (DTD) in the fish-task presented a less pronounced CB. Moreover, less DTD correlated significantly with a preference for a more intuitive thinking style (indicated by the *Faith in Intuition* score) and, in line with this, subjects who displayed the JTC-bias showed a significantly stronger preference for an intuitive thinking style than subjects who did not jump to conclusions. The opposite pattern of results was found in case of the preference for an analytical thinking style (indicated by the *Need for Cognition* score). Finally, the preference for intuitive thinking (in contrast to a preference for analytical thinking) predicted CB. Moreover, age was also a significant predictor of CB.

First and foremost, we were especially interested in the question of whether the conceptual similarities between CB and paranoia (16) are predicated on the same psychological mechanisms. While the correlation between DTD in the fish task and CB was of small effect size ($r = -.16$), we found a medium effect size (Cohen's $d = .53$) regarding the group differences between subjects who jumped to conclusions and those who did not. This implies that, while there is a rather small general association between decision-making behavior and CB, especially those subjects with an extreme reasoning style (a decision after two or less fish in the fish task) differ considerably from the rest of the sample regarding their overall CB. Consequently, our findings provide preliminary evidence for an implication of cognitive mechanisms (in this case, the JTC-bias) in CB that are typically linked to paranoia or delusional ideation (19).

Moreover, to our knowledge, our study is the first to present empirical evidence for an association of the JTC-bias and a preference for the use of a more intuitive thinking, as indicated by the correlation of DTD and the *Faith in Intuition* score as well as the significantly higher *Faith in Intuition* score in subjects who displayed the JTC-bias in the fish task. This is in line with the theoretical integration of Ward and Garety (32) who proposed that the JTC-bias might be an aspect of a broader tendency of an over-reliance on faster, heuristic reasoning processes. Consequently, the opposite pattern of results was found in case of a preference for analytical thinking. However, as our study is to our knowledge the first to show an association between the preference for an intuitive thinking style and the JTC-bias, our findings should be regarded as preliminary and require careful pre-registered replication in different samples and with different measures of JTC.

Furthermore, we set out to provide further evidence for the relevance and importance of a preference for a more intuitive thinking style regarding the formation of CB. In fact, results of the regression analysis indicate that a preference for intuitive thinking predicts the degree of CB, with a moderate effect size of $R^2 = .14$ (50). Simply said, a greater trust in one's own intuition (in conjunction with a propensity to jump to conclusions) leads to a faster acceptance of the "simple yet satisfying narratives" (51) which are found in many conspiracy theories. In contrast, it may require considerably more cognitive effort (which would, on the other hand, require a preference for analytic thinking) or it might be virtually impossible to retrace the impact of a complex network of individual agents, each pursuing their own agenda (52). As a consequence, people with a preference for intuitive thinking might tend to heuristically conflate these agents and thus assume that only a small group of individuals "is pulling the strings" (53) behind actions that could be perceived as coordinated. Additionally, conspiracy theories tend to trigger a stronger affective response, which in turn makes them more likely to appeal to persons who prefer an intuitive thinking style (37). This finding is in line with prior results indicating a close association of both constructs (37, 38).

Regarding the association of CB and analytic thinking, our results are in line with another study that did not find a significant association of both constructs (38). Since many authors count CB to other "stigmatized knowledge" (54) like esoteric or superstitious ideas, it may seem counter-intuitive that, on the other side, a preference for analytical thinking does not predict a less pronounced CB (as analytical thinking correlates negatively for example with religious or paranormal beliefs (55)). Surprisingly, interventions aiming at promoting analytic thinking were successful in reducing CB (37). Consequently, these contrasting findings warrant an explanation. As Jovan Byford puts it: "Conspiracy theorists do not see themselves as raconteurs of alluring stories, but as investigators and researchers." (14). As mentioned above, conspiracy theories are per definition "epistemically self-insulating against disconfirmation" (1) and strong analytic reasoning skills might even be used to generate ideology-consistent interpretations of evidence that are inconsistent with personal beliefs (36). Consequently, a preference for analytic thinking may not detract from or, in some cases, could actually benefit the maintenance of CB (38). Future studies could therefore scrutinize the role of possible moderators (e.g., ideology or political beliefs) of the association of analytic thinking and CB.

Another possible explanation concerns the measurement of both thinking styles: As the *Rational Experiential Inventory* (46) and its German version (45) used in the present study are both self-assessments, they could measure rather the self-perception of the participants than the actual thinking preferences the participants use more often in their daily life. In this regard, subjects that present a pronounced CB might see themselves "as investigators and researchers." (14) and therefore report a stronger preference for analytical thinking, while actually thinking rather intuitively. Consequently, future research could be improved by incorporating other, more objective measures of intuitive and analytic thinking, such as the *Cognitive Reflection Test* (56) or experimental paradigms that require participants to use either a more intuitive or analytical thinking style. However, despite the lack of clarity regarding the individual's actual use of the two styles of thinking, there is now in either case growing evidence that a greater faith in one's own intuition goes hand in hand with a stronger belief in conspiracy theories.

Interestingly, the age of the participants was also a significant predictor of CB. It may be that as people grow older, they may experience more political scandals, which in turn undermines their general trust in established institutions such as politics and the media and thus fuels CB (54). This finding could also indicate that other socio-demographic and socio-economic factors (e.g., formal education or income) could also contribute to the formation of CB, as "such beliefs confirm the person's sense that the world is beyond their control, while also protecting self-esteem by offering a simple explanation for existential and status-related problems" (14). This question should be examined more closely in future studies.

As to possible clinical implications of our findings, we would like to point out again that believing in conspiracy theories per se is not a mental disorder (11, 12). Real political conspiracies, such as the Iran Contra Affair or the Watergate Scandal (14) recurred throughout history and it would not have been possible to uncover them without a certain degree of mistrust of official institutions and narratives. On the other hand, CB is accompanied by a wide range of negative medical or societal effects such as a reduced willingness to vaccinate (2) or to combat climate change (3) and decreased political participation (4). Consequently, interventions aimed at reducing CB have increasingly come into the focus of conspiracy theory research. Psychological interventions like priming (37) or inoculation (57) showed preliminary, but promising results in reducing CB. If replicated, especially the high propensity to display the JTC-bias in individuals who present a pronounced CB could be the basis for new interventions aiming at reducing CB, as there are already well-established approaches that proved successful in reducing the tendency to jump to conclusions, like the *Metacognitive Training* (58) or *Cognitive Behavior therapy for psychosis* (59).

The present study has some notable features. First, based on a large sample of non-clinical individuals, our study is the first to provide empirical evidence for the notion that the JTC-bias might reflect a preference for intuitive thinking. Second, we were able to shed some light on the possible underpinnings of CB by highlighting that CB is most likely based upon similar cognitive mechanisms as paranoid ideation or delusions, in this case the JTC-bias. Accordingly, CB is predicted by a preference for intuitive thinking.

In interpreting the findings of our study, some limitations should be considered. First, our study was conducted as an online study. As none of assessments was performed face-to-face, subjects were not able to ask for additional information in case of difficulties of understanding. As miscomprehension is a common problem regarding JTC- tasks such as the beads task or the fish task (39), we tried to address this problem by creating a 4-min-long video with the purpose of explaining the fish task in an easily understandable manner. However, watching the video was not obligatory and we did not check for possible misunderstandings of the task. Additionally, the online survey included a lottery. We cannot rule out the possibility that some subjects only took part for the purpose of participation in the lottery and did not answer carefully. We tried to minimize this risk by asking the subjects after the experimental procedure if they considered their data to be valid and whether we could use their data. Referring to this, we emphasized that the answer would not affect the participation in the lottery. While only seven participants advised us against using their data, possibly some subjects may not have answered this question truthfully. Finally, another limitation concerns the exclusion of certain individuals. One participant was excluded because he declared to suffer from schizophrenia. Although it would certainly be exciting to investigate the extent to which schizophrenia, especially persecutory delusions, and CB are related, the focus of this study was supposed to be particularly on CB in non-delusional individuals.

Another limitation of our study should be addressed by future research: although experimental manipulation is not imperative to claim causality (in this case, assuming that a preference for intuitive thinking predicts CB (60)), future research could involve experimental paradigms in order to gain stronger evidence of the assumed causality of the constructs. Additionally, despite the advantages of online research (e.g., economy and a stronger feeling of anonymity (61)), our results should be verified in a traditional face-to-face setting. Furthermore, future studies are well-advised to pre-register their hypotheses and analyses, as studies that are not preregistered tend to overestimate effects (62). Finally, building on our promising results, future studies concerned with CB could scrutinize the role of other parameters involved in the formation and maintenance of paranoid ideation (e.g., belief flexibility or affective states, e.g., loneliness (26)).

In conclusion, we were able to shed some light on the cognitive underpinnings of conspiracy beliefs. More specifically, the results of the present study indicate that a preference for an intuitive thinking style, accompanied by a propensity to jump to conclusions, might be an important factor in the formation of conspiracy beliefs. In a nutshell, although the belief in conspiracy theories reflects by no means a mental disorder, it is possibly associated with the same cognitive processes as paranoid ideation or delusions.

## DATA AVAILABILITY STATEMENT

The dataset is available on this paper's project page on the OSF: https://osf.io/er374/.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Marburg, Ethics Committee of the faculty of Psychology. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

NP and SM contributed to conception and design of the study. NP organized the data analysis and performed the statistical analysis. NP wrote the first draft of the manuscript. DS and SM wrote sections of the manuscript. All authors contributed to the article and approved the submitted version.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.568942/full#supplementary-material

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## APPENDIX A

## OVERVIEW ABOUT THE SPECIFIC CONSPIRACY THEORIES USED IN THE PRESENT STUDY

English translation of the conspiracy theories used in the present study

I think…

1. J. F. Kennedy was not shot by Lee Harvey Oswald (alone).
2. Scientology has great influence in the federal republic of Germany; various large companies belong to Scientology.
3. in the former Union of Soviet Socialists Republic (USSR) there were several serious covered-up nuclear power accidents.
4. the true story behind the attacks of 11 September 2001 does not correspond to the version disseminated by the Bush government.
5. influential Jewish families control large parts of world affairs.
6. Lady Di (Diana of Wales) was murdered.
7. the USA invaded Iraq in 2003 in order to gain access to oil.
8. for some time now, various governments have had contact with aliens.
9. there is a secret society of "Illuminati" whose symbols are the All Seeing Eye, the pyramid and the number "23".
10. airplane condensation trails are in reality secret experiments, so-called "chemtrails", which damage the environment.
11. Jesus and Mary Magdalene fathered children, which is being covered up by the Church.
12. the World Trade Center collapsed mainly because it was blown up from inside.
13. there are various religious groups that perform human sacrifices.
14. the automotive industry is only abandoning the use of stainless steel in exhaust systems because their regular replacement would jeopardize sales.
15. there are religious sects that have complete control over the psyche of their members.
16. behind various events in world history are actually the Freemasons.
17. the pharmaceutical industry blocks the distribution of certain useful drugs.
18. the Nazis developed functioning flying discs in UFO-optic during World War II.
19. in the US there were several serious nuclear accidents that have been covered-up.
20. a small group of people directs the fate of the Earth.

*Original German Items*

Ich denke, …

1. J. F. Kennedy wurde nicht von Lee Harvey Oswald (allein) erschossen.
2. Scientology besitzt großen Einfluss in der BRD; verschiedene Großunternehmen gehören zu Scientology.
3. in der ehemaligen UDSSR gab es mehrere schwere vertuschte Atomkraftunfälle.
4. die wahre Geschichte hinter den Anschlägen vom 11. September 2001 entspricht nicht der von der Bush - Regierung verbreiteten Version.
5. einflussreiche jüdische Familien kontrollieren große Bereiche des Weltgeschehens.
6. Lady Di (Diana von Wales) wurde ermordet.
7. die USA sind wegen des Öls im Jahr 2003 in den Irak einmarschiert.
8. seit längerer Zeit haben verschiedene Regierungen Kontakt zu Außerirdischen.
9. es gibt einen Geheimbund der "Illuminaten", deren Symbole das Allsehende Auge, die Pyramide und die Zahl "23" sind.
10. Flugzeug-Kondensstreifen sind ab und an in Wirklichkeit Geheimversuche, sogenannte "Chemtrails", die die Umwelt schädigen.
11. Jesus hat mit Maria Magdalena Kinder gezeugt, was von der Kirche vertuscht wird.
12. das World Trade Center stürzte vor allem ein, weil es von innen gesprengt wurde.
13. es gibt verschiedene religiöse Gruppen, die Menschenopfer durchführen.
14. die Automobilindustrie verzichtet auf den Einsatz von rostfreiem Stahl bei Auspuffanlagen nur deshalb, weil das die Umsätze mit deren regelmäßigem Austausch gefährden würde.
15. es gibt religiöse Sekten, die die vollständige Kontrolle über die Psyche ihrer Mitglieder haben.
16. hinter verschiedenen Geschehnissen der Weltgeschichte stehen in Wirklichkeit die Freimaurer.
17. die Pharmaindustrie blockiert die Verbreitung gewisser sinnvoller Medikamente.
18. die Nazis haben im Zweiten Weltkrieg funktionierende Flugscheiben in UFO-Optik entwickelt.
19. In der USA gab es mehrere schwere vertuschte Atomkraftunfälle.
20. eine kleine Gruppe von Personen lenkt die Geschicke der Erde.

# APPENDIX B

**TABLE B1** | Intercorrelations between the specific conspiracy theories.

| | Theory | M | SD | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | JFK | 2.95 | 1.22 | **.224** | **.190** | **.444** | **.372** | **.328** | **.240** | **.266** | **.293** | **.299** | **.250** | **.396** | **.129** | **.205** | .066 | **.265** | **.229** | **.343** | **.204** | **.234** |
| 2 | Scientology | 2.25 | 1.18 | | **.438** | **.304** | **.403** | **.366** | **.167** | **.308** | **.325** | **.365** | **.138** | **.330** | **.234** | **.252** | **.291** | **.430** | **.306** | **.440** | **.472** | **.286** |
| 3 | Nuclear Accidents UDSSR | 2.89 | 1.19 | | | **.282** | **.288** | **.262** | **.132** | **.247** | **.265** | **.226** | **.168** | **.250** | **.268** | **.284** | **.251** | **.321** | **.318** | **.332** | **.601** | **.239** |
| 4 | 9/11 | 2.83 | 1.34 | | | | **.472** | **.451** | **.373** | **.371** | **.375** | **.383** | **.155** | **.681** | **.305** | **.348** | **.216** | **.395** | **.391** | **.405** | **.406** | **.406** |
| 5 | Jewish Conspiracy | 2.01 | 1.24 | | | | | **.450** | **.339** | **.409** | **.529** | **.552** | **.160** | **.507** | **.347** | **.302** | **.219** | **.651** | **.363** | **.535** | **.387** | **.575** |
| 6 | Lady Die | 2.62 | 1.32 | | | | | | **.279** | **.344** | **.312** | **.338** | **.127** | **.497** | **.352** | **.331** | **.214** | **.407** | **.263** | **.405** | **.417** | **.354** |
| 7 | Iraq War | 3.83 | 0.99 | | | | | | | **.150** | **.234** | **.189** | **.217** | **.360** | **.174** | **.358** | **.197** | **.345** | **.368** | **.197** | **.233** | **.379** |
| 8 | Aliens | 1.46 | 0.91 | | | | | | | | **.515** | **.554** | **.183** | **.452** | **.286** | **.177** | .080 | **.494** | **.296** | **.528** | **.338** | **.360** |
| 9 | Illuminati | 2.29 | 1.33 | | | | | | | | | **.503** | **.262** | **.492** | **.404** | **.318** | .078 | **.640** | **.360** | **.449** | **.256** | **.450** |
| 10 | Chemtrails | 1.46 | 0.97 | | | | | | | | | | **.141** | **.517** | **.256** | **.228** | .059 | **.548** | **.311** | **.559** | **.332** | **.482** |
| 11 | Jesus' Offspring | 2.62 | 1.35 | | | | | | | | | | | **.236** | **.245** | **.245** | .042 | **.193** | **.230** | **.175** | **.151** | **.197** |
| 12 | WTC Detonation | 2.16 | 1.35 | | | | | | | | | | | | **.366** | **.363** | **.139** | **.482** | **.341** | **.416** | **.351** | **.478** |
| 13 | Human Sacrifices | 3.45 | 1.16 | | | | | | | | | | | | | **.349** | **.297** | **.413** | **.331** | **.285** | **.374** | **.317** |
| 14 | Automotive Industry | 3.23 | 1.16 | | | | | | | | | | | | | | **.245** | **.311** | **.514** | **.276** | **.414** | **.373** |
| 15 | Mind Control | 3.95 | 1.14 | | | | | | | | | | | | | | | **.256** | **.238** | **.188** | **.252** | **.199** |
| 16 | Freemasons | 2.07 | 1.14 | | | | | | | | | | | | | | | | **.425** | **.493** | **.382** | **.498** |
| 17 | Pharma Industry | 3.58 | 1.26 | | | | | | | | | | | | | | | | | **.357** | **.442** | **.436** |
| 18 | Nazi UFOs | 1.82 | 1.18 | | | | | | | | | | | | | | | | | | **.436** | **.430** |
| 19 | Nuclear Accidents USA | 2.27 | 1.11 | | | | | | | | | | | | | | | | | | | **.406** |
| 20 | World Conspiracy | 2.40 | 1.37 | | | | | | | | | | | | | | | | | | | |

*Significant correlations are written in bold.*

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# Placing Cognitive Rigidity in Interpersonal Context in Psychosis: Relationship With Low Cognitive Reserve and High Self-Certainty

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**Introduction:** People with psychosis show impairments in cognitive flexibility, a phenomenon that is still poorly understood. In this study, we tested if there were differences in cognitive and metacognitive processes related to rigidity in patients with psychosis. We compared individuals with dichotomous interpersonal thinking and those with flexible interpersonal thinking.

**Methods:** We performed a secondary analysis using two groups with psychosis, one with low levels of dichotomous interpersonal thinking ($n = 42$) and the other with high levels of dichotomous interpersonal thinking ($n = 43$). The patients were classified by splitting interpersonal dichotomous thinking (measured using the repertory grid technique) to the median. The groups were administered a sociodemographic questionnaire, a semi-structured interview to assess psychotic symptoms [Positive and Negative Syndrome Scale (PANSS)], a self-report of cognitive insight [Beck Cognitive Insight Scale (BCIS)], neurocognitive tasks [Wisconsin Card Sorting Test (WCST) and Wechsler Adult Intelligence Scale (WAIS)], and the repertory grid technique. We used a logistic regression model to test which factors best differentiate the two groups.

**Results:** The group with high dichotomous interpersonal thinking had earlier age at onset of the psychotic disorder, higher self-certainty, impaired executive functioning, affected abstract thinking, and lower estimated cognitive reserve than the group with flexible thinking. According to the logistic regression model, estimated cognitive reserve and self-certainty were the variables that better differentiated between the two groups.

**Conclusion:** Cognitive rigidity may be a generalized bias that affects not only neurocognitive and metacognitive processes but also the sense of self and significant others. Patients with more dichotomous interpersonal thinking might benefit from interventions that target this cognitive bias on an integrative way and that is adapted to their general level of cognitive abilities.

**Keywords: self, schizophrenia, repertory grid, personal construct psychology, dichotomous thinking, cognitive bias**

# INTRODUCTION

People with psychosis exhibit impairments in cognitive flexibility (1, 2), a phenomenon considered a fundamental aspect of health with a major contribution on daily well-being. Cognitive flexibility refers to several dynamic processes that unfold over time and is reflected in how a person adapts to fluctuating situational demands, reconfigures mental resources, or shifts perspective (3). In psychosis, cognitive flexibility has been defined from two main approaches and using a variety of metacognitive and neurocognitive measures. As a metacognitive process, it is a complex higher order reasoning construct. It includes an individual's ability to release from a strongly held belief, once formed, in order to engage in further cognitive operations involved in making judgments under conditions of uncertainty: rethinking the possibility of being mistaken; reviewing the main belief in light of newer evidence/information; and generating and considering other explanations (4). In contrast, as a neurocognitive process, it is considered a component of executive functioning. In this sense, cognitive flexibility refers to the ability to switch thought and/or response patterns and target-directed behaviors. Further, cognitive flexibility is critical in using feedback to modify cognitive sets. Essentially, in the context of neurocognition, the paradigm has referred to the inability to set-shifting, also called "stuck-in-set behavior" (1).

From the metacognitive approach, impairments in cognitive flexibility in psychosis, also termed in the literature as belief inflexibility, have been mainly discussed in the context of reasoning about clinical delusions (4–6). People with psychosis exhibit impaired cognitive flexibility when reflecting about their delusional beliefs. One form of this cognitive rigidity is the construct of self-certainty (7), which suggests that the individual is excessively convinced of the accuracy of their own beliefs and is resistant to change their ideas. Individuals with psychosis are often overconfident in errors that maintain delusional beliefs, thus resulting in difficulties appreciating that one may be mistaken and refusing alternative explanations (2, 8). This reasoning process is altered in psychosis as compared with non-psychiatric controls (9) and is a predictor of treatment response (10).

From the neurocognitive approach, the relative inability to shift attentional set became the paradigm case of a cognitive consequence of frontal lobe alterations, based on the results of early studies using the Wisconsin Card Sorting Test (WCST) (1, 11, 12). Cognitive rigidity in psychosis has been largely studied using the WCST. Patients make more perseverative errors and complete a smaller number of categories than healthy controls (11). However, this pattern of results is not specific to psychotic disorders (13), and impairments in performing this task may strongly rely on general intellectual abilities (2). Waltz suggests that excessive cognitive rigidity is likely to be characteristic of subgroups of patients with specific disorder profiles (3, 12). This idea is supported by empirical studies that have detected subgroups of patients with different performance on the WCST (14–16). For instance, patients with a general and marked executive functioning impairment showed lower IQ and severe negative symptomatology. Accordingly, identifying the characterization of subgroups of patients with psychosis suffering cognitive rigidity may be of interest in current research.

Understanding the complexity of cognitive rigidity in psychosis may benefit from a wider conceptualization, such as the one provided by the personal construct theory (PCT). According to PCT (17, 18), people construe the self and others using a system of personal constructs, which form a complex and hierarchical network. Personal constructs are bipolar dimensions of meaning, which are constructed by the individual. People use this system to define and interpret their self and the people who constitute their main interpersonal world. When this system is rigid, it can manifest as a pattern of dichotomous interpersonal thinking. The dimension of dichotomous interpersonal thinking (polarized thinking) when interpreting the self and significant others reflects a thinking tendency to understand oneself and the others in extreme or dichotomous terms (19). People with psychosis exhibit high dichotomous interpersonal thinking as compared with controls (20–22). This is relevant because high levels of it have been linked to more severity of positive symptoms (23), to more psychopathology in general (20), and to lower social functioning (24).

The relationship between dichotomous interpersonal thinking and other known processes of cognitive rigidity in metacognition and neurocognition in psychosis should be unraveled. Cognitive biases may intrinsically happen in the context of the construal of self and interpersonal relationships, thus possibly being more mobilizing and effective for outcomes in therapy (23, 25, 26). Moreover, the relationship between metacognitive and neurocognitive processes related to flexibility is still poorly understood and is considered an underdeveloped area of research (2). Therefore, deeper understanding of cognitive flexibility processes in psychosis is needed in current research to better target this outcome in therapy. Cognitive flexibility is a mediating factor in improving symptomatology in cognitive and metacognitive therapies for psychosis (27, 28). While it may also be subject to change (29–31), it is resistant to change by antipsychotic medication (32). Clarifying the facets of cognitive flexibility in psychosis and identifying different profiles of impairment may aid in developing tailored cognitive therapy programs but also to partially explain heterogeneity in psychosis.

## Objective and Hypothesis

We aimed to identify differences in cognitive and metacognitive processes in patients with psychosis. For this aim, we compared individuals with high and low dichotomous interpersonal thinking while controlling for symptomatic and sociodemographic factors. This procedure allowed us to gain a full picture of dichotomous interpersonal thinking in the context of other dimensions of cognitive rigidity in psychosis.

We hypothesized that cognitive rigidity may be a general and underlying cognitive bias in psychosis that involves many cognitive processes beyond reasoning about delusions, overconfidence on own beliefs (i.e., self-certainty), and neurocognitive processes related to flexibility (executive functioning) or affects the sense of self. In other words, patients with high dichotomous interpersonal thinking may have impairments in metacognitive and neurocognitive processes related to rigidity. Moreover, these variables will differentiate two profiles of patients. This hypothesis stems from previous literature that found associations between these cognitive processes. For instance, an association of poor executive functioning and global cognitive capacity with high self-certainty has been reported (6). Also, making over-confident decisions has been largely reported in people with schizophrenia (33–35). Other approaches to the sense of self in psychosis have also found that interpersonal self-concepts seem to be hampered when neurocognitive impairments occur (36). On previous work, we also found an association of high self-certainty with dichotomous interpersonal thinking with the same sample of the present study (23).

# METHODS

## Participants and Procedure

A total of 85 outpatients with a confirmed diagnosis of a schizophrenia spectrum or related disorder were recruited from four participating mental health centers at Barcelona (Spain) and its surrounding area. As inclusion criteria, patients needed to have a diagnosis of schizophrenia, psychotic disorder not otherwise specified, delusional disorder, schizoaffective disorder, brief psychotic disorder, or schizophreniform disorder [according to the *Diagnostic and Statistical Manual of Mental Disorders* (Third Edition) (DSM-5)]; to be aged between 18 and 60 years; and to be clinically stable enough to do the interviews. Patients were excluded if they had an established diagnosis of traumatic brain injury, dementia, or intellectual disability (premorbid IQ $< 70$); current substance dependence; or were hospitalized. This research is a secondary analysis from a study about the role of personal identity in psychosis (23). The sample had a heterogeneous profile in terms of diagnosis (45.9% of schizophrenia, 24.7% of schizoaffective disorder, 18.8–5% of psychosis not otherwise specified, 4.7% of schizophreniform disorder, 3.5% of brief psychotic disorder, and 2.4% of delusional disorder) and disorder chronicity (69.4% of prolonged psychosis and 30.6% of early psychosis). More details of the sample characteristics can be consulted in the primary study (23).

The clinicians of the participating mental health centers referred the participants that met the inclusion criteria and verbally agreed to participate in the study. The first author carried out all the assessments. After receipt of more exhaustive information about the study and signing the informed consent and after confirmation of inclusion criteria was made, a demographic questionnaire and the repertory grid technique (RGT) were administered in the first and second sessions, while a third session was used for the other instruments. The study was approved by the research ethics committee of the coordinating center (*Parc Sanitari Sant Joan de Déu*).

## Instruments

### The Repertory Grid Technique (37–39)

Dichotomous interpersonal thinking was measured with the RGT, a semi-structured interview derived from the PCT. The RGT can adopt different flexible formats according to the aim of the study. In this case, we used an idiographic and interpersonal design, which assessed the personal meanings involved in personal identity, operationalized in terms of personal constructs. RGT is idiographic because personal constructs (i.e., the *items* of this instrument) are elicited from the participant rather than provided by the researcher, and it is interpersonal because these constructs are applied to a set of elements that represent other people who are relevant for the interviewee (parents, siblings, relatives, partners, and friends) evaluated along with "self now," "ideal self," and a "non-grata person" (someone they do not like). The dyadic method (34, 35) was used to elicit constructs, by comparing pairs of the mentioned elements and asking for differences and similarities between them (e.g., "nervous–calm"). After the elicitation procedure, participants rated each element of their grid on a 7-point Likert-type scale according to each construct elicited in the interview. An example of a repertory grid from one of our participants appears in a published case study (40). For the current study, we used the index of polarization (% of extreme ratings, "1" and "7" scores, in the grid data matrix) as a measure of dichotomous interpersonal thinking. This is considered a measure of dichotomous or extreme thinking in the interpersonal domain, a form of cognitive rigidity (19). High scores represent extremity, with the person having a tendency toward a dichotomous thinking style, while low scores are an indicator of flexible thinking.

### The Positive and Negative Syndrome Scale

This scale was used to assess psychotic symptoms (41, 42). We used Wallwork's factor analysis to derive positive, excitative, and cognitive symptoms (43). The positive factor included four items: delusions, hallucinations, grandiosity, and unusual thought content. The excitative factor contained four items: excitement, hostility, uncooperativeness, and poor impulse control. The cognitive factor included three items: conceptual disorganization, difficulty in abstract thinking, and poor attention. In addition, we analyzed separately expressive and experiential deficits as negative symptoms subdomains following the factorial division by Khan et al. (44). The expressive factor contained blunted affect, poor rapport, lack of spontaneity, and motor retardation, while the experiential factor included emotional withdrawal, passive social withdrawal, and active social avoidance.

## Metacognition

### The Beck Cognitive Insight Scale (7, 45)

This is a self-reported scale to measure cognitive insight. The Beck Cognitive Insight Scale is composed of two subscales: self-reflectivity and self-certainty. Both subscales are analyzed separately.

## Neurocognition

### The Wisconsin Card Sorting Test (46)

This neuropsychological task was used in its abbreviated and computer version to measure executive function, set-shifting, and cognitive flexibility. We included the normative scoring of the indexes of total number of correct categories and perseverative errors.

### The Vocabulary and Similarities Subtests of the Wechsler Adult Intelligence Scale (47)

The vocabulary subtest was used to measure premorbid IQ, an estimator used in research to assess cognitive reserve (48). The similarities subtest was used to assess ability for abstract thinking. The normative scoring was used in both cases.

## Data Analyses

We computed personal identity measures of data obtained from participants' repertory grids using GRIDCOR v4.0 (38) and entered these results in a database along with other measures.

We conducted the main analyses in three stages. First, we tested the normal distribution of variables. Since the polarization index did not adjust to a normal distribution, after visual inspection of the distribution, we identified two distant modes. See **Figure 1** for the bimodal distribution of scores of the polarization index. The descriptive analysis supported the identification of two modes on this index, one identified at the score of 11% and another one at the score of 41%. Therefore, we decided to divide the sample according to two groups, which were split according to the median of the distribution of scores in this index: high-dichotomous interpersonal thinking (polarization score over 33, meaning more than 33% of extreme scores in their grid) and low-dichotomous interpersonal thinking (polarization score equal or below to 33). Second, to better characterize these two groups, we performed a descriptive and comparative analysis using mean differences or chi-square tests for categorical variables. Third, we built a hierarchical binary logistic regression to detect the variables that were best able to differentiate between high- and low-polarized patients. We included as independent variables those that were significant at level $p < 0.05$ in the bivariate analysis after demographic variables that were significant in the bivariate comparisons. On a second block, we added our measure of metacognition, the index of self-certainty, based on a previous analysis of this sample as it was already known to be associated with dichotomous interpersonal thinking (23). On following blocks, we included the neurocognitive measures that, based on theoretical consideration and the magnitude of the effect sizes found in the previous bivariate comparison, should be able to differentiate between patients with low and high levels of dichotomous interpersonal thinking (i.e., cognitive reserve-premorbid IQ on third block, abilities for abstract thinking on fourth block, and executive functioning on fifth block). On the last block, we included symptomatology factors that reached statistical significance on the bivariate comparisons. Effect sizes and their confidence intervals were also calculated. All the analyses were done using the jamovi 1.0 software (49).

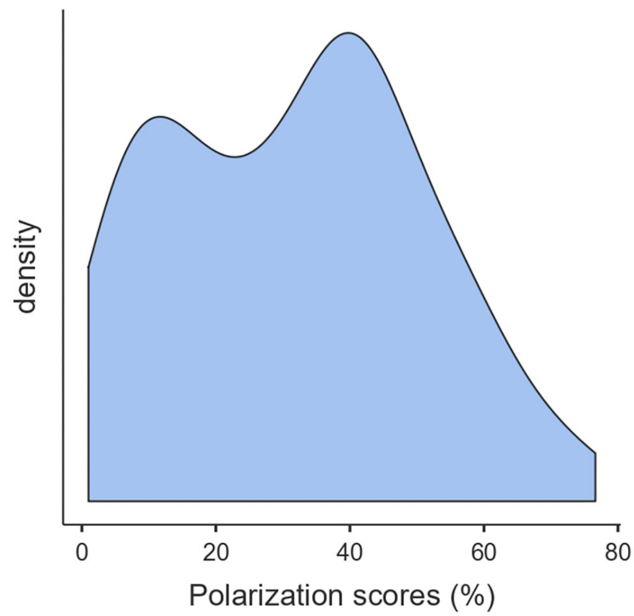


**FIGURE 1 |** Distribution of the scores of the polarization index (dichotomous interpersonal thinking).

# RESULTS

**Table 1** shows descriptive and comparative results for the sociodemographic, clinical, and cognitive variables for the high and low dichotomous interpersonal thinking groups. Patients with more dichotomous interpersonal thinking had an earlier age at onset, higher self-certainty, lower estimation of their cognitive reserve (vocabulary subtest of WAIS), lower abilities for abstract thinking (similarities subtest of WAIS), poorer executive functioning (number of categories completed and perseverative errors in the WCST), and more severity of excitative symptoms than patients with low levels of dichotomous interpersonal thinking, in all cases with a moderate effect size. There were no statistically significant differences in the other sociodemographic and clinical factors.

**Table 2** shows the hierarchical logistic regression analysis for predicting dichotomous interpersonal thinking with the variables that were found to associate with it. On a first analysis, we removed from our model the perseverative errors index of the WCST due to its high detected multicollinearity [variance inflation factor (VIF) of 4.14 and a detected correlation of 0.818 with the categories completed index of WCST], we based this selection on considering that the number of categories completed seemed to be a more adequate index for measuring cognitive flexibility (50). The other variables showed adequate levels of collinearity (VIFs all under 1.90 once this index was removed). In the first step, age at onset was entered, but it did not result on a significant model. In the second step, the metacognitive measure (self-certainty) was included, which resulted on a significant model that accounted for 6.6% (McFadden's $R^2$) and 12% (Nagelkerke's $R^2$) of the variance. The model comparison with respect to step 2 was also statistically significant. Finally, the final full model was composed of age at onset, self-certainty, and one domain of neurocognition, the estimated cognitive reserve (model of step 3). In the introduction of other domains of neurocognition, the similarities subtest of WAIS and of the WCST index of categories completed in subsequent steps did not add statistically significant contributions to the model (based on model comparisons). The final model showed adequate fit to

**TABLE 1 |** Comparison of two groups of patients with psychosis which were divided according to low and high levels of dichotomous interpersonal thinking.

| | Full sample (*N* = 85) % | Low DIT group (*n* = 42) % | High DIT group (*n* = 43) % | Statistical difference ($\chi^2$) | df | *p* | Cramer's V [95% CI] |
|---|---|---|---|---|---|---|---|
| Gender (% males) | 63.5 | 69.2 | 58.7 | 1.01 | 1 | 0.315 | 0.11 [0.108; 0.34] |
| Early psychosis | 30.6 | 35.9 | 26.1 | 0.96 | 1 | 0.328 | 0.11 [0.106; 0.34] |
| Marital status (single) | 72.9 | 69.2 | 76.1 | 6.43 | 4 | 0.169 | 0.275 [0.22; 0.49] |
| Secondary studies completed | 45.0 | 41.0 | 47.8 | 7.85 | 5 | 0.164 | 0.304 [0.24; 0.51] |
| Incapacity for employment | 37.6 | 25.6 | 47.8 | 5.78 | 5 | 0.328 | 0.261 [0.24; 0.47] |
| Diagnosis of schizophrenia | 45.9 | 35.9 | 54.3 | 5.19 | 5 | 0.393 | 0.247 [0.24; 0.45] |
| | **Mean (SD); Range** | **Mean (SD)** | **Mean (SD)** | **Statistical difference (t)** | **df** | ***p*** | **Cohen's d [95% CI]** |
| **Socio-demographics** | | | | | | | |
| Age | 37.1 (9.57); 19–57 | 37.67 (8.83) | 36.54 (10.22) | 0.537 | 83 | 0.593 | 0.12 [−0.31; 0.54] |
| Years of disorder | 11.4 (8.78); 0.5–39 | 10.15 (8.35) | 12.5 (9.09) | −1.230 | 83 | 0.222 | −0.27 [−0.69; 0.16] |
| Age at onset | 25.6 (7.54); 13–46 | 27.29 (7.30) | 24.04 (7.50) | 2.032 | 83 | 0.045 | 0.44 [0.07; 0.93] |
| Number of hospitalizations | 3.20 (3.98); 0–22 | 2.82 (3.26) | 3.52 (4.51) | −0.808 | 83 | 0.421 | −0.18 [−0.6; 0,26] |
| Antipsychotic dosage[a] | 28 (324); 0–2292 | 177.25 (171.15) | 270.04 (408.6) | −1.305 | 81 | 0.195 | −0.29 [−0.71; 0.14] |
| **Metacognition** | | | | | | | |
| BCIS self-reflectivity | 14.7 (4.36); 4–27 | 14.49 (4.19) | 14.96 (4.56) | −0.487 | 82 | 0.627 | −0.11 [−0.53; 0.32] |
| BCIS self-certainty | 8.07 (3.32); 1–18 | 7.19 (2.54) | 8.95 (3.79) | −2.254 | 82 | 0.025 | −0.54 [−0.97; −0.11] |
| **Neurocognition** | | | | | | | |
| WAIS vocabulary subtest | 106 (13.1); 70–140 | 110.83 (12.24) | 102.5 (12.67) | 3.196 | 83 | 0.002 | 0.69 [0.25; 1.13] |
| WAIS similarities subtest | 11.86 (3.25); 2–19 | 12.82 (3.22) | 11.07 (3.09) | 2.553 | 82 | 0.013 | 0.55 [0.12; 0.99] |
| WCST perseverative errors | 42.5 (8.11); 29–57 | 44.52 (8.26) | 40.67 (7.82) | 2.205 | 81 | 0.030 | 0.48 [0.05; 0.91] |
| WCST categories | 3.82 (2.11); 0–6 | 4.42 (1.97) | 3.24 (2.1) | 2.613 | 81 | 0.011 | 0.57 [0.13; 1.00] |
| **Symptomatology** | | | | | | | |
| PANSS excitative | 5.19 (1.68); 4–11 | 4.83 (1.19) | 5.52 (2.0) | −2.024 | 83 | 0.054 | −0.43 [−0.87; −0.01] |
| PANSS cognitive | 4.98 (1.91); 3–10 | 4.59 (1.71) | 5.3 (2.03) | −1.735 | 83 | 0.086 | −0.38 [−0.81; 0.05] |
| PANSS positive | 7.39 (3.23); 4–16 | 6.77 (2.8) | 7.91 (3.49) | −1.645 | 83 | 0.104 | −0.36 [−0.79; 0.07] |
| PANSS depressive | 11.8 (4.31); 5–23 | 11.26 (3.98) | 12.2 (4.56) | −1.002 | 83 | 0.319 | −0.22 [−0.64; 0.21] |
| PANSS expressive deficits | 5.31 (2.64); 4–16 | 5.18 (2.02) | 5.41 (3.08) | −0.404 | 83 | 0.687 | −0.09 [−0.51; 0.34] |
| PANSS experiential deficits | 5.87 (3.21); 3–15 | 5.79 (3.05) | 5.93 (3.38) | −0.199 | 83 | 0.843 | −0.04 [−0.47; 0.38] |

[a]*Antipsychotic drug doses are expressed as chlorpromazine equivalence; DIT, Dichotomous interpersonal thinking; Early psychosis, 5 or under 5 years of evolution of the disease; PANSS, Positive and Negative Symptoms Scale; BCIS, Beck Cognitive Insight Scale; WCST, Wisconsin Card Sorting Test; WAIS, Wechsler Adult Intelligence Scale.*

the data and explained between 14% (McFadden's $R^2$) and 24% (Nagelkerke's $R^2$) of the variance, correctly classifying 67.9% of the cases, with a sensitivity capacity of 0.716 and a specificity of 0.641. As shown in **Table 2**, after the estimated cognitive reserve was added and according to the *p*-values, an earlier age at onset and a lower self-certainty in the model did not reach statistical significance to explain their classification as the high or low dichotomous interpersonal thinking groups. However, according to the odds ratio (effect size), the strongest predictor was self-certainty, followed by estimated cognitive reserve.

## DISCUSSION

In this study, we tested differences in neurocognition and metacognition in patients with psychosis. To this aim, we compared individuals with high and low scores in dichotomous thinking. Our results show that the group with high dichotomous interpersonal thinking had poorer performance in self-certainty and executive functioning. This group also had an earlier age at onset, impaired abstract thinking, and lower estimated cognitive reserve than the group with flexible thinking. Finally, according to the logistic regression model, the factors that differentiated between the two groups were estimated cognitive reserve, followed by self-certainty.

Participants in the group with high interpersonal dichotomous thinking were limited in their cognitive flexibility. Also, their sense of self and perception of interpersonal relationships was characterized by cognitive rigidity as conceptualized from the neurocognitive (executive functioning) and metacognitive (self-certainty) domains. Additionally, these three constructs were measured using three different assessment approaches: a semi-structured interview, the RGT (dichotomous interpersonal thinking), a neuropsychological task (executive

**TABLE 2 |** Hierarchical logistic regression models predicting level of dichotomous interpersonal thinking.

| Predictor | AIC | Pseudo $R^2$ (McFadden's–Nagelkerke's) | Model comparison ($X^2$, *p*) | Overall model test ($X^2$, *p*) | Omnibus likelihood ratio test ($X^2$, *p*) | Log Odds ratio (*SE*) | Odds ratio | Odds ratio 95% *CI* |
|---|---|---|---|---|---|---|---|---|
| Step 1 | 113 | 0.028–0.052 | | 3.19 (0.074) | | | | |
| Constant | | | | | | 1.69 (0.82) | 4,248 | 0.857–21.05 |
| Age at onset | | | | | 3.619(0.074) | −0.05 (0.03) | 0,948 | 0.892–1.01 |
| Step 2 | 110 | 0.066–0.12 | 4.84 (0.028) | 8.03 (0.018) | | | | |
| Constant | | | | | | −0.05 (1.07) | 0,947 | 0.115–7.77 |
| Age at onset | | | | | 2.03 (0.154) | −0.04 (0.03) | 0,957 | 0.899–1.02 |
| Self-certainty | | | | | 4.84 (0.028) | 0.16 (0.08) | 1,172 | 1,011–1.36 |
| Step 3 | 104 | 0.14–0.24 | 8.05 (0.005) | 16.08 (0.001) | | | | |
| Constant | | | | | | 6.31 (2.70) | 554,031 | 4.39–221933.69 |
| Age at onset | | | | | 1.60 (0.206) | −0.04 (0.03) | 0,959 | 0.898–1.024 |
| Self-certainty | | | | | 2.72 (0.099) | 0.12 (0.08) | 1,134 | 0.972–1.321 |
| Estimated cognitive reserve | | | | | 8.05 (0.005) | −0.06 (0.02) | 0,944 | 0.904–0.988 |

*Odds represents the ratio of "High level of dichotomous interpersonal thinking" vs. "Low level of dichotomous interpersonal thinking;" AIC, Arkaike Information Criteria; SE, Standard error; CI, Confidence Interval.*

functioning), and a self-reported questionnaire (self-certainty). This convergence may support the idea that cognitive rigidity may be a generalized cognitive disruption present in some people with psychosis that manifests itself in specific domains such as neurocognition, metacognition, and the view of self and significant others. Patients in this group also showed earlier age at onset, a finding that is congruent with extensive research, suggesting that patients with earlier age at onset are more impaired in executive functioning and general cognitive abilities (51, 52). Our findings give further support to the idea that earlier age at onset could be a surrogate of disorder severity (53, 54), while high cognitive rigidity could be another marker of this severity.

Despite these results, the logistic regression showed that the domains that best differentiated patients with cognitive rigidity from those who with a more flexible, less polarized thinking pattern in the interpersonal context were the estimated cognitive reserve and the self-certainty index of cognitive insight. Although patients with high dichotomous interpersonal thinking had more impaired executive functioning as measured with the WCST, this measure did not contribute to explain the differences in the logistic regression model, which was an unexpected result. This result suggests that cognitive rigidity in the perception of self and others may rely more on basic cognitive abilities connected to cognitive reserve and on metacognitive processes related to overconfidence and rigidity to consider alternative explanations, rather than in specific abilities for flexibility in set-shifting. To the best of our knowledge, this is the first study to empirically support this idea. It has been suggested that overconfidence in own judgments may be influenced by acquired knowledge from past experience (55), which aligns with our results. Indeed, the inner construction of self and significant other is necessary built based on basic cognition, previous experiences, and metacognitive processes (22). It is not surprising that cognitive reserve emerged as a determinant factor, as in light of recent findings, patients with higher IQ are more likely to improve under metacognitive interventions (56). These results also support a growing body of evidence reporting that reasoning processes are underpinned by general cognitive functions (10, 35).

In a previous analysis, we found a small but significant association between high interpersonal rigidity and more positive symptoms (23). However, in the present study, we found that the severity of positive symptomatology did not differ between patients with higher and lower dichotomous interpersonal thinking. This result also contrasts with many other studies that related cognitive rigidity to increased positive symptoms (57). It could be that cognitive rigidity may be a cognitive bias related to but independent of the severity of positive symptoms, which could be influenced by many factors, thus being a stable trait of the disorder in a subgroup of patients. However, some considerations regarding our sample characteristics may also be considered. One explanation may be that we included patients with different symptom profiles of the psychotic spectrum, and the main literature in this topic has studied the presence of cognitive rigidity in active-deluded patients (2, 32).

Our study has some limitations that might affect the generalizability of the findings. First, the cross-sectional design of the study prevents drawing conclusions about causality; therefore, longitudinal studies are needed. Second, we conducted a short screening of neurocognitive and cognitive insight impairment. A more exhaustive assessment is needed to explore the links between dichotomous interpersonal thinking and comprehensive measures of cognitive biases and neurocognition. For instance, it is unknown whether other neurocognitive factors such as processing speed, working memory, or attention might have an influence on these results, as these factors have been shown to be affected in the presence of high self-certainty (6). A measure of belief inflexibility when reasoning about delusions should also be included in future studies to refine the validity of the study presented in this paper (5). Moreover, the relationship with other relevant cognitive biases that may share this underlying process of rigidity should be tested, such as need for closure, bias against disconfirmatory evidence, or jumping to conclusions (32, 58, 59). Third, regarding the sample characteristics and despite its clinical and functional heterogeneity, the proportion of chronic patients was much bigger than the proportion of recent-onset patients. Future studies with a focus on recent-onset patients would be needed. Finally, due to the bimodal distribution of the dichotomous interpersonal thinking index, we used the median split for dividing the groups. This statistical method for establishing groups has some advantages but has some drawbacks (48), so there may be other more complex statistical approaches that could yield different results. Different approaches to establishing groups according to their level of cognitive rigidity should be tested in future studies.

Despite the aforementioned limitations, our results may have implications for research and clinical practice. Chief among them is considering that cognitive rigidity may be a cognitive bias more generalized than previously considered that affects not only neurocognitive and metacognitive processes but also the sense of self and identity. Cognitive rigidity would be present in a subgroup of patients suffering psychosis. One possibility is that this subgroup of patients may benefit from decreasing their all-or-nothing tendency in their thinking pattern. To address this issue, the therapeutic work may be better approached by reducing the overconfidence in own judgments when thinking about themselves and the others. However, this intervention should always be adapted to the general intellectual level of each individual.

If these cognitive process rely on previous acquired knowledge and general cognitive abilities, they could be more amenable to change by using personalized interventions that focus on cognitive content (for example, cognitive-behavioral and metacognitive interventions) (55) and adapted to their unique interpersonal context. Alternatively, guaranteeing a minimum level of general cognitive abilities before considering intervention in cognitive rigidity may be recommended to maximize its benefit (56). Summarizing, patients showing high interpersonal dichotomous thinking might benefit from interventions that target this cognitive bias on an integrative way and adapted to their general level of intelligence. These suggestions should be tested in clinical trials of cognitive behavioral and metacognitive interventions in which changes in cognitive rigidity occur (31, 60, 61) or are expected to mediate the improvement in psychotic symptomatology (10, 27).

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Committee of Parc Sanitari Sant Joan de Déu. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

HG-M, SO, and GF designed the study and interpreted the results. HG-M wrote the first draft of the manuscript, collected the data for the study, and ran the statistical analyses. JU collaborated with the collection of data. HG-M, JU, GF, and SO edited the first draft of the manuscript. All authors approved the final version of the manuscript.

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# Inflexibility in Reasoning: Comparisons of Cognitive Flexibility, Explanatory Flexibility, and Belief Flexibility Between Schizophrenia and Major Depressive Disorder

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**Introduction:** Inflexibility in reasoning has been suggested to contribute to psychiatric disorders, such as explanatory flexibility in depression and belief flexibility in schizophrenia. However, studies tended to examine only one of the flexibility constructs, which could be related to each other, within a single group of patients. As enhancing flexibility in thinking has become one of the psychological treatment goals across disorders, this study aimed to examine three constructs of flexibility (cognitive flexibility, explanatory flexibility, and belief flexibility) in two psychiatric groups.

**Methods:** We compared three groups of participants: (i) 56 outpatients with a schizophrenia-spectrum disorder and active delusions, (ii) 57 outpatients with major depressive disorder and at least a moderate level of depression, and (iii) 30 healthy controls. Participants were assessed on symptom severity and flexibility, using the Trail-Making Task, the Attributional Style Questionnaire, the Maudsley Assessment of Delusions Scale (MADS) and the Bias Against Disconfirmatory Evidence (BADE) Task.

**Results:** Cognitive flexibility was reduced in the two clinical groups compared to controls. Explanatory flexibility was comparable across groups. The three groups differed in belief flexibility measured by MADS but not by the BADE task. Response to hypothetical contradiction was reduced in the delusion group than the other two groups, and the ability to generate alternative explanations was reduced in the delusion group than healthy controls.

**Discussion:** We found an effect of diagnosis on cognitive flexibility, which might be confounded by differences in intellectual functioning. Reduced belief flexibility tended to be specific to delusions.

**Keywords: flexibility, cognitive bias, transdiagnostic, reasoning, appraisal**

## INTRODUCTION

Cognitive approaches stress how biassed reasoning and appraisals may explain psychopathology [e.g., (1–5)]. Some researchers focus on maladaptive belief contents about one's external and internal experiences, such as attribution biases (6) and meta-worry (7, 8). In comparison, others focus more on how individuals formulate or maintain their thoughts. Such dysfunctional processes tend to include dichotomous thinking (9, 10), inadequate information gathering (11, 12), difficulty in evidence integration (13), etc. Flexibility in reasoning is one cognitive process that has received research attention in recent years, which in its broadest sense refers to the cognitive capacity to adaptively respond to changing contexts (14, 15). A failure to sensitively respond to different circumstantial factors in thinking, reasoning, and reflecting has been reported in various psychiatric disorders.

Cognitive flexibility refers to the ability to selectively focus on accessible mental sets in response to varied task requirements (15–17). As typically measured by the Wisconsin Card Sorting Task (WCST) (18), the Trail-Making Task (TMT) (19) and other set-shifting tasks [e.g., intra-inter dimensional task; (20, 21)], cognitive flexibility manifests in the faster and more accurate grasp of the task rule when it changes, and reduced time cost in shifting between sequences.

Recent reviews suggested a deficiency in cognitive flexibility across diagnostic categories (22–24), including schizophrenia (25, 26), major depressive disorder (14), autistic spectrum disorders (27, 28), and obsessive-compulsive disorder (29). Studies that examined cognitive flexibility between diagnostic groups had yielded mixed results. For example, Mahurin et al. (30) reported significantly more errors and longer completion time in patients with schizophrenia than patients with depression on the TMT. In contrast, Moritz et al. (31) found no difference between their schizophrenia and depression samples on neither TMT nor WCST, both performing worse than non-clinical controls. As cognitive flexibility may be directly influenced by several cognitive capacities including working memory, inhibitory control, and digit span (30, 32, 33), a more precise differentiation on how cognitive flexibility tends to be compromised in light of various diagnoses may enrich process-based research of psychopathology.

As a narrower concept than cognitive flexibility, explanatory flexibility refers to the responsiveness to contextual features when forming causal attributions (34–36). The underlying premise is that individuals are able (and expected) to take into account specific situational factors, hence leading to different ways of explaining the causes of different situations. Explanatory flexibility is typically measured by the standard deviation of stability and globality of attributions for negative events on the Attributional Style Questionnaire (35, 37), although some other studies had also included internality of attributions (36, 38).

Most research on explanatory flexibility centres around depression. It has been shown that reduced explanatory flexibility interacted with adverse life events to predict subsequent depressive symptoms (35). A higher level of explanatory flexibility, on the contrary, was associated with better adjustment and less relapse in patients (35, 38, 39). Explanatory flexibility tended to decrease in response to negative mood induction, especially in individuals with a history of major depressive disorder (MDD) (34). A handful of studies compared explanatory flexibility between psychiatric disorders, questioning the specificity of compromised explanatory flexibility in MDD. Fresco et al. (40) found reduced explanatory flexibility among college students with a self-reported generalised anxiety disorder than controls. Lackner et al. (41) found more reduced explanatory flexibility in patients with MDD, generalised anxiety disorder, and adjustment disorder than other psychiatric groups. In the only study that investigated explanatory flexibility among individuals with psychosis, Silverman and Peterson (38) reported a comparable level of explanatory flexibility in patients with schizophrenia as in patients with MDD. This result was yet to be replicated.

Belief flexibility refers to the metacognitive capacity of reflecting on one's own beliefs, changing them in light of reflection and evidence, and generating and considering alternatives (42, 43). Belief flexibility has been commonly assessed through a clinical interview, where an individual's idiosyncratic beliefs are discussed with an interviewer. There are three signs of belief flexibility: (1) when one acknowledges the possibility of being mistaken, (2) when one lessens their conviction in face of hypothetical and contradictory evidence, and (3) when one can generate new and alternative beliefs about their experience (44, 45). So et al. (46) found that these three measures of belief flexibility load on the same factor. Other researchers measured belief flexibility using the Bias Against Disconfirmatory Evidence (BADE) task (47, 48), where respondents are presented with standardised and hypothetical scenarios and are asked to rate the plausibility of various explanations when new evidence unfolds. Belief flexibility is operationalised on the BADE task by the change between initial and later plausibility ratings. Other self-report measures have also been recently used to capture the construct of belief flexibility, including Davos Assessment of Cognitive Biases Scale (49), Beck Cognitive Insight Scale (50), and Fast and Slow Thinking Questionnaire (51). As self-report relies largely on self-awareness and retention, doubts about the sensitivity of measuring belief flexibility using self-report questionnaires have been raised (51).

Research on belief flexibility has taken root in psychosis, where belief flexibility has been shown to be negatively associated with severity and conviction of delusions (42, 52) and may co-vary with delusions over time (46, 53). Sanford et al. (54) and Speechley et al. (48) compared BADE performance between individuals with high-delusional schizophrenia, individuals with low-delusional schizophrenia, individuals with another psychiatric disorder (obsessive-compulsive disorder and bipolar disorder, respectively), and healthy controls. Both studies found that BADE performance distinguishes the high delusional sample from the other groups. To our best knowledge, there have been no studies comparing belief flexibility between patients with schizophrenia and patients with unipolar depression, although Everart et al. (55) found in a community sample that those with a higher score of depression or social anxiety tended to be less flexible on the BADE task. In view of the specificity of belief flexibility to psychotic delusions, it has been argued that belief flexibility may be a putative mechanism of change in intervention for delusions (42, 52, 56).

In summary, at least three constructs of flexibility have been studied in psychiatric populations. Cognitive flexibility concerns the accuracy and speed of responding to changing task demands, explanatory flexibility concerns taking into account contextual factors when attributing causes to negative events, and belief flexibility concerns reviewing one's own beliefs. While evidence has accumulated for explanatory flexibility in depression and belief flexibility in psychotic delusions, it is not clear whether the same flexibility constructs are relevant across disorders. Development of the RDoC framework has led to an increase in emphasis on identifying similarities and differences in etiological factors underlying various disorders, which may inform the transdiagnostic application of process-based intervention (57, 58). Besides, while these flexibility constructs are measured using different tools, they represent the extent to which one's reasoning shifts when confronted with new information, and it remains unclear how these flexibility constructs may be related to one another. For example, Eifler et al. (59) and Riccaboni et al. (60) found that belief flexibility as measured by BADE was positively associated with cognitive flexibility, but Moritz et al. (61) found no association between the two. There has been no investigation of explanatory flexibility with either cognitive or belief flexibility. Exploring the inter-relationship between flexibility constructs will help to deepen our understanding of the cognitive structure of inflexibility in appraisal.

This study aimed to examine three constructs of flexibility together across two psychiatric groups. The two chosen groups were outpatients with MDD and schizophrenia-spectrum disorder with delusions because these two groups have been shown to have inflexible thinking. Key hypotheses were as follows:

1. Compared to healthy controls, there will be reduced cognitive flexibility in both the Delusion group and the Depression group
2. Compared to healthy controls, there will be reduced explanatory flexibility in both the Delusion group and the Depression group.
3. Compared to healthy controls and the Depression group, there will be reduced belief flexibility in the Delusion group

We also explored the associations between the flexibility constructs across groups.

## MATERIALS AND METHODS

The clinical groups were drawn from a randomised-controlled trial on the effect of metacognitive training on cognitive bias in schizophrenia and MDD (62). Data included in this study were collected at baseline (i.e., before training). The clinical trial was registered with the https://clinicaltrials.gov/ Protocol Registration and Results System (NCT03449394) by the US National Library of Medicine (NLM). Ethics approval was obtained from the Joint Chinese University of Hong Kong - New Territories East Cluster Clinical Research Ethics Committee (2014.031) and the New Territories West Cluster Research Ethics Committee (NTWC/CREC/18040).

### Participants

The sample consisted of two clinical groups and a healthy control group. All participants were aged between 18 and 65. Inclusion criteria for the Delusion group were (i) a diagnosis of schizophrenia spectrum disorder, and (ii) presence of active delusions at the time of assessment [scoring $\geq 3$ on item P1 of the Positive and Negative Syndrome Scale (PANSS)] (63). Inclusion criteria for the Depression group were (i) a diagnosis of MDD, and (ii) at least a moderate level of depression [total score $\geq 20$ on the Beck Depression Inventory-II (BDI-II)] (64). Exclusion criteria for both clinical groups were as follows: drug-induced or organic psychosis, bipolar disorder, a primary diagnosis of substance misuse, learning disability (FSIQ $< 70$), previous participation in cognitive/reasoning training program, psychotic depression, and depression with psychotic features. The control group consisted of age- and education-matched individuals who did not have any psychiatric diagnosis. Patients were recruited from hospitals via referral from the clinical team. Healthy controls were recruited from the community in Hong Kong through advertisements at educational institutions, churches, public transport stations, and vocational training centres.

### Measures

Psychiatric diagnoses were ascertained by the Chinese-bilingual Structured Clinical Interview for DSM-IV Axis I Disorders (65). Level of depression in the Depression group was confirmed by the BDI-II (64).

#### Clinical Symptoms

For the Delusion group, schizophrenia symptoms were assessed by using the Positive and Negative Syndrome Scale (PANSS) (63) and the Psychotic Symptoms Rating Scale (PSYRATS) (66). PANSS consists of 30 symptoms, rated on a 1 (absent) to 7 (extreme) scale. PANSS P1 indicates the overall delusional severity. PSYRATS consists of the auditory hallucinations subscale and the delusions subscale, with the latter being of interest in this study. The delusions subscale has a score range of 0–24, with items rated on a 0–4 Likert scale. Good psychometrics have been reported for PANSS and PSYRATS, respectively (63, 66, 67).

For the entire sample, the severity of depressive symptoms was measured using the Calgary Depression Scale for Schizophrenia (CDSS) (68, 69). This semi-structured interview scale has been extensively used to assess depression in patients with schizophrenia. It has high inter-rater reliability, sensitivity, specificity, and discriminant and convergent validity (70, 71). The items are rated on a 0–3 scale, and the total score ranges from 0 to 27. Across groups, the level of anxiety was measured by Generalised Anxiety Disorder 7-item scale (GAD-7) (72), which has good validity and reliability (73, 74).

## Flexibility Measures

All participants completed the following measures assessing three aspects of flexibility.

### *Cognitive Flexibility*

The Trail-making task (TMT) was developed to assess an individual's ability to direct thoughts and actions when monitoring alternating tasks (19). In Part A of the TMT, 25 numbered circles (1–25) are mixed and spread about on a white sheet of paper. Participants are asked to connect them in numerical order. In Part B, 13 numbered circles (1–13) and 12 circles with alphabetic letters (A–L) are mixed and spread about on a white sheet of paper of the same size. Participants are asked to connect them alternatively and in ascending order (i.e., 1-A-2-B...). In both parts, participants are asked to complete the task as quickly as possible. An experimenter would time the tasks and point out any respondent's errors immediately. Following the original test manual, cognitive flexibility was calculated as the difference in the completion time for Part B and Part A. A greater TMT difference score indicates poorer cognitive flexibility. TMT is one of the most commonly used measures for cognitive flexibility, and its psychometric properties have been studied widely (75, 76).

### *Explanatory Flexibility*

Attributional Style Questionnaire (ASQ) (6, 77) is composed of 12 hypothetical daily events, six positive (e.g., "You get a raise.") and six negative (e.g., "You go out on a date and it goes badly."). For each event, participant first provided a perceived cause for its occurrence. Then, they rated the cause on a 1-to-7-Likert scale regarding whether the cause was (1) external vs. internal, (2) temporary vs. stable, (3) context-specific vs. global. ASQ has acceptable-to-good internal consistency and reliability (77). Following Fresco et al. (35, 37, 40), explanatory flexibility was calculated as the standard deviation of the stability and globality items for negative events. A higher score indicates better explanatory flexibility, whereas a lower score indicates inflexibility or rigidity.

### *Belief Flexibility*

Belief flexibility was measured by the Maudsley Assessment of Delusions Schedule (MADS) (45) and the Bias Against Disconfirmatory Evidence Task (BADE) (47). Following the MADS interview protocol, a trained experimenter facilitated a discussion about the idiosyncratic affect-laden belief with each participant individually. For the Delusion group, the delusional belief as identified through the PANSS and PSYRATS interview was assessed. For the Depression group and healthy controls, belief flexibility was assessed in the context of explanations of negative daily-life experiences. We first invited the participants to focus on a specific experience that had bothered them personally over the past 2 weeks (for examples, see **Table 1**). Their interpretation about the event was then elicited. Participants were asked about how strongly they believed in that interpretation; only affect-laden beliefs that were held with more than 50% conviction were further assessed for belief flexibility. The procedure of identification and selection of the idiosyncratic beliefs was comparable across the three groups. As reported by Colbert et al. (78), among non-psychotic individuals, belief flexibility would be more reduced in light of personally meaningful beliefs than standard beliefs (e.g., "The sun will rise tomorrow"). Therefore, we adopted personally meaningful beliefs in this study for better sensitivity. Levels of conviction, preoccupation and distress associated with the belief were rated individually, using the PSYRATS score ranges.

Once the idiosyncratic belief was identified for the individual participant, the interviewer asked in a semi-structured manner if it was at all possible for the participant to be mistaken about the belief (PM). Then the interviewer proposed a piece of hypothetical and contradictory evidence, which, if true, would convincingly challenge the participant's belief, and assessed their response for the "reaction to hypothetical contradiction" (RTHC) item. Lastly, the interviewer asked the participant to provide an alternative explanation (AE) for their experience (44). The items PM, RTHC, and AE were rated on a dichotomous scale (i.e., flexible/inflexible).

The BADE task is a computerised task that assesses individuals' reappraisal of beliefs in response to disconfirmatory information presented for standardised scenarios. For each scenario, participants were asked to rate the likelihood of four predetermined explanations: one true, one absurd, and two lure explanations. Initially, the scenario appeared to indicate lure explanations. Two new pieces of information about the scenario were then provided one by one. With each new piece of information, the participants could adjust the ratings they had given. Likelihood of explanations was rated on a 0–100 scale. Following Woodward et al. (47), belief flexibility was calculated as the difference score between the third and the first rating of lure explanations, with a higher difference score indicating greater flexibility.

## Other Measures

General intelligence was estimated using the 4-subtest short form of the Wechsler Adult Intelligence Scale – Third Edition (79). Demographic information was collected via an unpublished questionnaire.

**TABLE 1** | Examples of idiosyncratic beliefs elicited for the assessment of belief flexibility (MADS).

| |
|---|
| Delusion group: |
| - People keep coming after me. |
| - People deliberately coughed at me and swore at me. |
| - A device owned by the university is controlling my thoughts. |
| Depression group: |
| - Peers in my church overlooked me as if I was not there. |
| - My parents did not talk to me, which suggests that I am a disappointment to them. |
| - I failed to take care of my mother well enough. |
| Control group: |
| - A client who complained about me made trouble out of nothing. |
| - The renovation worker was irresponsible. |
| - My heavy workload has cost my leisure time with friends. |

*MADS, the Maudsley Assessment of Delusions Schedule. The sentences are translated from Cantonese to English.*

## Procedure

Following informed written consent, participants completed a clinical interview which incorporated the above measures and tasks, as well as brief questions on demographic information. The assessment was conducted in a quiet lab by a graduate-level psychologist or psychiatrist under the supervision of expert interviewers.

## Data Analysis

For group comparisons of categorical variables, we used the chi-square test, followed by *post-hoc* Fisher's exact approach wherever significant differences were identified (80), with alpha level adjusted for Bonferroni correction. Group comparisons of continuous variables were performed on Kruskal-Wallis Test or ANOVA test where appropriate. Kruskal-Wallis comparisons were followed by Dunn's test for *post-hoc* Bonferroni comparisons (81, 82). ANOVA comparisons were followed by Dunnett-Tukey-Kramer test for *post-hoc* comparisons, considering its strength in reducing error rate when sample sizes were unequal yet homogeneous variance was assumed (83). We reported the Pearson correlation between continuous variables and the biserial correlation between categorical variables and continuous variables. Logistic regression and ANCOVA were used to control for potential covariates, including general intelligence and gender. Data analysis was conducted using jamovi (version 1.2) (84) and RStudio (version 1.2.5033) (85), both of which were based on R (version 3.6.3) (86).

# RESULTS

## Sample Characteristics

Demographic characteristics of the three groups are shown in **Table 2**. There was a significant group difference in gender, with more females in the Depression group than the other groups ($p < 0.001$). There was a significant group difference in estimated intelligence ($p < 0.001$), with the control group outperforming the two clinical groups, and the clinical groups not being different from each other. The three groups were comparable on age and year of education ($ps > 0.05$).

Within the Delusion group, the average PANSS scores were as follows: total score = 51.41 (SD = 9.77), Positive subscore = 14.73 (SD = 3.45), Negative subscore = 11.13 (SD = 4.83), General Psychopathology = 26.13 (SD = 6.42), Severity of delusions (P1) = 4.82 (SD = 1.15). The average number of hospitalisations was 1.32 (SD = 1.88). The average antipsychotic dosage (in chlorpromazine equivalents) was 492.04 (SD = 415.64, range 13.03–1,592.84). Within the Depression group, the average BDI-II score was 33.80 (SD = 11.91). The average number of hospitalisations was 0.42 (SD = 0.71), which was significantly lower than the Delusion group (Mann-Whitney $U = 1{,}082.50$, $p = 0.001$, Cohen's $d = 0.64$). The average antidepressant dosage (in Fluoxetine equivalents) was 37.76 (SD = 26.13, range 4.98–97.06).

As shown in **Table 2**, there were significant overall group differences on GAD-7 and CDSS ($ps < 0.001$). On both measures, the Depression group was higher than the Delusion group ($ps < 0.001$), which in turn was higher than healthy controls ($ps \leq 0.001$).

## Group Comparisons of Cognitive Flexibility

Means and SDs of flexibility indices are shown in **Table 3**. There was a significant main effect of group. Pairwise comparisons revealed that cognitive flexibility was significantly higher in controls than the two clinical groups (mean difference with the Delusion group = 2.67, $p = 0.011$; mean difference with the Depression group = 3.04, $p = 0.004$); whereas the two clinical groups did not differ significantly ($p = 0.981$). In follow-up analyses, the main effect of group disappeared when controlling for estimated IQ [$F_{(2,131)} = 1.80$, $p = 0.169$, partial $\eta^2 = 0.027$].

## Group Comparisons of Explanatory Flexibility

There was no significant difference in explanatory flexibility across groups (**Table 3**).

## Group Comparisons of Belief Flexibility

Dimensions of beliefs across groups are shown in **Table 2**. On MADS, there was a significant main effect of group in RTHC and AE, but not PM (**Table 3**). The Delusion group was significantly less flexible on the RTHC item compared to the other groups [Fisher's exact test = 3.17, odds ratio = 3.21 (95% CI = 1.35–7.63), $p = 0.012$ with Depression and Fisher's exact test = 7.31, odds ratio = 7.53 (95% CI = 2.73–20.8), $p < 0.001$ with Controls]. There was no significant difference between the Depression and Control groups ($p = 0.073$). The ability to generate alternative explanations was significantly reduced in the Delusion group compared to the Control group [Fisher's exact test = 3.93, odds ratio = 4 (95% CI = 1.53–10.4), $p = 0.006$], whereas no significant difference was found between the two clinical groups ($p = 0.127$) or between the Depression and Control groups ($p = 0.167$).

As there were significant group differences in gender, estimated IQ and emotional states, we analysed the significant associations again controlling for these variables. The results on belief flexibility remained significant ($ps < 0.05$).

There was no group difference on the BADE task performance.

## Association Between Flexibility Indices

Associations between flexibility indices are shown in **Table 4**. In the entire sample ($N = 143$), the completion time difference on TMT was negatively correlated with BADE difference score and AE, indicating that higher cognitive flexibility was associated with higher belief flexibility (as measured by BADE and MADS).

Among healthy controls ($N = 30$), TMT difference score was negatively correlated with BADE performance and RTHC, which indicated that higher cognitive flexibility was associated with higher belief flexibility (as measured by BADE and MADS). However, similar associations were not found in the two clinical groups. Across groups, explanatory flexibility was not correlated with cognitive flexibility ($ps > 0.05$). While explanatory flexibility was positively correlated with belief flexibility (on BADE only) in

**TABLE 2 |** Demographic characteristics and emotion states.

| | Delusion ($N = 56$) | Depression ($N = 57$) | Control ($N = 30$) | Group comparisons |
|---|---|---|---|---|
| Gender (Female/Male) | 26/30 | 47/10 | 16/14 | $\chi^2_{(2,143)} = 16.9$, $p < 0.001$ |
| Age | 41.45 (13.83) | 45.70 (13.07) | 44.87 (14.03) | Kruskal-Wallis $\chi^2_{(2)} = 2.88$, $p = 0.237$, $\varepsilon^2 = 0.02$ |
| Education in years | 11.66 (3.35) | 10.89 (3.61) | 11.80 (3.69) | Kruskal-Wallis $\chi^2_{(2)} = 2.1$, $p = 0.351$, $\varepsilon^2 = 0.01$ |
| WAIS-III | 26.38 (6.38) | 28.55 (6.40) | 32.69 (6.46) | $F_{(2,137)} = 8.84$, $p < 0.001$ |
| Hospitalisation | 1.32 (1.88) | 0.42 (0.71) | / | Mann-Whitney $U = 1{,}082.50$, $p = 0.001$, Cohen's $d = 0.64$ |
| GAD-7 | 7.65 (5.66) | 12.27 (5.28) | 1.53 (2.06) | Kruskal-Wallis $\chi^2_{(2)} = 59.20$, $p < 0.001$, $\varepsilon^2 = 0.42$ |
| CDSS | 3.57 (3.41) | 11.14 (5.30) | 0.63 (1.13) | Kruskal-Wallis $\chi^2_{(2)} = 81.57$, $p < 0.001$, $\varepsilon^2 = 0.57$ |
| **Belief** | | | | |
| Conviction | 3.32 (0.77) | 3.30 (0.66) | 3.00 (0.53) | Kruskal-Wallis $\chi^2_{(2)} = 6.86$, $p = 0.032$, $\varepsilon^2 = 0.05$ |
| Preoccupation | 2.26 (1.17) | 2.27 (1.04) | 1.03 (0.64) | Kruskal-Wallis $\chi^2_{(2)} = 29$, $p < 0.001$, $\varepsilon^2 = 0.17$ |
| Distress | 2.43 (1.11) | 3.26 (0.65) | 1.48 (1.15) | Kruskal-Wallis $\chi^2_{(2)} = 43.72$, $p < 0.001$, $\varepsilon^2 = 0.25$ |

*Standard deviations are in parentheses. WAIS-III, Sum of Scaled Scores from the Short Form of Wechsler Adult Intelligence Scale-III; GAD-7, Generalised Anxiety Disorder 7-item Scale; CDSS, Calgary Depression Scale for Schizophrenia.*

the Control group ($p < 0.05$), it was negatively correlated with belief flexibility (on MADS only) in the Delusion group ($ps < 0.05$). All correlation coefficients between flexibility indices in the Depression group were small-to-moderate and non-significant.

## DISCUSSION

The current study compared flexibility indices in patients with delusions, patients with depression, and healthy controls. We found that:

1. Compared to healthy controls, cognitive flexibility was reduced in both the Delusion group and the Depression group.
2. The three groups did not differ in explanatory flexibility.
3. Compared to controls and the Depression group, belief flexibility as measured by interview items was reduced in the Delusion group, but not belief flexibility as measured by the BADE task.

Our finding that both the Delusion group and the Depression group had reduced cognitive flexibility was consistent with previous studies (31), and lends support to the argument that cognitive flexibility may be generally associated with psychopathologies regardless of the diagnostic label (22–24). It is of note that the difference between clinical groups and healthy controls was no longer significant after controlling for estimated IQ. Executive functions such as updating and set-shifting that are crucial for TMT performance were shown to be also associated with fluid and crystallised intelligence (87, 88), suggesting a considerable shared variance between the two. Since general intelligence is typically lower in schizophrenia and considered a risk factor for disease (89–91), the extent to which such shared variance also overlaps with a genuine effect of the psychopathology remains speculative.

Our hypothesis about explanatory flexibility was partially supported. The comparable levels of explanatory flexibility between the Delusion group and the Depression group replicated Silverman and Peterson (38). As patients with psychotic depression were excluded from this study, and the Delusion group had a low CDSS score, the compromised explanatory flexibility in the Delusion group cannot be explained by depressive symptoms. Therefore, our results added to the accumulating evidence that explanatory flexibility is not unique to MDD but can be seen in other disorders as well. However, while the level of explanatory flexibility in our Depression group fell within the range of other MDD samples (39, 40), our healthy controls manifested a comparable level of explanatory flexibility, too. This initial finding, which potentially suggests non-specificity of explanatory flexibility, warrants further testing using a larger sample.

With regard to belief flexibility as measured by the clinical interview, we compared the responses based on delusions in the Delusion group, negative thinking in the Depression group, and a negative and personally significant belief for the healthy controls. Results on PM and RTHC were different. This was consistent with previous research (46, 92), suggesting that RTHC might rely on a different, if not deeper, level of reflections than PM. Even on such a stringent test using idiosyncratic beliefs that are salient to the individual participants, the Delusion group still manifested the lowest belief flexibility on two of the three MADS variables. While inflexible thinking has been studied in depression literature [e.g., (14, 37, 93)], to our knowledge, this was the first study that directly compared

**TABLE 3 |** Means and SDs of flexibility indices.

| | Delusion | | | Depression | | | Control | | | Group Comparisons | *post-hoc* pairwise comparisons |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***N*** | **M** | **SD** | ***N*** | **M** | **SD** | ***N*** | **M** | **SD** | | |
| **Cognitive flexibility** | | | | | | | | | | | |
| TMT B-A | 54 | 49.64 | 34.59 | 52 | 48.50 | 29.29 | 30 | 32.30 | 18.86 | Kruskal-Wallis $\chi^2_{(2)} = 10.13$, $p = 0.006$, $\varepsilon^2 = 0.08$ | Delusion less flexible than Control, Depression less flexible than Control |
| **Explanatory flexibility** | | | | | | | | | | | |
| ASQ | 55 | 1.45 | 0.50 | 56 | 1.45 | 0.63 | 29 | 1.44 | 0.54 | $F_{(2,137)} = 0.01$, $p = 0.995$ | |
| **Belief flexibility** | | | | | | | | | | | |
| **PM** | | | | | | | | | | $\chi^2_{(2,142)} = 5.31$, $p = 0.070$ | |
| Inflexible | 32 | | | 29 | | | 9 | | | | |
| Flexible | 24 | | | 28 | | | 20 | | | | |
| **RTHC** | | | | | | | | | | $\chi^2_{(2,141)} = 17.14$, $p < 0.001$ | Delusion less flexible than Depression and Control |
| Inflexible | 46 | | | 33 | | | 11 | | | | |
| Flexible | 10 | | | 23 | | | 18 | | | | |
| **AE** | | | | | | | | | | $\chi^2_{(2,141)} = 8.76$, $p = 0.013$ | Delusion less flexible than Control |
| Inflexible | 36 | | | 27 | | | 9 | | | | |
| Flexible | 20 | | | 29 | | | 20 | | | | |
| BADE Dif | 45 | 23.19 | 23.62 | 55 | 16.39 | 16.95 | 30 | 22.32 | 17.51 | Kruskal-Wallis $\chi^2_{(2)} = 2.73$, $p = 0.255$, $\varepsilon^2 = 0.02$ | |

*TMT, Trail-Making Test; ASQ, standard deviation for negative events on the Attributional Style Questionnaire; PM, possibility of being mistaken; RTHC, reaction to hypothetical contradiction; AE, alternative explanation; BADE, Bias Against Disconfirmatory Evidence Task; Dif, difference score; EI, evidence integration; CV, conservatism. Pairwise comparions were Bonferroni corrected.*

**TABLE 4 |** Correlations between flexibility indices within each group.

| | **All (*N* = 143)** | | **Delusion (*N* = 56)** | | **Depression (*N* = 57)** | | **Control (*N* = 30)** | |
|---|---|---|---|---|---|---|---|---|
| | **TMT** | **ASQ** | **TMT** | **ASQ** | **TMT** | **ASQ** | **TMT** | **ASQ** |
| ASQ | 0 | / | 0.22 | / | −0.13 | / | −0.23 | / |
| PM | −0.14 | −0.21 | −0.13 | −0.46** | −0.01 | −0.14 | −0.17 | 0.06 |
| RTHC | −0.18 | −0.13 | −0.12 | −0.04 | 0.03 | −0.19 | −0.50* | −0.22 |
| AE | −0.30** | −0.19 | −0.24 | −0.37* | −0.30 | −0.12 | −0.24 | −0.10 |
| BADE Dif | −0.21* | 0.08 | −0.24 | −0.07 | −0.11 | 0.10 | −0.39* | 0.37* |

*Pearson correlations (without Bonferroni correction) were reported among BADE, ASQ, and TMT, whereas biserial correlation among PM, RTHC, AE, ASQ, and TMT. TMT, Trail-Making Test difference score; ASQ, standard deviation for negative events on the Attributional Style Questionnaire; PM, possibility of being mistaken; RTHC, reaction to hypothetical contradiction; AE, alternative explanation; BADE, Bias Against Disconfirmatory Evidence Task; Dif, difference score; EI, evidence integration; CV, conservatism; *, p< 0.05. **, p< 0.01.*

individuals with psychotic delusions with individuals with MDD. Our finding lends support to the specificity of belief flexibility (measured on MADS) to patients with delusions. Our finding was consistent with our recent treatment trial (62) where change in belief flexibility did not moderate improvement in depression. However, the BADE difference score appeared to be smaller in the Depression group than the other two groups (albeit not statistically significant), which raises the possibility that the Depression group may be less flexible on the BADE task. Together with Everaert et al. (55), which found a similar pattern in a community sample, the possibility that individuals with depression may have reduced belief flexibility (although not as low as individuals with delusions) cannot be completely ruled out and is worth further investigation.

We explored the associations between flexibility constructs, which should be interpreted with caution, given the small group sizes. We found that higher cognitive flexibility was associated with higher belief flexibility, especially in the control group. Such association was consistent with Eifler et al. (59) and Riccaboni et al. (60). Since the association was evident for both interview and standardised task measures of belief flexibility, it is not likely to be an artefact of the nature of the task. As argued by Baddeley (94) and Banich (95), effortful modulation of mental processes (as opposed to autonomous, routine ones) may require activation of executive functioning. Such correlation was weaker (and not significant) in the clinical groups, which could possibly be attributed to the poorer cognitive flexibility in these groups. The hypothesis that cognitive flexibility might underlie other forms of flexibility was not fully supported, as cognitive flexibility was not associated with explanatory flexibility across groups. The association between explanatory flexibility and belief flexibility was equivocal, with a positive association manifested in the Control group, and a negative association in the Delusion group. What explanatory flexibility entails remains unclear. On the one hand, there is preliminary evidence that explanatory flexibility decreases when the negative mood is induced, leading to the argument that explanatory flexibility may be a result of a negative mood state (34, 40). On the other hand, the way explanatory flexibility is measured (i.e., standard deviation of ASQ item responses) may reflect participants' extreme responding and jumping-to-conclusions tendencies, which are particularly marked among patients with delusions and have been shown to be associated with lack of belief flexibility (12, 13, 42). Further research on explanatory flexibility will enhance our understanding of this construct and its role in making (re-)appraisals across psychiatric groups.

There are several limitations to the study. Firstly, the sample sizes were unequal, which might compromise the statistical power and lead to a type II error (96). We chose tests less impacted by unequal group sizes, but the results await replication. Secondly, this was a cross-sectional study, leading to no causality findings of the relationship between flexibility and diagnosis or symptoms. Longitudinal research would further shed light on whether flexibility, or in this case the lack thereof, leads to, perpetuates, results from, or only co-occurs with any single symptom or a particular diagnosis. Thirdly, we included the most commonly used measures of flexibility, which led to an imbalance in the number of measures across flexibility constructs. In particular, even though the TMT task is widely used to measure flexibility, this task is dependent upon motor speed function, which is affected in these disorders. It is unsure whether including another measure of cognitive flexibility, such as the Wisconsin card sorting task, would further strengthen the investigation. Our results cannot be generalisable to other measures of flexibility. Lastly, since we only included patients with schizophrenia-spectrum disorders and patients with major depressive disorder, how these flexibility constructs compare across other psychiatric groups remain to be tested.

This was the first empirical study investigating cognitive flexibility, explanatory flexibility, and belief flexibility across psychiatric groups, in comparison with a non-clinical group. We found an effect of clinical status on the more fundamental level of flexibility, which might be confounded by the group difference in estimated intelligence. Reduced belief flexibility tended to be shown in patients with delusions only, calling for more research on its specificity.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Joint Chinese University of Hong Kong - New Territories East Cluster Clinical Research Ethics Committee and the New Territories West Cluster Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

CZ and SS contributed to the study design. CZ came up with the first draft of the manuscript, which was reviewed and approved by all authors. All authors contributed to data collection and analysis.

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# Cognitive Biases Questionnaire for Psychosis (CBQp): Spanish Validation and Relationship With Cognitive Insight in Psychotic Patients

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**Introduction:** Cognitive biases are key factors in the development and persistence of delusions in psychosis. The Cognitive Biases Questionnaire for Psychosis (CBQp) is a new self-reported questionnaire of 30 relevant situations to evaluate five types of cognitive biases in psychosis. In the context of the validation of the Spanish version of the CBQp, our objectives were to (1) analyze the factorial structure of the questionnaire with a confirmatory factor analysis (CFA), (2) relate cognitive biases with a widely used scale in the field of delusion cognitive therapies for assessing metacognition, specifically, Beck's Cognitive Insight Scale (BCIS) (1), and, finally, (3) associate cognitive biases with delusional experiences, evaluated with the Peters Delusions Inventory (PDI) (2).

**Materials and Methods:** An authorized Spanish version of the CBQp, by a translation and back-translation procedure, was obtained. A sample of 171 patients with different diagnoses of psychoses was included. A CFA was used to test three different construct models. Associations between CBQp biases, the BCIS, and the PDI were made by correlation and mean differences. Comparisons of the CBQp scores between a control group and patients with psychosis were analyzed.

**Results:** The CFA showed comparative fit index (CFI) values of 0.94 and 0.95 for the models with one, two, and five factors, with root mean square error of approximation values of 0.031 and 0.029. The CBQp reliability was 0.87. Associations between cognitive biases, self-certainty, and cognitive insight subscales of the BCIS were found. Similarly, associations between total punctuation, conviction, distress, and concern subscales of the PDI were also found. When compared with the group of healthy subjects, patients with psychoses scored significantly higher in several cognitive biases.

**Conclusion:** Given the correlation between biases, a one-factor model might be more appropriate to explain the scale's underlying construct. Biases were associated with a greater frequency of delusions, distress, conviction, and concern as well as worse cognitive insight in patients with psychosis.

**Keywords: cognitive bias, psychosis, delusion, cognitive insight, self-certainty**

## INTRODUCTION

Cognitive biases are involved in the development and persistence of delusions (3–5). They occupy a central place in recent biopsychosocial models of psychosis (4, 6–8), both in terms of the content of thought (9, 10) and in the processes of reasoning and meta-cognition (4, 11). Cognitive and training therapies in metacognition base their active principle of intervention regarding delusions on the modification of cognitive biases (12). Metacognitive training decreases cognitive biases and improves positive symptomatology in psychosis (13–19).

People with delusions tend to show different reasoning biases. The most researched biases are jumping to conclusions (JTC) (3, 4, 20), attributional biases (21, 22), inflexibility in beliefs, and theory of mind deficits (ToM) (3, 23).

The JTC bias in patients implies that they tend to consider fewer data to arrive at a decision than healthy controls (23, 24), which has been observed in between one-third and two-thirds of subjects with delusions (4, 25–28).

JTC has also been found in healthy subjects with delusion-like experiences (28), subjects at high risk of suffering from psychosis (29), subjects with active psychotic symptoms at the time of evaluation (4), and in a more attenuated manner in psychotic patients' relatives (28, 30). Colbert and Peters (31) and Ross et al. (32) also found a significant presence of JTC in healthy people prone to delusions.

The results of a meta-analysis imply that JTC supposes an increase in the probability of the appearance of delusions in psychosis (33). This bias was found in people with psychosis who tended to look for less evidence when making decisions and who used more "extreme responses" when compared with both healthy subjects and subjects with other mental illnesses different from psychosis. The meta-analysis likewise concludes that there is an inverse relationship between data search and the severity of delusions.

Another meta-analysis implies that JTC would not be a transdiagnostic phenomenon of psychosis (34). It is specifically associated with delusions rather than with the diagnosis of schizophrenia and may contribute to its severity (35). Therefore, JTC is a stable feature that increases the vulnerability to the development of delusions and can predict the changes over time (36).

On the other hand, regarding attribution biases, some studies show evidence of an externalization–personalization bias for negative events in people with persecution delusions in comparison with healthy controls (37–40). Patients with symptoms of paranoia have a greater personalization bias for negative events than patients without these symptoms, and this bias is still evident in remission phases (41).

A review article concludes that deficits in ToM may be characteristic of schizophrenia because, despite being found in patients with delusions, they seem to be more strongly associated with negative and disorganized symptoms than specifically with delusions (23).

Although emotional-type biases have been associated with psychotic thinking (8, 42), few studies have linked Beck's described biases for emotional disorders with psychotic symptoms. Nonetheless, biases such as dichotomous thinking, emotional reasoning, and catastrophising have been associated with delusional symptomatology (4, 8).

Despite associations of internal emotional states with delusions, until the appearance of the Cognitive Biases Questionnaire for Psychosis (CBQp) (18), there was no scale to specifically measure Beck's biases in patients with psychosis.

The CBQp (18) was developed to assess cognitive biases in psychosis. It is based on the Blackburn Cognitive Styles Test (43), which was designed to assess common cognitive distortions in depression and amended to provide appropriate scenarios for psychotic patients. For the validation of the CBQp, the structure, validity, and reliability of the scale was analyzed in a group of subjects with psychosis. The CBQp scores were compared with those of depressed subjects and healthy controls. The results showed adequate internal consistency and test–retest reliability. The items of the scale had a bifactorial structure, implying that the five cognitive biases would not be independent. This result suggests the possibility that the CBQp evaluates a general thinking bias rather than different cognitive errors. The scores obtained in the anomalous perception (AP) and threatening events (TE) themes could be independently used.

Subjects with psychosis and those with depression obtained higher total CBQp scores than healthy controls (18). Subjects with active psychotic symptoms at the time of the evaluation obtained higher scores than the asymptomatic subjects, showing modest associations between the CBQp scores, and the severity of symptoms. The scores obtained in the theme of AP and the intentionalizing (Int) bias suggest some specificity in psychosis. The underlying construct of the CBQp could be specifically related to interpretation bias, not being associated with reasoning, judgement, or decision-making processes (18).

Catastrophising (Cat) and JTC biases predict delusional experiences not only in subjects with schizophrenia but also in healthy subjects. In subjects diagnosed with schizophrenia, the Cat bias was the best predictor of the total severity index of delusions (measured by the PSYRATS), while the cognitive dimension of these delusions was specifically related to JTC (44).

Furthermore, Daalman et al. (45) compared clinical and healthy voice-hearers with controls, finding that most cognitive biases prevalent in clinical voice-hearers, particularly with threatening event themes, were absent in healthy voice-hearers, except for emotional reasoning which may be specifically related to the vulnerability to develop auditory verbal hallucinations (45).

Another recent study evaluated the impact of metacognitive training (MCT) on cognitive biases in people diagnosed with schizophrenia, finding improvements in the Cat, emotional reasoning (ER), and JTC biases, with an important impact on the CBQp total score (46). These results suggest that one of the first objectives of metacognitive training, to reduce cognitive biases (12), was reached in this sample of chronic patients (46). The results of a recent study with an MCT and psychoeducation intervention in recent-onset psychosis imply the usefulness of the CBQp to detect improvements in cognitive biases (47).

Similarly, another study investigated the relationship between cognitive biases and the cognitive and emotional dimensions of delusions in patients with schizophrenia spectrum disorders, controlling confounding variables such as hallucinations (48). The results show that the JTC bias was associated with both the delusion conviction and the associated emotional discomfort. Only the emotional discomfort associated with auditory hallucinations was related to dichotomous thinking (DT) and Int biases. These results are consistent with previous results that found that JTC, measured by the CBQp, was related not only to clinical delusions but also to a non-clinical propensity to delusions (44).

All of these data support the idea that JTC may be relevant throughout the different stages of delusion formation (32, 33) and could be a vulnerability–trait factor that could increase the risk of developing delusional experiences (44, 49, 50).

This study translated to Spanish the Cognitive Biases Questionnaire for Psychosis. Our objectives were to obtain the psychometric properties of the Spanish version of the CBQp, specifically to (1) analyze the factorial structure of this questionnaire and obtain the descriptive statistics of each dimension for patients with psychosis and controls, (3) obtain the reliability for internal consistency for each scale, (4) relate cognitive biases with a widely used scale in the field of delusion cognitive therapies for assessing metacognition, specifically Beck's Cognitive Insight Scale (1), and (5) associate cognitive biases with delusional experiences evaluated with the Delusions Inventory (PDI) (2).

# METHODOLOGY

## Participants and Procedures

This study had a cross-sectional design with a comparison group based on cases and controls matched for sex and age.

The validation of the CBQp was carried out in several stages. Authorization for the Spanish adaptation of the CBQp (18) was obtained from the authors (Peters E, personal communication, 2013). The linguistic and cultural adaptation of the scale was carried out using the methodology of direct and inverse translation (translation–back-translation) (51). To test the scale structure of the Spanish version of the CBQp, the questionnaire was administered to a sample of patients. The patient sample consisted of 171 subjects with psychosis, of whom 103 (60.23%) were men. The participants were outpatients (58%) and inpatients (42%). They were recruited from three main sites: Hospital Universitari Institut Pere Mata (Reus), Parc Tauli Hospital Universitari (Sabadell), and Parc Sanitari Sant Joan de Déu (Barcelona). Regarding the diagnoses, 84 (48.8%) participants were diagnosed with schizophrenia, 39 (22.9%) had an unspecified psychotic disorder, 28 (16.5%) had schizoaffective disorder, seven (4.1%) had schizophreniform disorder, six (3.5%) had bipolar disorder, four (2.4%) had brief psychotic disorder, and three (1.8%) had delusional disorder. There was no significant difference in age between male ($M = 32.44$, SD $= 10.82$) and female participants ($M = 32.88$, SD $= 11.43$) [$t\ (169) = 0.25$, $p = 0.797$].

Subsequently, to establish comparisons, the CBQp was administered to a group of patients and healthy subjects. To ensure that the group of patients and healthy subjects were matched by sex and age, a subsample of 157 patients, of whom 95 (60.5%) were men, was compared with the group of controls with 30 participants. A control group of 30 voluntary participants, of whom 17 (56.7%) were men, who had no diagnosed psychiatric disorder, was recruited from the community (Tarragona, Cataluña). No significant differences were found in terms of age between men ($M = 31.71$, SD $= 6.70$) and women ($M = 32.77$, SD $= 7.65$; $p = 0.405$). No significant differences were found in terms of sex between the two groups ($\chi^2 = 0.155$; $p = 0.694$). Information on the participants is reported in **Table 1**.

The CBQp was administered together with the Beck Cognitive Insight Scale (BCIS) (1) and the Peters Delusions Inventory (2) to the Institut Pere Mata patients' group. BCIS was administered to both outpatients and inpatients, while PDI was only assessed in the inpatient sample (**Figure 1**).

All procedures were in accordance with the Declaration of Helsinki. Ethical approval was obtained from the local ethics committee (CEIm IISPV, www.iispv.cat). All the subjects consented to participate in the study and signed an informed consent form after a complete explanation of all procedures.

## Instruments

The CBQp (18) has a self-applied format with 30 descriptions of everyday situations, 15 on AP and 15 on TE, in which the subject must choose between three options that best describe how he or she would think about that situation. Each group of statements covers five cognitive biases: Int, Cat, DT, JTC, and ER. There are three statements per bias for each topic. Each vignette includes a forced choice on a three-point scale (1 = absence of bias, 2 = presence of bias with some qualification, 3 = presence of bias). The subject must imagine himself or herself in each situation and choose one of the three possible answers. Cronbach's alpha of the total CBQp was 0.89. The test–retest was 0.94 for the psychosis group and 0.70 for the healthy controls (18).

The BCIS (1) is a 15-item self-registration measure that assesses how patients evaluate their own judgement. It consists

**TABLE 1 |** Demographic information for the samples.

| Groups | Psychosis CFA | Control vs. Psychosis: Controls | Control vs. Psychosis: Psychosis | Psychosis PDI | Psychosis BCIS: Low CI | Psychosis BCIS: High CI |
|---|---|---|---|---|---|---|
| *N* | 171 | 30 | 157 | 50 | 45 | 43 |
| Gender (n) (%) | 103M (60.2%) | 17M (56.7%) | 97M (39.5%) | 30M (60%) | 23M (51.1%) | 31M (73.8%) |
| | 68F (39.8%) | 13F (43.3%) | 62F (60.5%) | 20F (40%) | 22F (48.9%) | 11F (26.2%) |
| | | $p = 0.694$ | | | $p = 0.029$ | |
| Age in years (mean, SD) | | 32.17 (7.02) 33.01 (11.32) | | | | |
| All | | $p = 0.594$ | | | | |
| M | 32.44 (10.82) | 31.71 (6.70) | 33.04 (10.97) | 37.07 (10.15) | 32.28 (11.51) | 32.71 (11.29) |
| F | 32.88 (11.43) | 32.77 (7.65) | 32.95 (11.92) | 37.30 (12.44) | 36.02 (12.59) | 30.18 (12.64) |
| | $P = 0.445$ | $p = 0.405$ | $p = 0.961$ | $p = 0.942$ | $p = 0.152$ | $p = 0.540$ |

*M, Male; F, Female; CFA, Confirmatory Factor Analysis; PDI, Peters Delusion Inventory; BCIS, Beck Cognitive Insight Scale; CI, Cognitive Insight.*

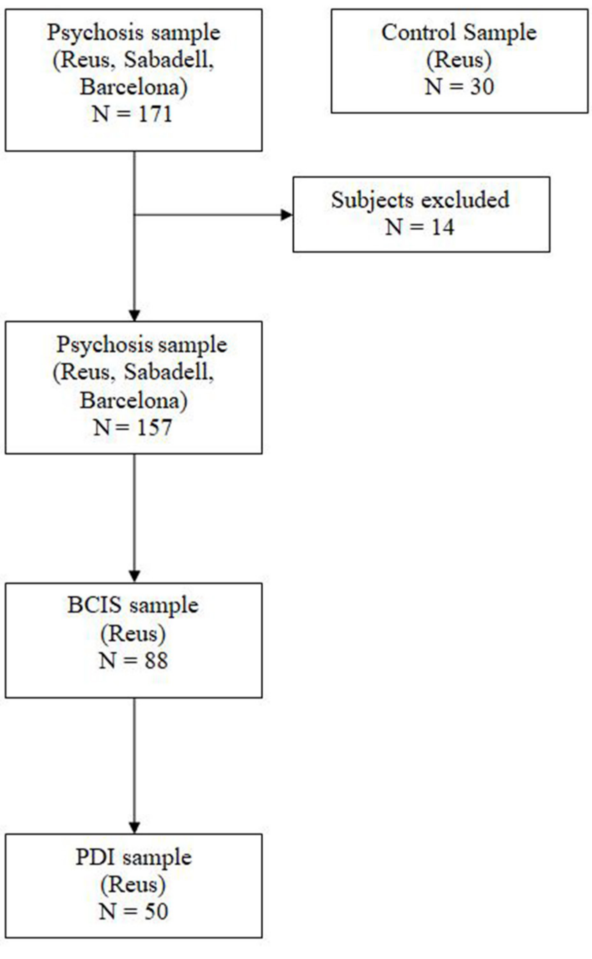


**FIGURE 1 |** Sample selection.

of two dimensions: self-reflectiveness (R) (nine items) and self-certainty (C) (six items). A composite index of cognitive insight is obtained as reflectiveness–certainty (IC = R—C) (subtraction of self-certainty from self-reflectiveness). The Cronbach coefficients of the self-reflectiveness and self-certainty for patients were 0.68 and 0.60, respectively (1). The internal consistency for the Spanish version of the BCIS was 0.59 for self-reflectiveness and 0.62 for self-certainty. The intraclass correlation coefficients of test–retest reliability were 0.69 for self-reflectiveness, 0.72 for self-certainty, and 0.70 for the composite index (52). Given that both of these subscales are composed of <10 items, the levels of internal consistency of the BCIS were considered to be acceptable for research purposes (53, 54), even though both coefficients were less than the 0.70 value recommended by Nunnally (55).

The Peters Delusion Inventory (2), with 21 items, consists of four scales to assess the presence/absence of delusional symptoms and their degree of conviction, preoccupation, and distress. For PDI, the Cronbach coefficient was 0.82. The test–retest reliability for the PDI yes/no and conviction scales was 0.78, while that for the distress and preoccupation scales was 0.81 (2). The Spanish version of the PDI had a Cronbach coefficient of 0.75 (56).

## Statistical Analysis

The psychometric properties of the scale structure, reliability, and validity of the Spanish version of the CBQp were analyzed:

1. Confirmatory factor analysis (CFA) was used to evaluate three alternative models of the scale construct, *i.e.*, a five-factor model hypothesizing that each factor represents a separate bias, a two-factor model in which each factor represents a theme (AP and TE), and, finally, a one-factor model in which a general thinking bias underlies the five types of cognitive biases. For the CFA, the sample size was estimated to be five participants per item (30 items), with a necessary sample of at least 150 participants (57, 58). We used the weighted least square mean and variance adjusted estimation method, which is a robust estimator that does not assume normality and is the best option for modeling categorical or ordered data (59). To estimate the goodness of fit of the CFA, the estimators root mean square error of approximation (RMSEA), CFI, Tucker–Lewis index (TLI), and standardized root mean residual square (SRMR) were used according to the criteria of Hu and Bentler (60). Akaike's information criteria (AIC) (61) and Bayesian information criteria

(BIC) (62) were also used to select the best model according to information criteria.

2. Analysis of the internal consistency to test the reliability of the CBQp scale was performed by means of Cronbach's alpha and composite reliability.

3. Several scales had a non-normal distribution. Differences between two groups of patients, based on the highest and the lowest scores according to the mean on the BCIS, and between samples (psychotic and healthy groups) were analyzed for the CBQp scales through the Mann–Whitney $U$-test, which is robust to non-normality. Comparisons between groups in terms of sex and age were carried out by $\chi^2$ and Student's $t$-test, respectively. Spearman's rho correlations were used to evaluate the association between themes and biases of CBQp and the BCIS and PDI scales.

The CFA and reliability calculations were conducted with the lavaan package (63) running under R 3.6.0 software, and the mean differences and correlations were conducted with SPSS v.23.

# RESULTS

## Scale Factor Structure

The statistics for the factorial model of the CBQp of one, two (TE and AP), and five factors (Int, Cat, DT, JTC, and ER) are shown in **Table 2**. Although somewhat better for the five-factor model (CFI = 0.952, TLI = 0.948, RMSEA = 0.029, SRMR = 0.093, AIC = 8846.898, and BIC = 9066.815), the adjustment indices were also good and similar in the one-factor (CFI = 0.947, TLI = 0.943, RMSEA = 0.031, SRMR = 0.096, AIC = 8852.954, and BIC=9041.454) and two-factor models (CFI = 0.947, TLI = 0.943, RMSEA = 0.031, SRMR = 0.096, AIC = 8853.346, and BIC = 9044.987). The factors had significant positive correlations ($r_s = 0.66$, $p < 0.001$) when analyzed as themes, with the association between biases in the range of 0.34–0.78 ($p < 0.001$). The item factor loadings in each of the three models are presented in **Table 3**. Items 9, 19, and 27 had a factor loading < 0.3.

## Reliability

Cronbach's alpha was 0.87 for the total scale (30 items), 0.76 for the AP scale (15 items), and 0.78 (15 items) for the TE scale. The composite reliability was 0.92 for the total scale and 0.86 for both the AP and TE scales.

## Validity

### Comparisons Between Patient and Control Samples

The descriptive statistics for the group of patients and the controls are shown in **Table 4**. The Mann–Whitney $U$-test showed that the group with psychosis had a higher score than the control group in the total score of the CBQp (Mdn = 41/Mdn = 38, $U$ = 1,705, $p = 0.017$), TE (Mdn = 21/Mdn = 20, $U$ = 1,826, $p = 0.051$), AP (Mdn = 20/Mdn = 18, $U$ = 1,725.5, $p = 0.020$), Int (Mdn = 7/Mdn = 7, $U$ = 1,758, $p = 0.024$), DT (Mdn = 8/Mdn = 7, $U$ = 1,655, $p = 0.009$), and ER (Mdn = 8/Mdn = 7, $U$ = 1,638, $p = 0.006$). The TE theme (Mdn = 21/Mdn = 20, $U$ = 1,826, $p = 0.051$) maintained a trend toward statistical significance.

### Comparison Between Groups Based on Cognitive Insight

The difference between the groups when the total sample was divided into a group with an equal or higher score than the mean and a group with a score below the mean on the Cognitive Insight Scale ($M$ = 6.42) (BCIS) is shown in **Table 5**. The Mann–Whitney $U$-test showed that the group with lower insight had a higher score than the group with higher insight in the total score of the CBQp (Mdn = 44/Mdn = 39, $U$ = 631.5, $p = 0.005$), TE (Mdn = 22/Mdn = 20, $U$ = 664.5, $p = 0.011$), AP (Mdn = 20/Mdn = 19, $U$ = 642, $p = 0.006$), Int (Mdn = 8/Mdn = 7, $U$ = 685.5, $p = 0.015$), Cat (Mdn = 9/Mdn = 8, $U$ = 653, $p = 0.008$), and JTC (Mdn = 10/Mdn = 9, $U$ = 636, $p = 0.005$). There were no differences between the groups according to the level of cognitive insight in the DT (Mdn = 9/Mdn = 8, $U$ = 777.5, $p = 0.107$) and ER (Mdn = 8/Mdn = 8, $U$ = 778.5, $p = 0.108$) biases.

### Correlations Between CBQp Scores and BCIS and PDI Scales

The significant correlations between the CBQp and the BCIS and PDI scales are shown in **Table 6**. A positive association was obtained between self-certainty and both themes, all the biases, and the total score of the CBQp: TE ($r_s = 0.30$, $p < 0.01$), AP ($r_s = 0.34$, $p < 0.01$), Int ($r_s = 0.40$, $p < 0.001$), Cat ($r_s = 0.23$, $p < 0.05$), DT ($r_s = 0.22$, $p < 0.05$), JTC ($r_s = 0.21$, $p < 0.05$), ER ($r_s = 0.30$, $p < 0.01$), and total score ($r_s = 0.35$, $p < 0.01$). The two themes and biases of the CBQp showed negative associations with the Cognitive Insight Scale, with the exception of the DT and ER biases: TE ($r_s = -0.26$, $p < 0.05$), AP ($r_s = -0.26$, $p < 0.05$), Int ($r_s = -0.30$, $p < 0.01$), Cat ($r_s = -0.28$, $p < 0.01$), and JTC ($r_s = -0.22$, $p < 0.05$). Similarly, the total CBQp score was negatively associated with cognitive insight ($r_s = -0.28$, $p < 0.01$). The self-reflectiveness scale of the BCIS only showed an association with the catastrophising bias of the CBQp ($r_s = -0.25$, $p < 0.05$). All the scales of the CBQp correlated positively with the scales of the PDI, with the exception of the Int bias. The highest correlations were obtained between the total score of the CBQp, AP, and Cat and the frequency of delusions, with the range of associations from 0.50 to 0.58 ($p < 0.001$).

# DISCUSSION

The objective of this study was to validate the Spanish version of the CBQp questionnaire in a sample of patients with psychosis. For this, the factorial structure of the different models of the underlying construct in cognitive biases was analyzed. We aimed to obtain the reliability of the scale and the relationship of the biases with the BCIS for evaluating patients' metacognitive capacity and a widely used scale in the field of cognitive therapy for delusions. Finally, we analyzed the relationship between the biases and the PDI scale, an instrument to assess the

**TABLE 2 |** Goodness of Fit for the Confirmatory Factor Analysis (CFA) (Psychosis group) ($N = 171$).

| CBQp | CFI | TLI | RMSEA | SRMR | AIC* | BIC* |
|---|---|---|---|---|---|---|
| 1-factor model | 0.947 | 0.943 | 0.031 (0.015–0.042) | 0.096 | 8852.954 | 9041.454 |
| 2-factor model | 0.947 | 0.943 | 0.031 (0.015–0.042) | 0.096 | 8853.346 | 9044.987 |
| 5-factor model | 0.952 | 0.948 | 0.029 (0.012–0.041) | 0.093 | 8846.898 | 9066.815 |

*CFI, Robust comparative fit index; RMSEA, Root mean square error of approximation; SRMR, Standardized root mean square residual; TLI, Tucker-Lewis index; AIC, Akaike's Information Criteria; BIC, Bayesian Information Criteria. *Because of the nature of both AIC and BIC, they were computed from maximum-likelihood estimations of the models.*

**TABLE 3 |** Cognitive Biases Questionnaire for Psychosis (CBQp) factor loadings from the CFA.

| | 2 Factors (Themes) | | | 5 Factors (Biases) | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 Factor | 1 (TE) | 2 (AP) | 1 (Int) | 2 (Cat) | 3 (DT) | 4 (JTC) | 5 (ER) |
| CBQ1 | 0.434 | 0.436 | – | 0.439 | – | – | – | – |
| CBQ2 | 0.432 | – | 0.436 | – | 0.426 | – | – | – |
| CBQ3 | 0.660 | – | 0.667 | 0.669 | – | – | – | – |
| CBQ4 | 0.588 | 0.593 | – | – | 0.578 | – | – | – |
| CBQ5 | 0.328 | 0.331 | – | – | – | 0.386 | – | – |
| CBQ6 | 0.578 | – | 0.584 | – | – | – | 0.575 | – |
| CBQ7 | 0.590 | 0.593 | – | – | 0.578 | – | – | – |
| CBQ8 | 0.737 | – | 0.744 | – | – | – | – | 0.790 |
| CBQ9 | 0.261 | 0.264 | – | – | – | – | 0.265 | – |
| CBQ10 | 0.469 | – | 0.473 | – | 0.463 | – | – | – |
| CBQ11 | 0.536 | 0.540 | – | – | – | 0.621 | – | – |
| CBQ12 | 0.711 | 0.717 | – | – | 0.696 | – | – | – |
| CBQ13 | 0.526 | 0.529 | – | – | – | – | – | 0.564 |
| CBQ14 | 0.513 | – | 0.517 | – | – | 0.585 | – | – |
| CBQ15 | 0.564 | 0.568 | – | – | – | 0.648 | – | – |
| CBQ16 | 0.570 | – | 0.575 | – | – | – | – | 0.612 |
| CBQ17 | 0.436 | – | 0.442 | – | – | – | 0.433 | – |
| CBQ18 | 0.726 | 0.731 | – | – | – | – | 0.723 | – |
| CBQ19 | 0.262 | 0.263 | – | – | – | – | – | 0.285 |
| CBQ20 | 0.648 | – | 0.654 | 0.654 | – | – | – | – |
| CBQ21 | 0.479 | – | 0.482 | – | – | – | 0.479 | – |
| CBQ22 | 0.580 | 0.584 | – | 0.587 | – | – | – | – |
| CBQ23 | 0.450 | – | 0.453 | 0.455 | – | – | – | – |
| CBQ24 | 0.794 | 0.800 | – | – | – | – | – | 0.852 |
| CBQ25 | 0.802 | – | 0.810 | – | 0.786 | – | – | – |
| CBQ26 | 0.447 | – | 0.450 | – | – | – | – | 0.480 |
| CBQ27 | 0.212 | – | 0.213 | – | – | 0.246 | – | – |
| CBQ28 | 0.443 | 0.446 | – | 0.448 | – | – | – | – |
| CBQ29 | 0.571 | 0.576 | – | – | – | – | 0.571 | – |
| CBQ30 | 0.525 | – | 0.529 | – | – | 0.598 | – | – |

*TE, threatening events; AP, anomalous perceptions; Int, intentionalising; Cat, catastrophising; DT, dichotomous thinking; JTC, jumping to conclusions; ER, emotional reasoning.*

degree of conviction, preoccupation, and distress produced by delusional symptoms.

Related to the factor structure of the CBQp, our results imply that the three factorial solutions had a good fit. In the study with the original version of the scale, the two- and five-factor models did not fit the data if independence was assumed in the factors (18). With related factors, the two-factor model best fit the underlying structure of the scale, suggesting that the scores of the themes could be used separately. In the Spanish version of the CBQp, we obtained a significant association between the themes and between the biases. Given the extremely high between-factor correlations in the two-factor and five-factor models and the relatively small differences in fit, the principle of parsimony leads us to choose the one-factor model as the best model explaining the data. A one-dimensional model of the scale's construct would be more parsimonious. Our results

**TABLE 4 |** CBQp differences between patients with psychosis and controls.

| CBQp | Psychosis (*N* = 157) | | Control (*N* = 30) | | *z* | *p* |
|---|---|---|---|---|---|---|
| | Mdn | M (sd) | Mdn | M (sd) | | |
| Total score | 41 | 43.17 (8.90) | 38 | 38.90 (3.90) | −2.396 | 0.017 |
| Threatening events (TE) | 21 | 22.25 (4.96) | 20 | 20.07 (2.11) | −1.954 | 0.051 |
| Anomalous perceptions (AP) | 20 | 20.92 (4.51) | 18 | 18.83 (2.27) | −2.331 | 0.020 |
| Intentionalising (Int) | 7 | 7.82 (1.87) | 7 | 6.93 (0.94) | −2.265 | 0.024 |
| Catastrophising (Cat) | 8 | 8.67 (2.26) | 8 | 8 (1.46) | −1.195 | 0.232 |
| Dichotomous thinking (DT) | 8 | 8.50 (2.23) | 7 | 7.33 (0.92) | −2.628 | 0.009 |
| Jumping to conclusions (JTC) | 9 | 9.79 (2.32) | 9 | 9.23 (1.50) | −0.945 | 0.345 |
| Emotional reasoning (ER) | 8 | 8.39 (2.44) | 7 | 7.17 (1.48) | −2.762 | 0.006 |

**TABLE 5 |** CBQp scale differences between groups based on Cognitive Insight.

| CBQp | Low Cognitive Insight* (*N* = 45) | | High Cognitive Insight** (*N* = 43) | | | | |
|---|---|---|---|---|---|---|---|
| | Mdn | M (SD) | Mdn | M (SD) | Mann-Whitney U | *z* | *p* |
| CBQ total | 44 | 45.66 (10.51) | 39 | 40 (6.07) | 631.5 | −2.80 | 0.005 |
| Threatening events (TE) | 22 | 23.42 (5.62) | 20 | 20.55 (3.67) | 664.5 | −2.53 | 0.011 |
| Anomalous perceptions (AP) | 20 | 22.24 (5.36) | 19 | 19.44 (3.12) | 642 | −2.73 | 0.006 |
| Intentionalising (Int) | 8 | 8.35 (2.42) | 7 | 7.09 (1.28) | 685.5 | −2.43 | 0.015 |
| Catastrophising (Cat) | 9 | 9.33 (2.58) | 8 | 7.97 (1.59) | 653 | −2.66 | 0.008 |
| Dichotomous thinking (DT) | 9 | 8.93 (2.52) | 8 | 8.09 (1.77) | 777.5 | −1.61 | 0.107 |
| Jumping to conclusions (JTC) | 10 | 10.31 (2.66) | 9 | 8.83 (1.67) | 636 | −2.80 | 0.005 |
| Emotional reasoning (ER) | 8 | 8.73 (2.43) | 8 | 8 (2.32) | 778.5 | −1.60 | 0.108 |

**BCIS score ≥ 6.42; **BCIS score < 6.42.*

are consistent with those obtained in the validation study of the German version of the CBQp. This study showed that the one-factor model is the one with the best goodness of fit, also showing good fit for two- and five-factor models (64). As has been justified previously, the CBQp evaluates a general thinking style that underlies the cognitive biases previously recorded by Beck, with some variations depending on the type of situation (18). Thus, the different biases seem to represent a general tendency to process information in a distorted and alarming way.

The reliability (internal consistency) for the CBQp (0.87) was satisfactory and similar to the English version (0.89) (18), Flemish version (0.86) (64), and Polish version (0.83) (46). On the other hand, the reliability of the *anomalous perceptions* and *threatening events* themes, with Cronbach $\alpha$ of 0.76 and 0.78, respectively, are in a "moderate–high" range of internal consistency (65). Additionally, elevated composite reliability points to the unidimensionality of a construct. In our case, the composite reliability for the full scale was 0.92, suggesting that a single construct underlies all of the items.

Analyzing descriptive statistics, the Spanish version of the CBQp showed similar scores to those obtained with the English version, although with some slightly lower values. Thus, for cognitive biases, our scores were approximately one point lower. This difference is greater in the total score of the scale, with an average of 47.3 in the English version (18) compared to 43.19 in ours. On the other hand, a study that was carried out with a spectrum of schizophrenic patients with or without delusions obtained scores of 60.91 and 58.98, respectively (44). In the *threatening events* and *anomalous perceptions* themes, two previous studies with psychotic patients found higher scores than our validation study (18, 44). These differences between studies could be due to the distinct composition of diagnoses and/or the severity, intensity, and frequency of delusions in the samples. In our study, the analysis was not controlled for the severity of the symptomatology, so in future studies it would be necessary to recruit homogeneous samples in terms of diagnoses and the type and intensity of symptoms to establish more precise comparisons.

When compared with the healthy subjects' group, the psychotic patients scored significantly higher in the CBQp total score, in AP theme, and in all the biases, except for Cat and JTC. These results are discordant with the differences found in the English CBQp version, where all biases were significantly higher in the group of subjects with psychosis (18). In our study, the absence of differences between the patients and the control group in the TE theme and in both the Cat and JTC biases could have two explanations. First, Beck's cognitive biases were initially developed to define a depression-associated thinking

**TABLE 6 |** CBQp correlations with BCIS and PDI scales.

| CBQp | BCIS (*N* = 88) | | | PDI (*N* = 50) | | | |
|---|---|---|---|---|---|---|---|
| | Self-reflectiveness | Self-certainty | Cognitive insight | Total Yes/No | Distress | Preoccupation | Conviction |
| Total score | | 0.35** | −0.28** | 0.56*** | 0.55*** | 0.55*** | 0.58*** |
| Threatening events (TE) | | 0.30** | −0.26* | 0.53*** | 0.48*** | 0.52*** | 0.53*** |
| Anomalous perceptions (AP) | | 0.34** | −0.26* | 0.51*** | 0.56*** | 0.51*** | 0.55*** |
| Intentionalising (Int) | | 0.40*** | −0.30** | | | | |
| Catastrophising (Cat) | −0.25* | 0.23* | −0.28** | 0.52*** | 0.50*** | 0.50*** | 0.57*** |
| Dichotomous thinking (DT) | | 0.22* | | 0.35* | 0.35* | 0.35* | 0.29* |
| Jumping to conclusions (JTC) | | 0.21* | −0.22* | 0.47** | 0.50*** | 0.45** | 0.50*** |
| Emotional reasoning (ER) | | 0.30** | | 0.42** | 0.46** | 0.47** | 0.46** |

****p* < 0.001; ***p* < 0.01; **p* < 0.05.*

style, having a broad emotional component and not just a psychotic cognitive–perceptual component, which could justify the presence of these biases in a healthy population. Thus, it would have been interesting to evaluate depressive and anxiety mood in both samples to identify the subjects' tendency to a distorted thinking style due to emotional issues. In future studies, it would be necessary to control emotional variables for evaluating the specificity of these cognitive biases to psychosis. On the other hand, the number of subjects in our control sample was 30, which, although similar to the original validation study, could subtract representativeness from the comparison between patients and controls.

It should be noted that the only previous study that provides the exploration of differences between a sample of patients and controls related to CBQp scores is the validation study of Peters et al. (18). When they compared the psychosis group with a group of subjects with depression, no significant differences between the groups regarding the TE theme were obtained. Similarly, other non-intuitive results were obtained, as the cognitive biases of JTC and PD were superior in the depression group than in the psychosis group (18). These results could imply, as mentioned above, that CBQp could be assessing negative-emotionality content biases.

We would like to highlight that our validation study sample had a similar proportion of men and women. To date, few studies have analyzed the presence of sex differences concerning cognitive biases in psychosis, finding no significant differences (66, 67). However, de Vos et al. (66) suggest the possibility of a subtle effect of sex differences related to delusion-associated cognitive biases, which is necessary to carry out more extensive studies with more statistical power to detect it (65). Indeed sex differences in cognitive biases could be expected because of these biases' link to neuropsychological performance (19, 68, 69) and global functioning (70) and the previously found differences between men and women concerning these domains (71, 72). These differences have also been found in affective symptoms (72) and awareness and attribution of psychotic symptoms (73). Therefore, although our control sample's size is small, it could be representative, using similar male and female percentages to those used in the psychosis group.

To our knowledge, the association between cognitive biases (CBQp) and cognitive insight (BCIS) has not been studied. As an expected result, in our study, both the themes and the biases were related to the self-certainty dimension of the BCIS, which measures the degree of conviction in the "reality" of the delusion contents of patients, showing more self-certainty based on a greater presence of biases. Except for emotional reasoning and dichotomous thinking, all CBQp scales were associated with cognitive insight. Previous studies have also obtained results pointing out JTC's association with self-certainty (74), supporting the idea of overconfidence about one's own decisions in psychotic patients (1). On the other hand, other studies did not find any association between JTC and the BCIS scales (self-reflection, self-certainty, and cognitive insight index) (75). It should be noted that these studies used probabilistic tasks for assessing cognitive biases and not the CBQp (74, 75).

In our results, except for ER and DT, the CBQp scores were associated with cognitive insight, showing that it decreased with a greater presence of biases. Similarly, when the sample was divided into two groups concerning cognitive insight (high/low), the group with less insight showed a greater presence of cognitive biases (CBQp total score) as well as higher scores in both themes (TE and AP) and Int, Cat, and JTC biases of the questionnaire. Cognitive insight would respond to the objectivity, reflexivity, and openness of the subject to external feedback (1), suggesting a greater presence of cognitive biases and a lower personal ability to detect them, associated with low cognitive insight.

Moreover, the results supporting the improvement of cognitive biases and cognitive insight after MCT (46, 76) suggest that there may be common thought and information processing mechanisms for both mental phenomena. Specifically, several studies show JTC's decrease after MCT (17, 46, 47), sometimes by the simple fact of making the subjects aware of the presence of biases (13, 77, 78), which would go in the line of achieving adequate cognitive insight. Nevertheless, it would be necessary to continue expanding the evidence in this field, analyzing the role of cognitive biases in insight formation processes.

Regarding delusional symptoms, in our study, both themes and all biases, except intentionalizing, were associated with the PDI scales. These results suggest that not only a greater presence of delusional symptomatology but also increased concomitant conviction, concern, and distress are involved in cognitive biases. Jumping to conclusions has a similar association with both emotional and cognitive dimensions. Some authors suggest that it would be more related to delusions' conviction (4). Other authors (44, 48) also found an association between JTC and the cognitive dimension of delusions (conviction and worry). They obtained similar results concerning the emotional dimension (distress) (48), and this hypothesis was refuted in our study. Although correlations are similar, catastrophising would be associated first with the cognitive dimension of delusions (conviction) and second with the emotional dimension (distress). Similarly, the hypothesis of previous studies (79–81), which suggests that Cat is related to the distress caused by delusions, would be confirmed. In this sense, our findings delve into the idea that cognitive biases assessed by CBQp are related not only to the cognitive dimension of delusions but also to the emotional dimension. This could imply that deficits in the metacognitive components of information processing in psychosis should be assumed from the cognitive–emotional state of patients. However, some studies with CBQp found no relationship between cognitive biases and the emotional dimension of delusions (44), while others found no relationship with either dimension (48). Therefore, more evidence is needed.

In summary, the Spanish version of the CBQp has replicated the factorial model of the general thinking style construct of a tendency to process information in a distorted and alarming way. The questionnaire has excellent reliability. The themes and cognitive biases of the questionnaire have been associated with greater delusional symptomatology and, equally, with worse metacognition when assessed by cognitive insight. Therefore, the psychometric properties and validation of the Spanish version of the CBQp guarantee that this instrument can be used as an assessment of cognitive biases in the Spanish language. Given the importance of cognitive biases in cognitive and metacognitive therapies of psychosis (12), instruments such as the CBQp, designed in a format based on everyday situations, are very useful in the evaluation of these biases in the previous phase or in the maintenance of delusions.

This study has several limitations. First, the low factor weight of three questionnaire items implies a worse association of these items with their theoretical factor. However, this result could be a limitation from psychometry's point of view, but this does not necessarily mean that these items need to be excluded; these items could provide relevant information concerning the clinical construct, and because of this, they are useful in bias measurement. Second, the analysis did not control for the severity of the symptomatology. Subsequent studies should analyze the biases according to the type and intensity of the delusions. Third, given the emotional component in Beck's biases, it would have been appropriated to control for mood state with the CBQp. Finally, diagnostic heterogeneity and the limited availability of sociodemographic data could limit the generalization of the study's results. The healthy subjects' sample was selected from health professionals' environment. In future studies, it would be necessary to analyze the descriptive statistics of biases in a broader sample of the general population. This would ensure more representativeness of the results, being able to establish cutoff points regarding to the healthy population and facilitating data generalization.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comitè Ètic d'Investigació Clínica Institut d'investigació Sanitària Pere Virgili (CEIm IISPV de Reus). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

LC, JL, SO, AG-Z, and AC designed the study and participated in the linguistic adaptation of the Spanish version of the CBQp. DG-P, GM, JL, and AG-Z performed the data analysis. JL, SO, AG-Z, VS-G, DP, JMC, JV, and EV participated in the interpretation of data. LC, JL, AC, MA, and AG-Z participated in the acquisition, analysis and interpretation of data. LC and AG-Z wrote the paper with input from all authors. All authors discussed the results and contributed to the final manuscript, revised the manuscript content, and approved the final version of the manuscript.

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# Probing the Hypersalience Hypothesis—An Adapted Judge-Advisor System Tested in Individuals With Psychotic-Like Experiences

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Individuals with psychotic-like experiences and psychosis gather and use information differently than controls; in particular they seek and rely on less information or over-weight currently available information. A new paradigm, the judge-advisor system, has previously been used to investigate these processes. Results showed that psychosis-prone individuals tend to seek less advice but at the same time use the available advice more. Some theoretical models, like the hypersalience of evidence-matching hypothesis, predict that psychosis-prone individuals weight recently available information to a greater extent and thus provide an explanation for increased advice-weighting scores in psychosis-prone individuals. To test this model, we adapted the previously used judge-advisor system by letting participants receive consecutively multiple pieces of advice. To meet this aim, we recruited a large MTurk community sample ($N$ = 1,396), which we split in a group with high levels of psychotic-like experiences (at least 2 *SD* above the mean, $n$ = 80) and a group with low levels of psychotic-like experiences (maximum 0.5 *SD* above the mean, $n$ = 1,107), using the Community Assessment of Psychic Experiences' positive subscale. First, participants estimated five people's age based on photographs. Then, they received consecutive advice in the form of manipulated age estimates by allegedly previous participants, with outliers in some trials. After each advice, participants could adjust their estimate. This procedure allowed us to investigate how participants weighted each currently presented advice. In addition to being more confident in their final estimates and in line with our preregistered hypothesis, participants with more frequent psychotic-like experiences did weight currently available advice more than participants with less frequent psychotic-like experiences. This effect was especially pronounced in response to outliers, as fine-grained *post-hoc* analysis suggested. Result thus support models predicting an overcorrection in response to new incoming information and challenges an assumed general belief inflexibility in people with psychotic experiences.

**Keywords: schizophrenia, psychosis, cognitive biases, jumping to conclusions, belief flexibility, information processing, decision-making, psychosis-prone**

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# INTRODUCTION

Several cognitive models suggest biases in information processing as a factor for the formation and maintenance of psychosis (1, 2). Prominent biases are the jumping to conclusions bias [JTC; (3)], bias against disconformitory evidence [BADE; (4)], and overconfidence (5). In the best-known paradigm to tap data gathering, the beads task (6) and its variants the fish-task (7) and box task (8), participants collect information before making a decision on a probabilistic reasoning task. Yet, the task faces a number of caveats including low reliability and comprehensibility. In this study, we used an alternative paradigm, an adaptation of the judge-advisor system, to tap different biases concurrently [JAS; (9)]. The JAS has been developed in the field social and organizational psychology [for a review, see Bonaccio and Dalal (10)], but has recently been applied in clinical research (11, 12). Our adaptation allows to investigate how participants seek and use advice on estimation tasks, which are processes that likely involve the cognitive biases belief flexibility, jumping to conclusions, and confidence in judgements.

In the JAS task, a participant makes an initial estimate (e.g., in this study about a person's age based on a photograph) and then receives advice [e.g., in this study (fabricated) answers by previous participants]. After a participant received advice, they can adjust their estimate. Kaliuzhna et al. (12) used the JAS in a study on patients with schizophrenia: In the first part, participants made estimates on knowledge questions (e.g., when was UNO created?). In the second part, participants received estimates by another individual as advice and had the option to adjust it. Against the initial hypothesis, patients with schizophrenia adjusted their estimate more than healthy controls in response to advice. Likewise, in one of our previous studies on participants along the psychosis-spectrum, participants with more frequent psychotic-like experiences (PLEs) did weight the first advice more than participants with less frequent PLEs (13).

The finding that individuals with more frequent psychotic(-like) experiences weighted advice more than controls is surprising considering a series of previous studies suggesting the opposite: Psychotic patients have shown to be immune toward conflicting evidence against their delusion (14). Also on delusion neutral material—for example measured with the BADE paradigm (15)—patients with schizophrenia (16) and people with more frequent PLEs (17) show a tendency to stick to initial explanations even after being confronted with evidence speaking against it. However, the hypersalience of evidence-matching hypothesis (18) provides a rationale for an increased advice weighting: According to this theory, patients with schizophrenia put more weight toward currently available information in the direction of this evidence; at the same time, previous information is considered less. If so, individuals with more frequent PLEs should weight currently available advice more than individuals with less frequent PLEs.

This hypersalience of evidence-matching hypothesis is derived from the observation of "overcorrection" in the fish task [(7); a variant of the classical beads task; (6)] intended to capture jumping to conclusions: When participants have to deduce from which of two lakes with opposite ratios of colored fish (e.g., lake 1: 80% red fish and 20% green fish; lake 2: 20% red fish and 80% green fish) a fisherman catches fish, contrary evidence—for example a green fish after three consecutive red fish—leads to an increase in probability ratings for the lake containing more green fish (but not a decreased rating for the lake containing more red fish) in schizophrenia patients compared to controls. This "overcorrection" has been observed already in one of the first studies with this task (19), and was replicated multiple times (20–22). In their analysis, Speechley et al. (18) showed that this overcorrection only applies to probability ratings to the lake favored by the current fish [match between hypothesis (lake) and information (fish)], while the probability rating of the opposing lake is not overcorrected (non-match between hypothesis [lake] and information [fish]); thus the name "hypersalience of evidence-matching hypothesis."

## The Aberrant JAS

In the version of the JAS we are using, the participant makes an initial estimate about a person's age based on a photograph and then receives advice in the form of (fabricated) answers by previous participants. To explicitly test the hypersalience model for advice weighting, we made the following adaptations to the original JAS-paradigm: Participants received multiple, consecutive pieces of advice. Important to note is that participants did neither know nor could they influence the number of pieces of advice they would see in any given trial. However, after each advice, participants could revise their estimate. Further, we manipulated the advice so that some pieces of advice were "outliers" differing largely from the other advice (hence the name *Aberrant JAS*). The hypersalience of evidence-matching hypothesis predicts that individuals with more frequent PLEs weight these outliers stronger as they consider previous information less.

To simulate information seeking, we additionally asked participants after each advice whether they preferred more advice (which did not alter the probability whether more advice would be shown). After the final estimate, participants rated how confident they are in their decision, to investigate a possible overconfidence (5). Thus, the Aberrant JAS provides measures on the integration of consecutively incoming information, information seeking and confidence in judgements. Additionally, as has been done before by Hofheinz et al. (11) in a depression sample, we investigated the role of self-esteem in exploratory fashion, as lower self-esteem seems to be related to more advice taking (23).

## Aims and Hypotheses

This study followed two main aims. First, we wanted to test the hypothesis that individuals with more frequent PLEs weight currently available advice more than controls. Second, we wanted to optimize the JAS-paradigm for the research of mechanisms on information processing in relation to psychosis. Therefore, we designed and analyzed different sequences of advice. We performed this study on a community sample by dividing participants in groups based on the positive subscale of the Community Assessment of Psychic Experiences (24) as previously done by multiple research groups (13, 25–27). This approach has the advantage to first validate this new task on a non-burdened population, which is also free from confounds like medication that influence information processing (28, 29). Along the hypothesis that (1) participants with more frequent PLEs would weight currently available information more than participants with less frequent PLEs, we also tested the hypotheses that (2) they would weight all advice (averaged) more, (3) prefer to see less advice, (4) and are more confident in their final estimate (rated after estimate). Finally we hypothesized that (5) confidence correlates with subjective competence in task performance (rated before experiment started)—moderated by group—as previous studies suggest that patients with schizophrenia mostly feel overconfident in areas they feel competent in (30, 31).

# METHODS

## Preregistration and Ethics

Before data collection (July 4th, 2019; time-stamped), we publicly preregistered the study on *As Predicted* (#21768). Our local ethics committee approved the study (#LPEK-0074)[1].

## Recruitment

We recruited participants via Amazon Mechanical Turk (MTurk). To ensure data quality we followed suggestions by Kees et al. (32) which means that participants could only participate if they had a U.S. IP address, had an acceptance rate of 95% or higher based on at least 100 previous MTurk tasks (so called human intelligence tasks), and had not participated in a previous study by our working group before.

Of 1,616 people who had begun the survey, 1,570 finished. In line with our preregistered protocol, we excluded (blind to results) 71 participants because of poor results on an attention assessment (self-rated attentiveness during the study of $\leq 5$ on a 7-point Likert scale), 75 participants due to an implicit attention test [item within the sociodemographic questionnaire: "People vary in the amount they pay attention to these kinds of surveys. Some take them seriously and read each question, whereas others go very quickly and barely read the questions at all. If you have read this question carefully, please write the word yes in the blank box below labeled other. There is no need for you to respond to the scale below" (33)] and 28 due to excessive speeding as defined by a response time of 50% of the median completion time (cut off: 4.99 min). One participant was excluded due to an error by the user (for more details, see section Preprocessing below). After removing 176 (11.2%) participants in total, 1,395 participants were included in the analysis.

[1] *As one of the reviewers pointed out, we should have debriefed participants at the end of the experiment that advice was fabricated.*

# MATERIALS

## Community Assessment of Psychic Experience Scale (CAPE)

We asked all participants to fill out the 20-item long positive subscale of the Community Assessment of Psychic Experience Scale (24), measuring positive psychotic-like experience. Items are answered on a scale from 1 ("never") to 4 ("nearly always"). The internal consistency in our sample (Cronbach's $\alpha = 0.898$) was similar to previous studies [meta-analytic mean $\alpha = 0.91$; (34)]. As defined in the preregistration report, the sample was divided into PLE-High with participants scoring at least two standard deviations above the mean ($n_{PLEs-High} = 80$) and PLE-Low ($n_{PLEs-Low} = 1{,}106$) with participants scoring at maximum 0.5 standard deviations above the mean. This approach has been used in multiple psychometric high-risk studies (13, 25–27). We also report results of the eight item long depressive subscale. The negative subscale was not assessed.

## Rosenberg Self-Esteem Scale (RSES)

Rosenberg's Self-Esteem Scale (35) is a 10-item long self-report inventory measuring global self-esteem answered on a four-point Likert scale from 1 ("strongly disagree") to 4 ("strongly agree").

## Subjective Competence

Before the estimation task started, participants responded once to the question "How good do you judge yourself to be at estimating other people's age?" using a Likert scale from 1 ("very good") to 5 ("very bad").

## The Aberrant Judge-Advisor System

The sequence of the experiment was adopted from the classical judge-advisor systems [JAS; (10)]: That means participants first made an initial judgement, then they received advice along with the option to adjust their initial judgement. The most relevant outcome is whether and how much participants adjusted their initial judgement in response to the advice (or in this case to the sequence of pieces of advice).

**Figure 1** illustrates the adapted Aberrant Judge-Advisor System: At the start, participants saw five portraits (770 × 512 pixels) with individuals of White race of various ages (3 men and 2 women) taken from the Siblings Database of the CG&V Group (36). Each picture was presented one at a time and participants first gave an initial estimate on the age of the person in the picture (by typing the age in digits). Only after participants have given all five initial estimates, we informed participants that they would see the same pictures again along with "randomly drawn estimates from participants, who gave those estimates in a previous small study with 100 participants." These answers were in fact pre-determined and functioned as advice (we avoided the term "advice" in the instructions). For each picture, the total number of pieces of advice varied, but in each case, the pieces of advice were revealed one at a time. Participants did not have any knowledge about the total number of pieces of advice. **Table 1** depicts the exact number and distances of advice for all five trials, along with explanations of the intended rationale. Important are

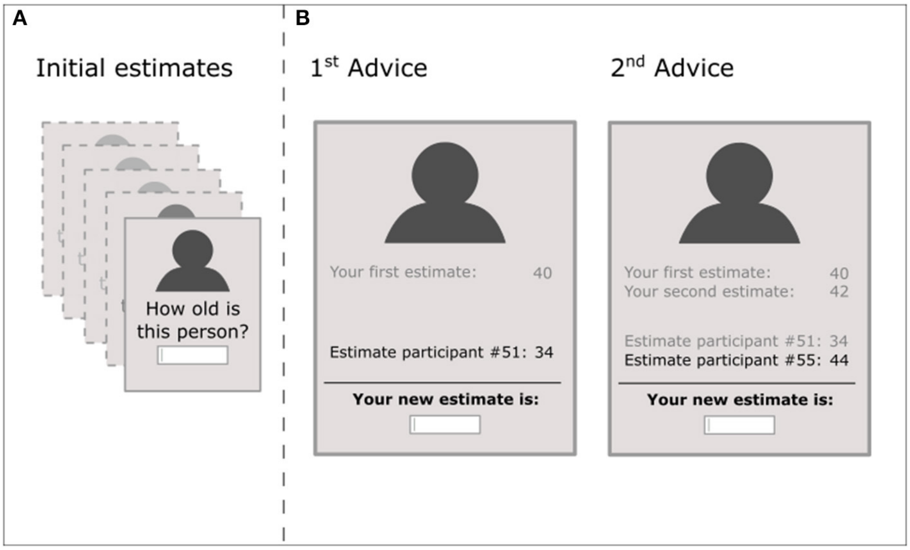


**FIGURE 1 |** Schematic representation of the Aberrant JAS. **(A)** Participants consecutively saw portrait pictures of five different persons, for which they gave each an initial estimate. **(B)** In the second step, participants saw the same portrait pictures in the same order along with advice, which we framed in the experiment as "estimates from previous participants." As an example, we illustrated trial 3: The first advice was −15% to the initial estimate and participants made a new estimate. Thereafter, participants saw the second advice (+10% to the initial estimate) and again gave a new estimate. This estimate was the final estimate, as the trial ended after two pieces of advice (number of pieces of advice per trial were unknown to participants and ranged from 1 to 5). As illustrated, in all steps, participants saw the portrait picture, all their previous estimates, all previous advice and the new advice highlighted. Participants gave their estimates by typing in a number in digits for which there was no time constraint. As additional measures (not depicted), participants responded after each new estimate whether they would prefer to see more estimates from previous participants (along the information that this does not influence the number of pieces of advice). After each trial terminated, participants rated their confidence in their last/final estimate.

the "outliers" in trial 2 and 4, which we defined as advice that deviated largely from previous, little divergent, advice. The order of the five trials was fixed for all participants, the corresponding picture, however, was randomly allocated to the trials. All advice was presented along the picture, all previous pieces of advice on this picture and all previous estimates the participant made on this picture. For each presented advice, participants gave a new, possibly revised estimate. To do so, they had to type in their estimate in digits again.

Further, they answered the question "Would you prefer to see more estimates from others before making a final decision?" The answer to this question, however, would not influence the number of pieces of advice. Participants knew that their answer would have no influence as we have pointed this out: "(Your answer does not influence whether you see more estimates or not)." After participants had seen the predetermined number of pieces of advice, the estimate was set as final. Participants subsequently rated their confidence. There was no time constraint during any part of the experiment.

# Scoring

## Preprocessing

Of 24,927 estimates made, 5 estimates were outside the range of 20–83 and deleted because they likely represented typos (age estimates were 4, 391, 412, 445, and 569). One participant gave this answer at the first estimate. Consequently, the resulting generated advice was also unrealistic; hence, we excluded this participant from the analysis as this revealed to the participant that the advice was not real, but automatically generated.

## Information Integration: Advice Weighting

The most common procedure to calculate the degree a participant integrates advice is relative advice weighting (RAW). The basic formula is (RAW = [final estimate—initial estimate]/[advice—initial estimate]; formula 1), which is the ratio between the change in estimate by the distance of advice. We adapted the formula for relative current advice weighting and relative average advice weighting.

*Relative current advice weighting* (RCAW) aims at capturing the weight a participant put toward the advice presented last. This is the most relevant outcome regarding our hypotheses. We were interested, for example, in how much a participant weighted the fourth advice for the second picture. We a priori defined relative current advice weighting as the change in estimates between pieces of advice, relative to the distance between the new/current advice and the previous estimate (RCAW = [new estimate—previous estimate]/[current advice−previous estimate]; formula 2). This formula has an intuitive interpretation: If a participant does not change the estimate, the RCAW is 0. If the participant follows the advice completely, the score will be 1. If the participant takes the middle between the previous estimate and the new advice, the RCAW will be 0.5. A negative score would mean that the participant changed their estimate in the opposite direction to the advice (e. g., in trial 1: initial estimate: 40, advice: 37, new estimate: 42; would results in RCAW = −0.67). No score

**TABLE 1 |** Explanation of trials—relative distance of advice to the initial estimate and the intended rationale.

| Rule | | | |
|---|---|---|---|
| **Trial 1** | | | |
| | 1st Advice | −7.5% | The purpose of this trial was to ensure participants believe every estimate might be the last one |
| **Trial 2** | | | |
| | 1st Advice | +17.5% | Note the outlier of the 4th advice |
| | 2nd Advice | +30% | |
| | 3rd Advice | +25% | |
| | 4th Advice | −10% | |
| **Trial 3** | | | |
| | 1st Advice | −15% | In this trial, there are two opposing/contradicting pieces of advice |
| | 2nd Advice | +10% | |
| **Trial 4** | | | |
| | 1st Advice | −5% | Note the outlier of the 4th advice, after all previous pieces of advice were confirmatory of the initial estimate |
| | 2nd Advice | +2.5% | |
| | 3rd Advice | +0% | |
| | 4th Advice | +22.5% | |
| **Trial 5** | | | |
| | 1st Advice | +12% | All advice hinted in the same direction |
| | 2nd Advice | +14% | |
| | 3rd Advice | +8% | |
| | 4th Advice | +18.5% | |
| | 5th Advice | +10% | |

was calculated for the case that the current advice equaled the previous estimate, as the denominator of this formula 2 resulted in zero in this case.

*Relative average advice weighting* (RAAW) uses the basic formula 1 described above, but averages the pieces of advice, as previously done [e.g., (37)]. The resulting formula is RAAW = [final estimate—initial estimate]/[mean advice—initial estimate] (formula 3). For illustration, take picture 5 (also, see **Table 1**): If a participant gave an initial estimate of 30, the five pieces of advice (34, 34, 32, 36, and 33) averaged to 33.8. Hence, an adjustment by 1 year from 30 to 31 led to RAAW = (31–30)/(33.8–30) = 1/3.8 ≈ 0.26; equivalent to saying the advice was integrated by 26%.

It is important to note that for both RCAW and RAAW, scores outside the range 0–1 are not unlikely. In picture 4, for example, the average advice is 5% above the initial estimate. With an initial estimate of 25, the average advice was 26.5. Yet, the outlier at the final estimate (advice: 31 years) might have changed the estimate to 27, resulting in a RAAW score of 2/1.5 = 1.33.

### Information Sampling: Number of Preferred Advice (NoPA)

After each piece of advice, we asked participants "Would you prefer to see more estimates from others before making a final decision?" Hereby "Yes, I would prefer more estimates" was scored as 1 and "No, I have enough information" was scored as 0. We informed participants that the answer does not influence the number of pieces of advice shown. We calculated a mean Number of Preferred Advice (NoPA) score per trial, which ranged between 0 and 1 and represents the percentage participants on average preferred to see more advice per trial. If, for example in trials 4 (see, **Table 1**) a particiapnt prefered to see more advice after the first and fourth advice (each scored as 1), but not after the second and third advice (each scored as 0) the NoPA score in this trial was 2/4 = 0.5.

### Confidence

At the end of each trial, participants rated their confidence in their estimate ("Please indicate how confident you are in your estimate:") on a 4-point scale from 1 ("not very confident"), 2 ("moderately confident"), 3 ("very confident") to 4 ("100% confident"). Note that the confidence score differs to subjective competence described above: Subjective competence is rated before the task and assesses the general competence in this type of task (in this case the competence in estimating people's age based on a picture), while confidence refers to the confidence after each trial has ended.

## Procedure and Preregistered Analysis

After participants gave informed consent, they answered the CAPE, RSE, and rated their subjective competence in estimating ages. Then, they completed the JAS. Finally, they rated their subjective competence again and provided sociodemographic information.

We computed all main analyses as indicated in the public AsPredicted protocol. We tested the a priori hypothesis of increased RCAW scores, RAAW scores and confidence as well as well as the lower preference to see more advice (NoPA) for the PLEs-High group compared to the PLEs-Low group with Welch's *t*-tests. For this, scores were averaged on the subject level across trials; for the main analysis of RCAW, we additionally averaged this score across advice per trial. Further, we calculated a correlation between Subjective Competence (rated before the task) and Confidence (rated at the end of each trial) and tested whether this correlation was moderated by group. Subjective competence and group were centered for this moderation analysis. We tested whether correlations are significantly different from zero with Student's *t*-tests. The role of self-esteem was analyzed in exploratory fashion.

# RESULTS

Sociodemographic and core psychopathological data is summarized in **Table 2**, self-reported lifetime diagnoses in **Supplementary Table 1**. Participants in PLEs-High reported (non-significantly) more psychiatric diagnoses, were more frequently male, younger, less educated, and racially more diverse than participants in PLEs-Low.

## Preregistered Analysis

There were no major deviations from the preregistered protocol. First, the number of participants completed the study were 1,570 instead of 1,500 unintendedly caused by wrong settings on MTurk. Even though not specified in the preregistered

**TABLE 2 |** Participants' characteristics and group differences.

| | PLEs-High ($n$ = 80) | PLEs-Low ($n$ = 1,106) | Group differences | |
|---|---|---|---|---|
| **Gender** | | | $\chi^2$ (2) = 15.591 | $p < 0.001$ |
| Female | 36.25% | 58.86% | | |
| Male | 62.50% | 40.69% | | |
| A different term than female or male/I wish not to answer[a] | 0.00% | 0.45% | | |
| Age | 33.69 (*SD* = 10.80; *range* = [19, 63]) | 39.41 (*SD* = 12.81; *range* = [18, 88]) | $t(98.83) = 4.513$ | $p < 0.001$ |
| **Level of Education** | | | $\chi^2$ (6) = 7.088 | $p = 0.313$ |
| Less than high school | 1.25% | 0.45% | | |
| High school graduate | 12.50% | 10.49% | | |
| Some college | 25.00% | 23.96% | | |
| 2-year degree | 5.00% | 11.66% | | |
| 4-year degree | 45.00% | 37.97% | | |
| Professional degree | 11.25% | 13.38% | | |
| Doctorate | 0.00% | 2.08% | | |
| Years of Education | 12.80 (*SD* = 5.14) | 14.90 (*SD* = 5.10) | $t(90.601) = 3.522$ | $p < 0.001$ |
| **Race/Ethnicity**[b] | | | $\chi^2$ (6) = 17.637 | $p < 0.007$ |
| American Indian or Alaska Native | 2.50% | 0.72% | | |
| Asian or Asian American | 8.75% | 6.78% | | |
| Black or African American | 17.50% | 7.23% | | |
| Latino or Hispanic | 10.00% | 5.70% | | |
| Native Hawaiian or Pacific Islander | 0.00% | 0.09% | | |
| White or European American | 65.00% | 80.92% | | |
| Neither/A term not listed above/I wish not to answer[a] | 1.25% | 1.63% | | |
| **Psychopathology** | | | | |
| CAPE-positive | 2.467 (*SD* = 0.282) | 1.289 (*SD* = 0.163) | $t(82.846) = 36.852$ | $p < 0.001$ |
| CAPE-depression | 2.489 (*SD* = 0.566) | 1.821 (*SD* = 0.434) | $t(85.856) = 10.344$ | $p < 0.001$ |
| Rosenberg Self-Esteem Scale | 3.001 (*SD* = 0.588) | 2.660 (*SD* = 0.616) | $t(91.966) = 4.988$ | $p < 0.001$ |

[a]*Answers were summarized;* [b]*multiple answers were possible.*

protocol, we report Cohen's effect size parameter $d$ along with the preregistered statistical tests, including its 95% confidence interval (95% CI). For the formula 2 RCAW, we also did not specify the scenario in which the new advice equaled the previous estimate: The denominator for the formula RCAW would then be zero, thus no score was calculated (see above in Methods section).

As predicted, PLE-High weighted current advice (RCAW) more than PLE-Low with a medium effect size (RCAW PLEs-High: 0.20 (*SD* = 0.28), RCAW PLEs-Low: 0.13 (*SD* = 0.13); ($t(81.226) = 2.380$); $p = 0.020$; $d = 0.54$, 95% CI [0.31, 0.77]). This means, participants from the PLEs-High group adjusted their estimates more in response to new information available than participants from the PLEs-Low group. For the averaged advice (RAAW), group differences were in the expected direction, but the group difference was not significant (RAAW PLEs-High: 0.45 (*SD* = 0.73), RAAW PLEs-Low: 0.36 (*SD* = 0.42); ($t(82.945) = 1.076$); $p = 0.285$; $d = 0.20$, 95% CI [−0.03, 0.42]). Against our hypothesis, PLE-High preferred to see more advice, even though this difference was not significant (NoPA PLEs-High: 0.68 (*SD* = 0.92), NoPA PLEs-Low: 0.52 (*SD* = 0.73); ($t(86.39) = 1.518$); $p = 0.133$; $d = 0.21$, 95% CI [−0.01, 0.44]). As expected, PLE-High were more confident in their final estimates at a medium to large effect size (Confidence PLEs-High: 2.84 (*SD* = 0.58), Confidence PLEs-Low: 2.41 (*SD* = 0.54); ($t(89.167) = 6.475$); $p < 0.001$; $d = 0.80$, 95% CI [0.57, 1.03]). Correlations between subjective competence and confidence were small and significant on trend level in PLEs-High [$r$ = 0.206; $t(78) = 1.857$; $p = 0.067$], medium and significant in PLEs-Low [$r$ = 0.342; $t(1{,}104) = 12.089$; $p < 0.001$], and medium and significant in the entire sample [$r$ = 0.351; $t(1{,}184) = 12.901$; $p < 0.001$]. The moderation analysis with confidence as response variable, subjective competence as predictor and group as moderator revealed a significant model [$F_{(3,1,182)} = 67.1$; $p < 0.001$; $R^2_{adjusted} = 0.143$]. Significant predictors in this model were subjective competence and group (both $p < 0.001$). The interaction term, however, was not significant ($p = 0.298$). This means, confidence in the estimates were mainly driven by subjective competence, neither proneness to PLEs nor an interaction of both. Of note, PLE-High reported higher subjective competence than PLE-Low with medium effect size (Subjective Competence PLEs-High: 3.85 (*SD* = 0.81), Subjective Competence PLEs-Low: 3.36 (*SD* = 0.83); ($t(91.233) = 5.173$); $p < 0.001$; $d = 0.59$, 95% CI [0.36, 0.82]). In sum, hypotheses 1 and 4 were supported, hypothesis 5 partially and hypotheses 2 and 3 not supported.

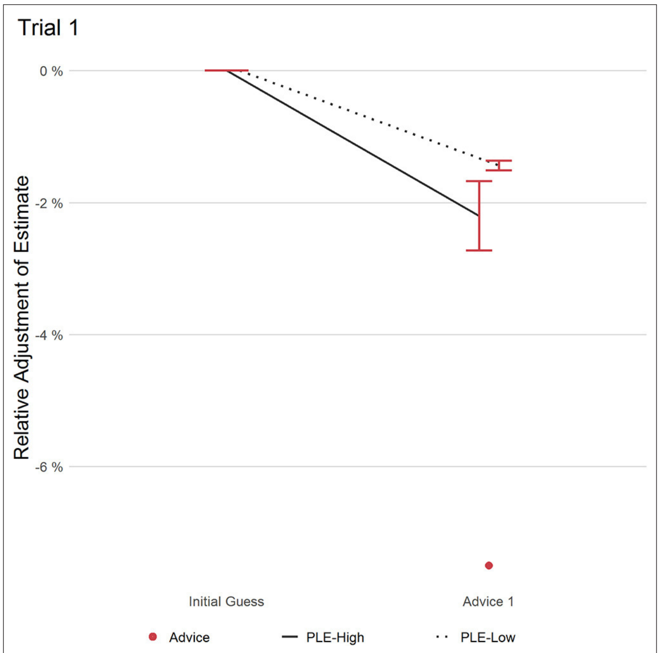


**FIGURE 2 |** This figure displays the relative adjustment of estimates per group in trial 1. Red dot refers to the distance of advice relative to the initial estimate. Error bars refer to the standard error of the mean.

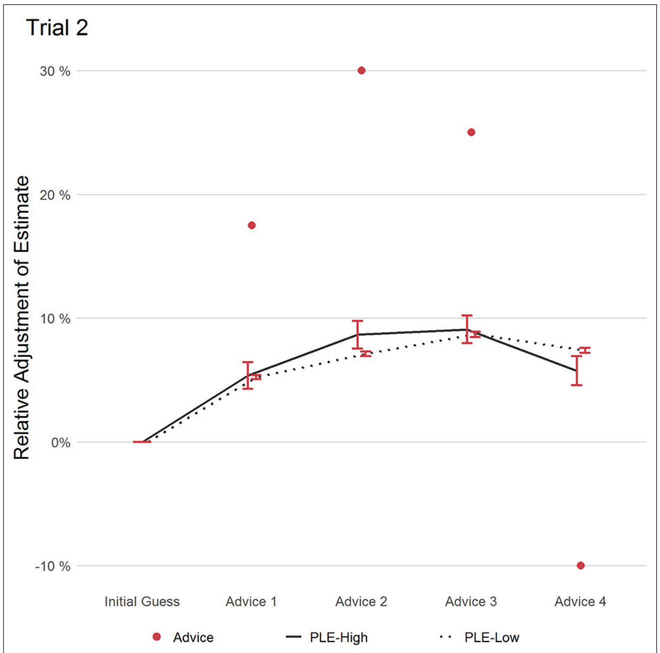


**FIGURE 3 |** This figure displays the relative adjustment of estimates per group over all pieces of advice in trial 2. Red dots refer to the distance of each advice relative to the initial estimate. Error bars refer to the standard error of the mean.

## Exploratory Analysis

As described in the Methods section, each trial followed a specific rationale. Hence, we continued with our exploratory analysis, presented trial wise. For this, we plotted per trial the estimates relative to the initial estimate in percentage. For example, if someone adjusted their estimates from an initial estimate of 30–33 following advice, the relative adjustment would be (33-30)/30 = 10%. This exploratory analysis follows the second aim of this study, which is to improve the JAS paradigm and to provide researchers with insights on different manipulation for future uses of the Aberrant-JAS.

### Trial 1

Descriptively observable in **Figure 2**, PLEs-High adjusted their estimate more than PLEs-Low in response to the advice, which did not reach significance (RAAW/RCAW PLEs-High: 0.29, RAAW/RCAW PLES-Low: 0.19; ($t(82.457) = 1.480$); $p = 0.143$; $d = 0.28$, 95% CI [0.06, 0.51]). As this trial consisted of one piece of advice only, RAAW and RCAW scores were identical.

### Trial 2

**Figure 3** shows the adjustment of the estimates relative to the initial estimate over different pieces of advice (depicted as red dots). Both groups adjusted similarly after the first advice. However, the second advice—deviating the most from the initial estimate—led to slightly stronger adjustment in the PLEs-High group as indicated by a higher RCAW score compared to PLEs-Low of medium effect size (PLEs-High: 0.31, PLEs-Low: 0.08; ($t(79.233) = 1.788$); $p = 0.078$; $d = 0.68$, 95% CI [0.45, 0.91]). PLEs-High also weighted advice 4—the outlier in this trial—more than PLEs-Low, even though this difference has also not reached significance (PLEs-High: 0.22, PLEs-Low: 0.05; ($t(80.418) = 1.746$); $p = 0.085$; $d = 0.46$, 95% CI [0.23, 0.69]). The increased advice weighting of PLEs-High in response to the outlier was driven by two factors: First, almost half of PLEs-High (47.5%) adjusted their estimate following the outlier, while only around one in four (28.2%) in the PLEs-Low group adjusted theirs ($t(88.428) = 3.345$; $p = 0.001$; $d = 0.43$, 95% CI [0.20, 0.65]). Second, of the participants who changed their estimate in response to the outlier, PLEs-High weighted the advice more strongly than PLEs-Low at a medium effect size, even though this difference did not reach significance in this subgroup analysis (PLEs-High: 0.46, PLEs-Low: 0.16; ($t(38.907) = 1.461$); $p = 0.152$; $d = 0.44$, 95% CI [0.10, 0.78]). In summary and in line with the theoretical assumptions, PLEs-High tended to weight the most extreme advice 2 and the outlier (advice 4) stronger than PLEs-Low.

### Trial 3

In trial 3 (see **Figure 4**), participants saw two contrasting pieces of advice with the first advice being 15% lower and the second advice being 10% higher than the individual participant's initial estimate. After the first advice, both groups made similar adjustments of their estimate. The second advice, however, revealed a group difference in RCAW scores, which bordered significance (PLEs-High: 0.18, PLEs-Low: 0.08; ($t(77.784) = 1.748$); $p = 0.084$; $d = 0.43$, 95% CI [0.19, 0.66]). PLEs-Low were reluctant to change their estimate back to their first estimate in response to advice 2: Relative to the initial estimate, PLEs-Low adjusted their estimate by 1.6% which was closer to the averaged advice (2.5%) than

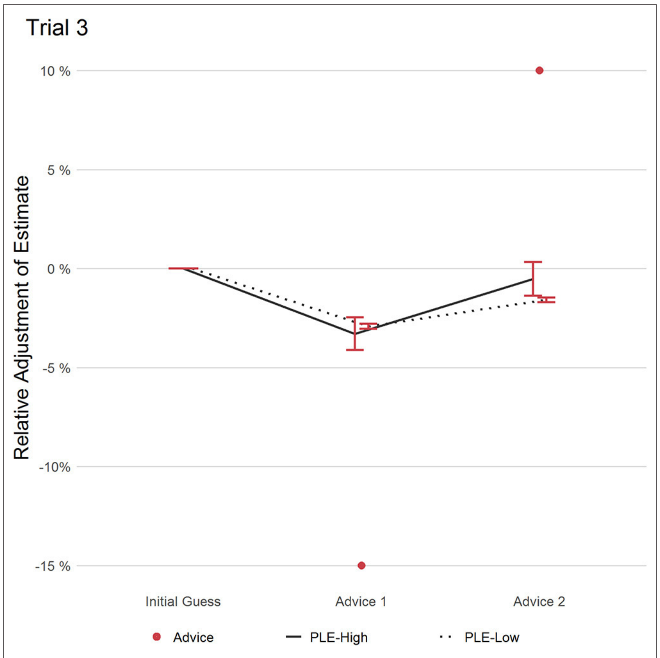


**FIGURE 4 |** This figure displays the relative adjustment of estimates per group over all pieces of advice in trial 3. Red dots refer to the distance of each advice relative to the initial estimate. Error bars refer to the standard error of the mean.

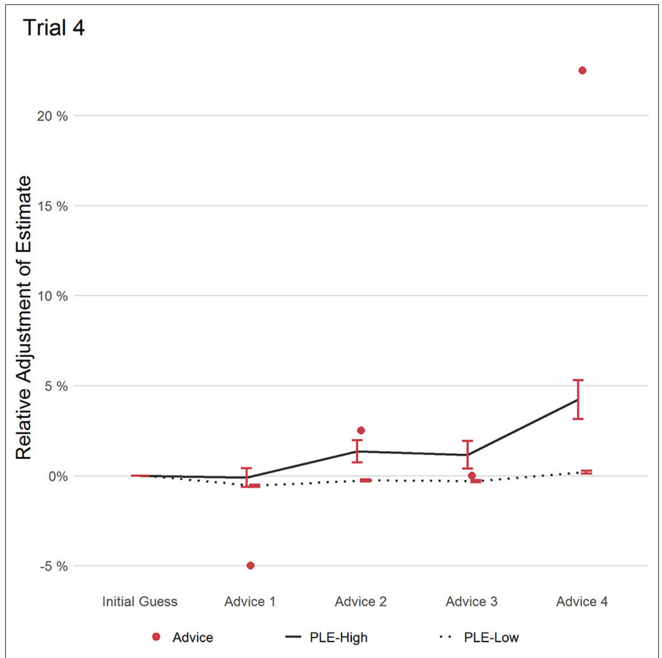


**FIGURE 5 |** This figure displays the relative adjustment of estimates per group over all pieces of advice in trial 4. Red dots refer to the distance of each advice relative to the initial estimate. Error bars refer to the standard error of the mean.

their initial estimate. Hence, the resulting RAAW score was large for PLEs-Low (0.70). Cautiously, this could be interpreted as indicative that PLEs-Low was less ready to adjust their estimate in light of contradicting information despite the cost of ending up leaning to one side of advice.

### Trial 4

Trial four, see **Figure 5**, consisted of four pieces of advice. The first three deviated only little from the initial estimate, therefore both groups showed only little deviation from their initial estimate. Advice four deviated from the first three pieces of advice. While PLEs-Low weighted this last piece of advice only marginally (RCAW = 0.02), PLEs-High weighted it heavily (RCAW = 0.18). This difference in RCAW scores on the fourth advice was significant with a large effect size ($t(79.746) = 3.398$; $p = 0.001$, $d = 1.07$, 95% CI [0.84, 1.30]), and as a result also the weighting of the advice averaged in this trial RAAW, again with a large effect size (PLEs-High: 0.81; PLEs-Low: 0.03; ($t(80.016) = 3.807$); $p < 0.001$; $d = 1.10$, 95% CI [0.87, 1.34]). Similar to trial 2, more participants of the group PLEs-High adjusted their estimate (36.31%) in response to the outlier of advice 4, compared to participants in group PLEs-Low (12.61%), revealing a significant medium effect ($t(84.465) = 4.304$); $p < 0.001$; $d = 0.69$, 95% CI [0.46; 0.92]). Furthermore, of all participants who adjusted their estimate, PLEs-High weighted the last piece of advice more strongly (RCAW PLEs-High: 0.50; RCAW PLEs-Low: 0.15; ($t(30.596) = 3.150$); $p = 0.003$; $d = 1.01$, 95% CI [0.59; 1.43]). To conclude, even after three pieces of advice deviating from the initial estimate only marginally, thereby "confirming" the initial estimate, PLEs-High weighted the fourth advice, deviating from the initial estimate and the previous advice strongly, more than PLEs-Low.

### Trial 5

In trial 5 (see **Figure 6**), participants saw five pieces of advice, all hinting in the same direction by similar magnitude. PLEs-High had at trend-level slightly higher RCAW scores in response to advice 1 (PLEs-High: 0.35, PLEs-Low: 0.25; ($t(89.936) = 1.746$); $p = 0.084$; $d = 0.21$, 95% CI [−0.02, 0.44]). From advice 2 to 5, both groups paralleled mostly in their advice weighting with no significant differences in RCAW scores ($p \geq .105$). However, RCAW scores averaged over the five pieces of advice revealed a borderline-significant group difference with medium effect size (PLEs-High: 0.23, PLEs-Low: 0.11; ($t(80.07) = 1.797$); $p = 0.076$; $d = 0.51$, 95% CI [0.29, 0.74]). Still after five pieces of advice, both groups have adjusted their estimates similarly according to RAAW scores (PLEs-High: 0.43, PLEs-Low: 0.39; ($t(82.323) = 0.412$); $p = 0.681$; $d = 0.08$, 95% CI [−0.14; 0.31]). That means, multiple uniform pieces of advice did not lead to stronger adjustment by any group.

## Advice Weighting and Self-Esteem

In exploratory fashion, we investigated the relationship between self-esteem and performance in the JAS-task. Looking at both the entire sample and the group PLEs-High, self-esteem did neither correlate with RCAW [entire sample: $r = -0.005$; ($t(1{,}184) = 0.161$); $p = 0.872$; PLEs-High: $r = 0.071$; ($t(78) = 0.627$); $p = 0.532$] nor RAAW [entire sample: $r = -0.035$; ($t(1{,}184) = 1.203$); $p = 0.229$; PLEs-High: $r = -0.107$; ($t(78) = 0.953$); $p = 0.344$] or NoPA [$r = -0.038$; ($t(1{,}184) = 1.314$); $p = 0.189$; PLEs-High:

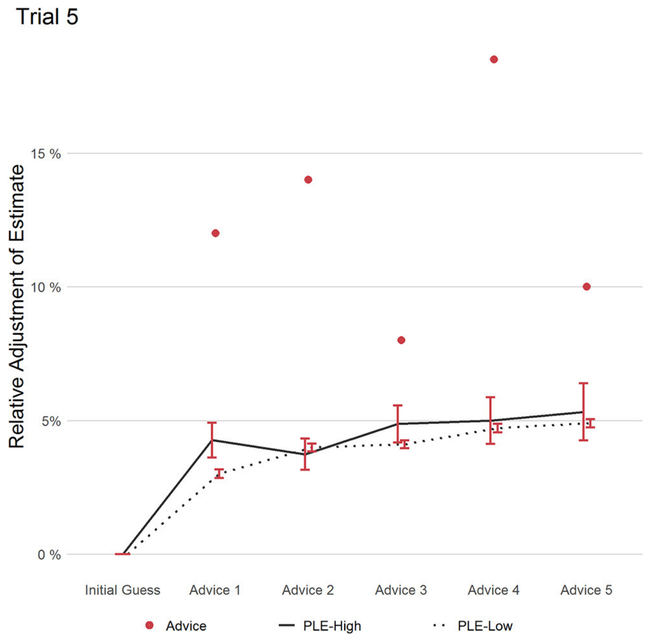


**FIGURE 6 |** This figure displays the relative adjustment of estimates per group over all pieces of advice in trial 5. Red dots refer to the distance of each advice relative to the initial estimate. Error bars refer to the standard error of the mean.

$r = 0.019$; ($t(78) = 0.170$); $p = 0.866$]. However, higher scores in global self-esteem were related to higher confidence in their estimate in the entire sample [$r = 0.171$; ($t(1{,}184) = 5.955$); $p < 0.001$]. Within PLEs-High, the correlation was the same ($r = 0.178$) but did not reach significance [$t(78) = 1.601$; $p = 0.114$].

## Task Evaluation

After the task, we asked participants to rate five statements pertaining to the task, revealing two group differences regarding the task: PLEs-High found the correct answer less important and more readily believed that advice was "just there to mislead." For exact wording and statistics, see **Table 3**.

# DISCUSSION

## Summary of Main Findings

This study aimed to investigate how people with more frequent psychotic-like experiences (PLEs) integrate information using an adapted Judge-Advisor System (JAS), the *Aberrant JAS*. Participants estimated a person's age and could change their estimate in response to consecutively provided advice in the form of (fabricated) answers by previous participants. The degree to which a participant adjusted their estimates gives a clear measure as to how much this participant weighted the newly presented information.

We expected participants with more frequent PLEs to weight the currently available advice more than participants with less frequent PLEs. This preregistered hypothesis was supported. However, adjustments at the end of each trial did not differ between both groups, as indicated by advice weighting scores considering all pieces of advice averaged per trial. Unexpectedly, participants with more frequent PLEs preferred to see more advice than people with less frequent PLEs. In this regard this study adds to the increasing literature failing to replicate the jumping to conclusions account on some paradigms (38–41). Yet, people with more frequent PLEs were more confident in their final estimate compared to participants with less frequent PLEs. We did expect an increased confidence due to the same finding in the forerunner study (13) and previous findings on overconfidence related to psychotic experience (5). However, overconfidence usually refers to false answers. This group difference using this somewhat difficult task to estimate one's age purely from a photograph thus adds to the literature on overconfidence. Confidence in one's response was predicted by subjective competence in estimating ages rated before the task. However, this relation was similar in both groups and there was no moderation by group (and thus there is no indication that the link between subjective competence and confidence is somehow different in people with more frequent PLEs). In sum, hypotheses 1 and 4 were supported, hypothesis 5 was partially and hypotheses 2 and 3 were not supported.

In addition to the increased relative current advice weighting scores, *post-hoc* trial-wise analysis provided additional evidence that participants with more frequent PLEs put more weight toward currently available information than people with less frequent PLEs: In trial 4, the first three pieces of advice deviated only marginally from the initial estimate, with a fourth advice deviating largely. People with more frequent PLEs adjusted their estimate more often and more strongly in response to this new information than participants with less frequent PLEs. A similar pattern could be observed in trial 2, in which participants with more frequent PLEs did weight the fourth advice—an outlier as it hinted in the opposite direction to the initial estimate than the previous three pieces of advice (see **Table 1**)—more than participants with less frequent PLEs. In summary, people with more frequent PLEs, compared to people with less frequent PLEs, more readily accepted and integrated newly available (deviant) information while somewhat considering previous advice/information less.

## Increased Information Integration Explained by Hypersalience of Evidence-Matching Hypothesis, Unstable-Attractor Network, Circular Inference, and Liberal Acceptance

Results show an increased integration of currently available information by participants with more frequent PLEs, which thus supports the hypersalience of evidence-matching hypothesis model (18). The hypersalience of evidence-matching hypothesis model posits that patients with schizophrenia perceive new evidence that fits to a hypothesis as "hypersaliently fitting", leading them to increase their conviction in this hypothesis, while they give the same evidence less weight for a re-evaluation of the contrary hypothesis.

To illustrate how this model translates to participants' behavior in our study, especially the strong correction of the estimate in response to the outlier advice in trial 2 and 4 by participants with more frequent PLEs: The (fabricated)

**TABLE 3 |** Endorsements toward statements of the task.

| | PLEs-High ($n$ = 80) | PLEs-Low ($n$ = 1,106) | Group differences (Welch's $t$-test) | |
|---|---|---|---|---|
| The correct answer was not important to me. | 2.71 ($SD$ = 1.26) | 2.28 ($SD$ = 1.10) | $t(87.845) = 2.982$ | $p = 0.004$ |
| I wanted to trust my first impression. | 3.95 ($SD$ = 1.01) | 4.08 ($SD$ = 0.74) | $t(85.346) = 1.147$ | $p = 0.255$ |
| The task was fun. | 3.96 ($SD$ = 1.25) | 4.01 ($SD$ = 0.92) | $t(85.349) = 0.366$ | $p = 0.716$ |
| The previous answers by other participants were just there to mislead me. | 3.51 ($SD$ = 1.03) | 2.93 ($SD$ = 1.00) | $t(90.036) = 4.910$ | $p < 0.001$ |
| It was annoying to see more previous answers by other participants than I wanted to. | 3.58 ($SD$ = 1.23) | 3.49 ($SD$ = 1.31) | $t(92.36) = 0.581$ | $p = 0.563$ |

*Scaled from 1 "strongly disagree" to 5 "strongly agree."; PLEs, psychotic-like experiences.*

advice suggesting that the person on the photo may be older than previously thought "hypersaliently" points toward the idea (hypothesis) that the person is older than originally thought. This hypersalience might then also lead to an ignoring of one's own initial estimate as well as previous advice.

This neglect of previous advice, once new advice is presented could also be explained by the unstable-attractor network (42), according to which patients with schizophrenia have an increased instability in cognition. In their analysis of the beads task (variant of the fish task), Adams et al. (42) showed that patients with schizophrenia updated their probability estimates more in response to unexpected input and less to consistent input. In a design related to the original fish task, Jardri et al. (43) investigated the certainty toward either lake after the first catch, given a prior probability for either lake to be chosen. The authors could show an "under-weighting of priors" and explain this with the "circular inference" stemming from an excitatory/inhibitory imbalance in hierarchical neural processing: Ascending inference loops—a top-down approach leading to interpret current sensory information as prior knowledge ("expect what we see")—are stronger in schizophrenia patients than in controls. These ascending inference loops could explain that participants with more frequent PLEs under-weight previous advice once new advice is presented; as could be observed by the increased weighting of outliers in trials 2 and 4.

An alternative explanation for the increased weighting of current information by participants with more frequent PLEs in our JAS paradigm is liberal acceptance (2, 44, 45): People with a liberal acceptance bias (which is assumed to be more present in people with PLEs and schizophrenia) have a decreased decision threshold for accepting a hypothesis. For example, individuals with schizophrenia put an increased likelihood-rating to conclusions that controls judge as unlikely (46). Similarly, individuals with schizophrenia decide for a lake on the fish task at a lower probability rating (47). Likewise, "liberally accepting" another person's estimate as likely/correct could explain why people with more frequent PLEs put more weight to advice from unknown "previous participants."

## Increased Information Integration and Belief Inflexibility

However, other findings suggest individuals with schizophrenia show a decreased integration of new information and a general belief inflexibility [for a review, see Eisenacher and Zink (4)]. For example in the bias against disconfirmatory evidence paradigm using delusion-neutral material (15) psychosis-prone individuals correct the likelihood rating of scenarios disconfirmed in light of new information to a lesser degree than controls (16, 48). This task behavior has been linked to a lack of evidence integration (integration of disambiguating information) rather than conservatism (unwillingness to give high likelihood ratings) (49, 50). Belief inflexibility in individuals with schizophrenia was also shown in the *What is this?* Task by Serrano-Guerrero et al. (51). Further, from a clinical perspective, individuals with delusions show a strong belief inflexibility regarding their delusions (14, 52).

Thus, one should be particularly careful concluding from this study's results that individuals with more frequent PLEs are generally more ready to change beliefs in light of new information. Instead, future studies should clarify under which conditions psychosis-prone individuals accept new input for the formation of beliefs and under which conditions beliefs are upheld despite disconfirmatory input. These somehow contradictory processes have recently been integrated in two independent reviews by Ward and Garety (53) and Moritz et al. (2) in which one process related to the formation of delusional beliefs and the other to its maintenance.

Furthermore, in a related probabilistic advice-taking task, participants with more frequent PLEs did use less advice and assumed advice to be more intentionally misleading than participants with less frequent PLEs (54). However, there is an important difference to the Aberrant JAS we use: Participants in Wellstein's task had to choose between two colors, for which they had to rely either on a partly volatile advisor or on a non-social cue as they had no additional information on which color to choose. Whereas, participants in our task could also rely on their own judgement and were thus less dependent on advice.

## The Novelty of the Aberrant JAS

We want to point out two important aspects in which the Aberrant JAS differs from classical tasks capturing reasoning in relation to psychosis. Compared to the beads or fish task—from which relevant models (hypersalience of evidence-matching hypothesis, and unstable-attractor network, circular inference) are derived—the Aberrant JAS is not a probabilistic reasoning task, where an optimal solution can be derived. Estimating someone's age based on a photograph "correctly" is very difficult and there is also no obvious optimal solution to advice weighting, especially with multiple contradicting advice (37, 55). At the same time, the Aberrant JAS is presumably easier to understand and involves a scenario much more likely to encounter in the real world. It also provides a much more direct measure on how information is being integrated in a judgement and does not rely on probability or confidence ratings from a rather artificial reasoning task as a measure for information weighting.

Further, the Aberrant JAS is a social task. While social frameworks are a frequent contextual factor for the exacerbation of positive symptoms, the social nature of the task adds noise as different groups possibly have different assumptions about advice (e.g., assuming advice to be hostile). On the other hand, belief formation is a social process (56). Thus, we can assume a special importance of social processes in belief formation in schizophrenia (53). For example, Jolley et al. (57) found that patients with caregivers show much increased belief flexibility than those with no caregivers. This highlights the importance to investigate belief flexibility and cognitive biases in social contexts.

### Limitations and Outlook

This study has important limitations. For example, we have investigated a community sample with no further information on the clinical status of participants. Further, our sample has also shown differences in demographic variables (e.g., age, education). Performance on cognitive bias paradigms have shown to be affected by pharmacological treatment (28, 29), psychological interventions (58), need for care (59), current symptomology (16), and stress (60). Thus, this study needs to be replicated within clinical samples under consideration of these possible confounds. Future studies should also validate the task further, for example by comparing task performance to the bias against disconfirmatory evidence paradigm, by investigating different estimation tasks, or by providing more background information about the advisors. While we believe our differently designed trials (e.g., in terms of number and distance of advice) provide valuable insights for other researchers to design their trials, this variance in trial design likely decreased power. Thus, future studies may focus on specific trial design, for example on trials with outliers only. Finally, *p*-values in exploratory trial-wise analysis need to be treated with caution (61). While all exploratory analyses were based on theoretical assumptions, they were mainly data-driven generating an ignored alpha-error accumulation through multiple *post-hoc* tests. However, our main analyses were preregistered, an important corner-stone in good scientific practice (62).

### Conclusion

This study introduced the intuitive Aberrant JAS, an adapted JAS-paradigm. The Aberrant JAS captures—within a social framework—information integration relevant to cognitive biases related to psychosis. As expected, participants with more frequent PLEs adjusted their estimates more readily toward currently available new advice, especially if this advice was an outlier (differing from previous pieces of advice and one's initial estimate). This increased readiness of participants with more frequent PLEs to change their estimate due to new incoming information challenges previous accounts on a general inflexibility in revising conclusions, but supports models predicting an "overcorrection" due to an elevated weighting of incoming information, which have been related to the formation and maintenance of psychotic experiences or delusions, for example in schizophrenia.

## DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because datasets are only available upon legitimate requests. Requests to access the datasets should be directed to JS, j.scheunemann@uke.de.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Lokale Psychologische Ethikkommission (LPEK) am Zentrum für Psychosoziale Medizin—Martinistrasse 52 20246 Hamburg Germany. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

JS, RF, and SM developed the research idea. SM was PI of the study. RF contributed largely to the discussion. All authors have written and proof-read the manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2021.612810/full#supplementary-material

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# Exploring the Interplay Between Adversity, Neurocognition, Social Cognition, and Functional Outcome in People With Psychosis: A Narrative Review

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History of adversity is associated with subsequent psychosis, and with a spectrum of cognitive alterations in individuals with psychosis. These cognitive features go from neurocognitive aspects as working memory and attention, to complex social cognitive processes as theory of mind and emotional perception. Difficulties in these domains impact patients' social and occupational functioning, which has been shown to be more impaired in those previously exposed to childhood trauma. However, the interplay between adversity, neurocognition, and functioning is yet poorly understood. This narrative review aims to explore the evidence on whether deficits in neurocognitive and social cognitive domains may act as possible putative mechanism linking adversity with functioning in people with psychosis. We show available evidence supporting the link between adversity and poorer functioning in psychosis, especially in chronic stages; and replicated evidence suggesting associations of social cognition and, to a lesser extent, neurocognition with impairment in functioning in patients; although there is still an important gap in the literature testing particularly deficits in social cognition as mediator of the link between adversity and functional decline in psychosis. Targeting interventions focusing on neurocognition and social cognition in individuals with adversity and psychosis seems important, given the severe deterioration of these patients in these domains, although more research is needed to test whether such treatments can specifically improve functioning in individuals with psychosis and adversity. Literature aiming to understand the determinants of functional outcome should consider the pervasive impact of childhood adversity, and its related effects on cognition.

**Keywords: childhood adversity, functional outcome, neurocognition, social cognition, narrative review**

## INTRODUCTION

Psychotic disorders are among the leading causes of disability worldwide (1) with recovery rates in terms of functional level below 15% of the patients with schizophrenia (2). Functional outcome, which covers activities of daily living, vocational activities, social relationships, and degree of independence (3), is a key element of the poor outcome in psychotic disorders, greatly impacting the social disability burden (4). Deficit in functional level is detectable before the onset of the illness, present in its early stages, and it often persists, remaining relatively poor despite resolution of acute psychosis (5). Moreover, evidence suggests some independence of the functional decline from symptom dimensions such as delusions, hallucinations, and disorganization (6). Thus, finding potentially treatable determinants of functional outcome is one of the main goals in schizophrenia research (7, 8).

Both Neurocognition and Social Cognition are also very important domains in psychosis (9–12), and such deficits account for the diversity of functional outcomes in the disorder, more effectively than symptoms (7, 13, 14). Interventions such as cognitive remediation (8), Social Cognition and Interaction Training (SCIT) (15), Social Cognitive Skill Training (SCST) (16) or metacognitive and social cognition training (MSCT) (17), among others (18, 19), have been developed in order to improve such domains, with promising benefits (20). However, despite these observed benefits, whether they have a positive impact on functional outcomes is still unclear (18). Meta-analytic evidence has shown that three-quarters of variance in functional outcome remains to be explained (7), which suggests that other factors also have an impact on functioning.

Childhood adversity affects functioning and cognition in the general population (21, 22), and these domains have been shown also to be more impaired in patients with previous exposure to childhood adversity (21, 23). Evidence suggests that some cognitive biases and neurocognitive domains mediate the link between adversity and psychosis (24, 25). In this regard, Howes and Murray developed a sociodevelopmental-cognitive model, providing an integrated explanation of how the social environment can lead to psychosis through neurobiological changes in the brain as well as cognitive bias (26). Moreover, a recent systematic review has shown that negative schemas about the self, the world and others mediate considerably the adversity-psychosis association (25). However, these works have not covered which potential mechanisms may operate on the link between adversity and functional decline in those with psychotic disorder. A better understanding of the nature of the association between adversity and functional decline, as well as its interplay with neurocognition and social cognition, may help to better define patients at risk of developing such deleterious outcomes and to specifically apply interventions that can target possible mediating mechanisms. Moreover, whether traumatized individuals with psychosis may better benefit from interventions commonly addressed to improve neurocognition or social cognition (8, 18, 27, 28) remains an intriguing unexplored question.

In this review we will explore the interplay between adversity, neurocognition, social cognition, and functional outcome in people with psychosis. To explore this question we will summarize the relevant evidence on the association between adversity and neurocognition (section Adversity and Neurocognition) overviewing the literature on possible biological pathways in this relationship (section Possible Biological Pathways Involved in Cognitive Deficits); explore available evidence on the relationship between adversity and social cognition (section Adversity and Social Cognition); and how neurocognition and social cognition interplay for their impact on functioning in subjects with psychosis (section Interplay Between Neurocognition, Social Cognition, and Functioning in People With Psychosis). We will appraise evidence exploring the link between adversity and functioning in patients (section Adversity and Functional Outcome), and we will explore emerging evidence suggesting possible mediating pathways between adversity and functioning outcome through cognitive domains (section Is There Evidence of a Mediation Between Adversity and Functional Outcome Through Cognition?). Lastly, we will discuss potential clinical implications of current research, as well as methodological issues and gaps in the literature (section Discussion, Future Directions, and Implications).

## ADVERSITY AND NEUROCOGNITION

According to the NIMH-Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS), eight different domains of cognitive impairment have been identified for schizophrenia (9): speed of processing, attention and vigilance, verbal learning, working memory, problem solving, visual learning, and social cognition. In the current work, we will refer to the first seven when talking about neurocognition, and discuss social cognition independently.

Childhood adversity, which occurs during a neurodevelopmental period critical for brain maturation and development, has been linked to earlier pruning, reduced gray matter volume, flexibility impairments, and lower IQ in adulthood (21, 29). We know from both animal and human studies that exposure to extreme stress and trauma during periods of brain development are characterized by lasting changes in brain functioning (30, 31) and in the biological stress system such as the Hypothalamic Pituitary Adrenal (HPA) axis (32, 33). Although biological evidence in the field of trauma and psychosis has focused mainly on positive symptoms or psychosis itself, research has attempted to study possible biological mechanisms linking adversity and cognitive functions.

An increasing body of evidence supports that exposure to early life adversity may affect neurocognition (NC) at presentation in psychosis. A recent meta-analysis consisting of 3,315 individuals with a psychotic illness found a significant negative association (with low effects) between overall cognition and childhood adversity, $r = -0.055$, 95% CI $-0.09$, $-0.02$. Furthermore, when dividing into subdomains of neurocognition, a modest, negative association was observed between childhood trauma and working memory, $r = -0.091$, 95% CI $-0.15$, $-0.03$ (34). As suggested by Vargas et al., an association seems to be present although with low effects, and a careful mapping of different types of childhood adversities, timing of the trauma and severity of exposure is important to drive this field forward (34). One of the few studies that has investigated the association between different types of childhood adversities and cognitive domains found that physical neglect, followed by physical abuse were the strongest predictors of cognitive impairment in psychosis (35). This is supported by a recent independent study by Mørkved et al., which also demonstrated that childhood physical neglect more than other types of trauma were associated with cognitive impairment in adulthood (36). Another important factor is the timing of trauma, which has been found to play an important role on how adversity can increase the risk of psychosis (37), although more studies are needed. For instance, MRI data highlight the importance of specific time of trauma exposure on brain development, given the different processes the brain undergoes between childhood, adolescence, and young adulthood, including periods of production and pruning of synapses and signaling mechanisms (38). Furthermore, it has been reported that reduction in hippocampal volume is associated with childhood sexual abuse at ages 3–5 years and ages 11–13 years, whilst exposure to a stressful event between 14 and 16 years activates the prefrontal cortex (PFC) and is associated with synaptic loss by young adulthood (39). Nonetheless, whether neuroanatomical findings linked to trauma have neurocognitive correlates should still be addressed in future studies.

## POSSIBLE BIOLOGICAL PATHWAYS INVOLVED IN COGNITIVE DEFICITS

Although the biological mechanisms linking adversity with the neurocognitive alterations in patients with psychosis are yet to be fully understood, some biomarkers have been proposed. These studies mainly assess the moderating effect of some biological measures on the association between adversity and cognition in people with psychosis.

The role of cortisol and a dysregulation of the Hypothalamic Pituitary Adrenal (HPA) axis (32, 33) has been extensively studied, with abundant preclinical evidence suggesting that stress increases glucocorticoid secretion, which reduces neurogenesis and synaptogenesis, especially in the hippocampus (40). A putative idea of mechanism could be that trauma is associated with higher levels of glucocorticoids in the brain, leading to a reduction in the number of glucocorticoid receptors in the hippocampus which may reduce the negative feedback from the hippocampus to the HPA axis (41). This results in stress sensitivity, which involves an HPA axis that is over-active and excessively reactive to subsequent environmental stressors, and which further augments glucocorticoid levels (41, 42). There is evidence suggesting that this elevation of glucocorticoids generate neurotoxicity and atrophy in the hippocampus, which may possibly explains the diminution of the size of the hippocampus of patients exposed to adversity (31, 43); as well as their relationship with neurocognitive dysfunction (34).

Brain-derived neurotrophic factor (BDNF) is another important protein for brain development and its low presence may be responsible for the observed reduced plasticity in patients with severe mental disorders (44, 45). A history of childhood adversity or being a met carrier of the BDNF val66met are both associated with a significant reduction of BDNF mRNA levels (46, 47). For example, a study by Aas et al., found that met carriers of the BDNF val66met who reported high levels of childhood trauma (specifically sexual or physical abuse) had reduced volumes of hippocampal subfield CA2/3 and CA4 dentate gyrus compared to patients without childhood trauma and compared to Valine (val/val) carriers (46). Patients who were met carriers and who reported childhood trauma also had the poorest cognitive functioning (48), supporting a role of BDNF levels, childhood trauma, and brain functioning in psychosis. The study is also an example of a two hit model including both environmental and genetic factors targeting the same biological pathway associated with cognitive impairment in psychosis.

Another biomarker suggested to modify the role of trauma on brain development is oxidative stress (49). The study by Alameda et al., found that patients with a higher oxidation status measure in blood was negatively associated with hippocampal volume in those early psychosis patients with trauma, while those with trauma and a lower oxidation status displayed better cognitive functions (specially memory, vigilance/attention, and speed of processing). Thus, as suggested by the authors, a redox profile, characterized by high vs. low oxidation status may represent an important biomarker for defining treatment strategies in traumatized patients with psychosis (49).

Despite this emerging evidence, no clear biological mediating pathway has been consistently explored. Different non-competing biological pathways may be involved and be differentially expressed across individuals with the disorder. Selecting patients based on specific biomarker profiles may allow better capturing the link between adversity and specific neurocognitive domains. Yet, this complex link is far from being fully understood, which makes it difficult to address specific pharmacological means in patients with cognitive impairment (see section Discussion, Future Directions, and Implications).

## ADVERSITY AND SOCIAL COGNITION

Within the social cognition (SC) domain, NIMH consensus recognized five subdomains including: Theory of Mind (ToM), social perception, social knowledge, emotion perception and processing, and attributional style (50). Briefly, ToM involves the ability to infer one's own and other people's mental states (51). Social knowledge refers to awareness of the roles, rules, and goals that characterize social situations and guide social interactions (52), and social perception indicates the ability to judge these roles, rules, and relationships in a social context (53). Emotional recognition is measured as the accuracy at recognizing the emotions of others. Attributional style refers to an individual's tendency to see events as being caused by the self, other individuals or external factors (54). Metacognition is another, broader, social cognitive concept overlapping with the above categories, and is defined as the awareness and understanding of one's own and others' mental processes (55).

Despite the available literature exploring the links between childhood adversity and neurocognitive domains in people with psychosis (34), less attention has been paid to the impact of adversity on social cognition. Associations between different forms of adversity and domains of social cognition have been reported in the general population (56, 57) and in non-psychotic disorders (58), but to the best of our knowledge only 13 studies have addressed this question in samples of individuals with psychosis. **Table 1** shows available studies examining the association between abuse or neglect and social cognition domains in people with psychosis. These papers have all been published from 2016 onwards, except one in 2011 (62) which shows the growing amount of interest in this field in recent years. As a whole, seven studies contained analyses with at least one significant association between a category of abuse and a social cognitive domain (24, 60–62, 66, 70, 71); six with a category of neglect (24, 64, 65, 68–70); two with a composite category of adversity (59, 64), and only one study didn't find any association between adversity and social cognition (67). Regarding time of exposure, only one study examined this, showing that neglect at age 11–12 was the strongest predictor of deficits of emotion regulation and mentalizing abilities (69).

Nonetheless, the high levels of heterogeneity in the measures used preclude pointing at specific effects between childhood adversity types and social cognitive subdomains. Furthermore, samples were fairly small, with just one sample above 200 cases (24); and only one study was conducted in FEP (70). Moreover, concerns have been raised with regards to the validity of psychometric properties of existing measures in social cognitions domains in people with psychosis, suggesting an urgent need to improve such instruments (72, 73).

We can conclude that there is some emerging evidence suggesting a link between exposure to abuse, neglect and a dysfunction of various social cognitive domains, but research is still limited and needs consistent replication in large samples.

## INTERPLAY BETWEEN NEUROCOGNITION, SOCIAL COGNITION, AND FUNCTIONING IN PEOPLE WITH PSYCHOSIS

Consistent evidence has accumulated during the last 20 years suggesting the presence of an association between neurocognition and social cognition with functional outcome in people with psychosis (7, 14, 74). Individuals who are able to comprehend social and emotional stimuli may have acquired better interpersonal and communication skills, and thus have a better functional capacity. On the other hand, greater problems in the storage and processing of information in memory and in the ability to think flexibly about abstract ideas results in greater difficulties in thinking about and recognizing emotions (66).

The last meta-analysis in this field, conducted on 166 studies and 12,868 participants has revealed that the association between neurocognition, social cognition and functional outcome shows small-to-medium effect sizes, with 7.3% of the overall variance in functional outcome explained by social cognition, against 4.4% for neurocognition (7). In line with others (75, 76), this work suggests a possible partial mediation between neurocognition and functioning through deficits in social cognition (7), indicating that neurocognition deficits may precede the latter. Despite these relevant findings, it remains to be understood which are the other determinants of the deficits of functioning in patients with psychosis, since a great amount of variance remains unexplained (6). For example, it remains to be explored whether cognitive bias such as negative schemas about the self the world and others, or jumping to conclusions may play a role in the adversity-functional decline dyad in those with psychosis. Moreover, the effect sizes of the associations between neurocognition, social cognition, and functioning being small to medium could mean that deficits in social cognition or neurocognition may be particularly deleterious for specific groups of patients. This suggests the importance of better understanding which subgroups of patients have greater risk to develop social cognition and neurocognition deficits and subsequently poorer functional outcomes, being those patients exposed to trauma potentially among those more vulnerable subgroups.

## ADVERSITY AND FUNCTIONAL OUTCOME

In the last 20 years, childhood adversity has been studied as another potential factor predisposing to functional decline in people with psychosis. Lysaker et al. showed in 2001 for the first time that a history of sexual abuse was associated with poorer social abilities in a sample of chronic patients suffering from schizophrenia, and subsequent work extended these findings to the vocational and work performance domains (54). Also, participants with histories of maltreatment were significantly more likely to have poorer peer relationships in childhood, and more difficulty in school (77). An increasing number of studies were conducted since, replicating these findings examining mainly the impact of abuse and neglect in small samples of chronic patients with schizophrenia (78), some of them following prospective designs (79, 80). From 2010, larger studies in First-episode of psychosis (FEP) emerged, and interestingly, when the functional level was measured at baseline, in most of them no differences between exposed and non-exposed to abuse were found (23, 81, 82), with still some exceptions (83). Results examining the long-term impact of adversity on functioning are mixed, especially with FEP patients. For instance, Alameda et al. (49) and Alameda et al. (23) showed long lasting detrimental effects on functioning up to 3 years of follow-up as measured with the GAF; while neither Trotta et al. (83) nor Ajnakina et al. (84) did find such differences in GAF at 1 year and 5 years follow-up, respectively. However, the latter showed that living alone was more likely in patients exposed to parental separation (84). Two recent large studies in patients with psychosis (85, 86) confirm

**TABLE 1 |** Characteristics of the studies examining the association between abuse or neglect and social cognition domains in people with psychosis.

| Study | Country | Participants *N* (% female) | Age Mean | Measures of childhood adversity | Cognitive measures | Functional outcome measures | Main findings |
|---|---|---|---|---|---|---|---|
| Aas et al. (59) | Norway | 101 SMI (45%) | 31.9 | CTQ | Brain activation measured with fMRI during presentation of faces with negative or positive emotional expressions | GAF | Stronger differentiation in brain responses between negative and positive faces with higher levels of trauma |
| Aydin et al. (60) | Turkey | 35 SCZ (37.1%)<br>35 HC (60%) | 29.91 SCZ<br>31.05 HC | CTQ | MAS-A | / | Childhood emotional abuse was related to metacognitive capacity |
| Brañas et al. (61) | Spain | 62 SCZ (46.8%) | 31.15 | Semi-structured interview | HT; DFAR | / | Patients with childhood trauma other than sexual abuse were more able to recognize fear as a facial emotion |
| Choi et al. (62) | USA | 143 SMI (51%) | 38.47 | Adapted subscale of the childhood maltreatment assessment scale of (63) | HT; I-SEE | NOSIE-30 | The adverse effects of the severity of history of child physical abuse on social functioning were compensated for by greater social inference and lower external locus of control |
| Garcia et al. (64) | Spain | 79 EP (39.2%)<br>58 HC (48.3%) | 25.34 EP<br>23.95 HC | CTQ | MCCB | GAF | Childhood trauma was associated with poorer social cognition |
| Kilian et al. (65) | South Africa | 56 FEP (25%)<br>52 HC (33%) | 23.8 FEP<br>25.1 HC | CTQ | MCCB | / | The association between neglect and social cognition was present and was not illness-specific |
| Lysaker et al. (66) | US | 101 SZ (15.2%) | 46.26 | TAA | MAS; BLERT; WCST; WAIS-III; HVLT; CPT-II | / | Patients with a history of childhood sexual abuse had lower awareness of other people's emotions |
| Mansueto et al. (24) | Netherlands | 757 SMI (25%) | 27.66 | CTQ | WLT; CPT-HQ; WAIS-III; HT | / | In male psychotic patients, lower mentalization, attention and vigilance mediated the association between childhood neglect and negative symptoms, disorganization, and excitement, while poor working memory mediated association between childhood abuse and disorganization, excitement, and emotional distress |
| Palmier-Claus et al. (67) | UK | 20 SZ (35%)<br>20 FEP (20%)<br>14 UHR (57.1%)<br>120 HC (70.8%) | 39.6 SZ<br>24.6 FEP<br>22.6 UHR<br>20.1 HC | CTQ | HT; RMET | PSP | Childhood adversity significantly predicted worse social functioning, but greater in the non-clinical compared to the clinical sample |
| Rokita et al. (68) | Ireland | 74 SZ (32.4%)<br>116 HC (44.8%) | 44.6 SZ<br>35.0 HC | CTQ | HT; RMET; ERT; WAIS-III | / | Association between physical neglect and emotion recognition in both groups |
| Schalinski et al. (69) | Germany | 168 SMI (33.3%)<br>50 HC (44%) | 27.9 SMI<br>26.8 HC | MACE | MCCB | / | Cumulative adverse childhood experiences and physical neglect at age 11 were significantly negatively associated with social cognition in patients |
| Trauelsen et al. (70) | Denmark | 92 non-affective FEP (27.2%) | 22.4 | CTQ | MAS | / | Different types of childhood trauma were associated with better metacognitive abilities |
| Weijers et al. (71) | Netherlands | 87 non-AP (35.6%) | 31.7 | CECA | HT | SFS | The severity of parental abuse was associated with mentalizing impairment, but not with social dysfunction |

*SMI, severe mental illness; CTQ, Childhood Trauma Questionnaire; GAF, Global Assessment of Functioning Scale; fMRI, functional magnetic resonance imaging; SCZ, schizophrenia; HC, healthy control; MAS, Metacognition Assessment Scale; HT, Hinting Task; DFAR, Degraded Facial Affect Recognition; I-SEE, Inventory for Self-Efficacy and Externality; NOSIE-30, Nurses' Observation Scale for Inpatient Evaluation Total Positive Subscale; EP, early psychosis; MCBB, MATRICS Consensus Cognitive Battery; SZ, schizophrenia or schizoaffective disorder; TAA, Trauma Assessment for Adults; BLERT, Bell-Lysaker Emotion Recognition; WCST, Wisconsin card sorting test; WAIS-III, Wechsler adult intelligence scale III; HVLT, Hopkins verbal learning test; CPT-II, Conners Continuous Performance Test II; WLT, World Learning Task; CPT-HQ, Continuous Performance Test; PSP, Personal and Social Performance Scale; RMET, Reading the Mind in the Eyes Task; ERT, Emotion Recognition Task; FEP, First Episode Psychosis; UHR, Ultra High Risk; MACE, Maltreatment and Abuse Chronology of Exposure Scale; non-AP, non-affective psychosis; SFS, Social Functioning Scale.*

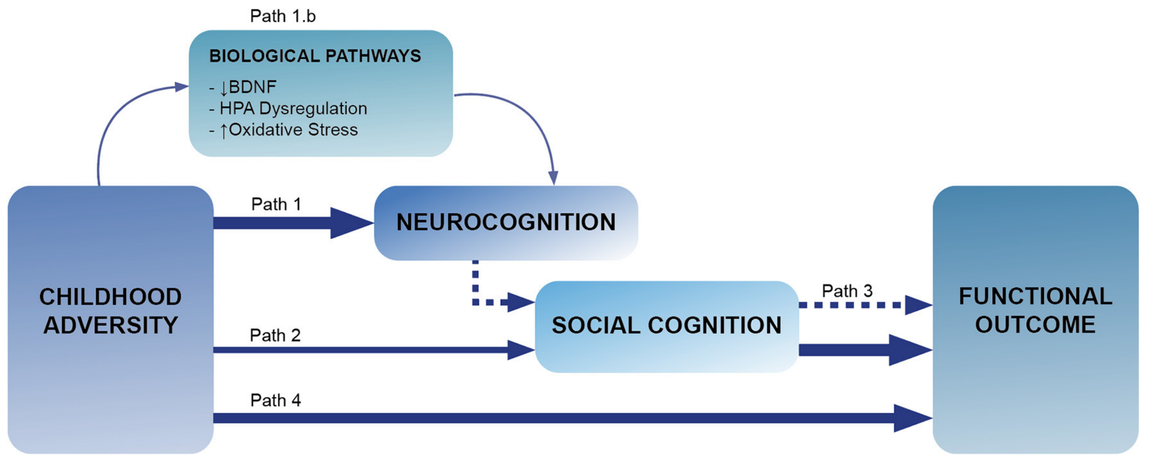


**FIGURE 1 |** This Figure illustrates the paths explored in this review. Path 1 explores the links between adversity and neurocognition (section Introduction), with path 1.b looking for biological mechanism linking this association (section Adversity and Neurocognition). Path 2 refers to the associations between childhood adversity and social cognition (section Possible Biological Pathways Involved in Cognitive Deficits),with path 3 exploring the links between neurocognition, social cognition and functioning (section Adversity and Social Cognition). Lastly, path 4 corresponds to the links between childhood adversity and functioning (section Interplay Between Neurocognition, Social Cognition, and Functioning in People With Psychosis).

the association between exposure to different adversity types and poorer social outcomes after adjusting for a broad range of confounders. These studies highlight other important aspects such as greater effects for non-affective psychoses as compared to affective psychoses (85); the presence of cumulative effects; and a stronger association between emotional trauma and poorer functional outcomes (86).

These disparities between chronic and FEP, and between baseline and follow-up measures can be attributed to different reasons. First, as previously mentioned, the timing of trauma, which has been often underreported (87), can be acting as an important moderator. As far as we know, only two studies have addressed this issue in FEP samples, showing that adversity prior to age 12 is more deleterious and long lasting as compared to when adversity occurs between 12 and 16 (23, 88). Second, observed differences between baseline and follow-up could be due to the progressive development of other mediating or confounding factors during the illness phase and which are not yet present at onset, for example neurocognitive or social cognitive deficits (as aforementioned discussed). Another suggested reason is the potential varying effect of different personality traits (89), and the heterogeneity in outcome measures used across studies, with broad measures such as GAF possibly diluting and masking specific effects between specific subtypes of adversity and functional domains (71).

In summary, heterogeneous evidence suggests a link between exposure to adversity such as abuse, neglect and early parental separation on a range of functioning outcomes, although specific effects need to be better understood. So far, this association seems to be more often present in chronic individuals with psychosis, with the reasons for this yet to be explored; there is some evidence suggesting some cumulative effects (86); and it seems there is a more pervasive effect when exposure occurs earlier (23, 88).

## IS THERE EVIDENCE OF A MEDIATION BETWEEN ADVERSITY AND FUNCTIONAL OUTCOME THROUGH COGNITION?

As it has been shown in this review and as it can be illustrated in **Figure 1**, there is consistent evidence suggesting a link between adversity and functioning; between neurocognition, social cognition and functioning, with suggestions that deficits in neurocognition may precede those in social cognition; and some emerging studies suggesting that adversity also may be associated with social cognitive deficits in patients. Therefore, it seems reasonable to hypothesize that neurocognitive and social cognitive domains may act as mediators between adversity and functioning. However, evidence testing this hypothesis is poor, and the limited evidence available does not support such a hypothesis. Only two studies have tested this in patients with psychosis, both testing social cognition as a mediator (67, 71), and none of them found evidence of mediation. Another study (62) did not test meditation effects, but examined whether deficits in social inference (measured by The Hinting Task) were moderating the effect of adversity on social dysfunctioning measured during 12 months of psychiatric rehabilitation. To the best of our knowledge, no study explored the mediating effect of neurocognition in the adversity-functioning association.

Although a possible mediating role of social cognition between adversity and functioning has been shown in studies conducted in the general population, based on the current evidence, we cannot imply that this is the case in psychosis. However, since only two studies were found testing this hypothesis, we believe that more research is required and that this remains a plausible hypothesis that should be further addressed in future.

## DISCUSSION, FUTURE DIRECTIONS, AND IMPLICATIONS

Most of the research conducted in trying to understand the connections between adversity and psychosis has focused on positive symptoms as the outcome of interest (25). However, as suggested in our review, other domains, also affected by adversity, such as functional decline and cognition, have been notably less well-studied, despite constituting key targets for recovery (7, 90). Considerable effort has been made in trying to understand the determinants of functional outcome considering different aspects of psychopathology and demographic factors (6) or neurocognition and social cognition (7, 14, 74). However, research to date has rarely considered the potential determinant effect of adversity in that equation, and how it can interacts with other important domains, which has been the focus of the current work.

Research presented in this review suggests that when considering the determinants of functional outcome, childhood adversity needs to be considered. As illustrated in **Figure 1**, our review provides emerging evidence showing a link between adversity and neurocognition (sections Adversity and Neurocognition and Possible Biological Pathways Involved in Cognitive Deficits) and social cognition (section Adversity and Social Cognition) and between childhood adversity and functional impairment (section Adversity and Functional Outcome). Given the links between adversity, neurocognition, social cognition, and functional outcome, there is ground to hypothesize that exposure to adversity may lead to functional impairments in patients through deficits in neurocognition and social cognition, with those in neurocognition preceding the social cognition ones (**Figure 1**). So far, only two studies have tested the potential mediating effects of social cognition between adversity and functioning (67, 71), where no evidence of such mediation was found. Nevertheless, these pioneer studies were conducted in small samples (141 subjects overall) and require replication. We strongly believe that this is an area that needs to be further explored, and we hypothesize that, despite the so far negative studies, mediation is plausible and should be further investigated.

With regards to biology, addressing studies in the future testing biological mediating mechanisms between adversity and neurocognitive and social cognitive domains will allow exploration of new potential pharmacological targets that could be used as add-on to enhance interventions addressing cognitive deficits (91). In this line, a plausible pathway is related to oxidative stress, which could potentially be corrected with antioxidants, such as N-Acetyl Cysteine (NAC), making it a promising add-on to therapies targeting SC and NC (92). This is of particular interest given evidence showing that traumatized individuals with a better redox status (lower oxidation) showed better cognitive domains as compared with traumatized subjects with higher oxidation and to non-traumatized subjects in terms of cognitive functioning (49). Interestingly, randomized controlled trials in people with psychosis have shown that NAC, a potent antioxidant agent, has shown efficacy in improving cognitive domains in FEP (93) and functioning in chronic patients (94). Supplementing cognitive remediation therapy with antioxidant compounds in people with psychosis with a disrupted redox homeostasis may help to improve their cognition, and subsequently enhance their functional level.

Regarding therapies targeting SC deficits, such as SCIT and SCST, results are still mixed in their potential positive impact on functional outcome from a recent review (7), but the studies included did not take into account the possible moderating effect of exposure to adversity. In light of our findings on the association between adversity and social cognition, we suggest that further studies should test the efficacy of such interventions taking into account exposure to adversity.

## CONCLUSIONS

There are solid grounds to suggest that individuals with psychosis and a history of adversity have poorer neurocognitive functions than those without histories of adversity, with also emerging evidence suggesting a link between abuse, neglect, and various social cognitive domains in patients with psychosis. Literature suggests that deficits in neurocognition precedes those in social cognition, and that these domains are particularly deleterious for functioning. To date, no evidence has demonstrated that deficits in cognition may mediate the links between adversity and functioning, but this needs to be further explored as research is still scarce. Different non-competing biological pathways involving the HPA axis, or alterations in the levels of neurotrophic factors and redox dysregulation may be triggered by adversity experiences leading to cognitive alterations in psychoses. These pathways could be differentially expressed across individuals. Selecting patients based on specific biomarker profiles may allow studies to better capture effects between adversity, specific neurocognitive and social cognitive domains, and the ultimate impact on functioning, which can eventually allow specific pharmacological and therapeutic targets to be developed. More research to better understand which subgroups of patients are at greater risk to develop neurocognitive and social cognitive deficits and subsequently poorer functional outcomes is warranted.

## AUTHOR CONTRIBUTIONS

LA developed the rational and idea of the present manuscript. VR coordinated and aligned the different contributions. All co-authors contributed in parts of the writing and revision of the present review.

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# The Indirect Effect of Trauma via Cognitive Biases and Self-Disturbances on Psychotic-Like Experiences

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Although self-disturbances (SD) are considered to be a core psychopathological feature of schizophrenia spectrum disorders, there is still insufficient empirical data on the mechanisms underlying these anomalous self-experiences. The aim of the present study was to test a hypothesized model in which cognitive biases and exposure to traumatic life events are related to the frequency of SD which, in turn, contribute to the frequency of psychotic-like experiences (PLEs). Our sample consisted of 193 Polish young adults from the general population (111 females; 18–35 years of age, M = 25.36, SD = 4.69) who experience frequent PLEs. Participants were interviewed for PLEs, SD and social functioning as well as completed self-reported questionnaires and behavioral tasks that measure cognitive biases (e.g., safety behaviors, attention to threat, external attribution, jumping to conclusion, source monitoring, overperceptualization). The model was tested using path analysis with structural equation modeling. All of the hypothesized relationships were statistically significant and our model fit the data well [$\chi^2(23) = 31.201$; $p = 0.118$; RMSEA = 0.043 (90% CI = 0.00–0.078), CFI = 0.985, SRMR = 0.041, TLI = 0.976]. The results revealed a significant indirect effect of traumatic life events on PLEs through SD and self-reported cognitive biases. However, performance-based cognitive biases measured with three behavioral tasks were unrelated to SD and PLEs. The frequency of SD explained a substantial part (43.1%) of the variance in PLEs. Further studies with longitudinal designs and clinical samples are required to verify the predictive value of the model.

**Keywords: self-disturbances, psychotic-like experiences, adverse life events, trauma, cognitive biases, psychosis risk**

## INTRODUCTION

Phenomenological analyses along with empirical studies suggest that self-disturbances (SD), which are anomalous experiences of basic sense of self, are the core psychopathological feature and phenotypic trait marker of schizophrenia spectrum disorders (1–6). SD refers to the so-called minimal or basic self ("ipseity"), which is conceptualized as the tacit, pre-reflective level of selfhood and the ground of various aspects of conscious awareness (5). It is thought that instability of this minimal self gives rise to anomalous subjective experiences (e.g., a sense that one's thoughts are anonymous and "not mine," a feeling as if the boundary between self and world is unclear), which may evolve into frank psychotic symptoms (7). In fact, it has been shown that SD precede the development of clinical symptoms of psychosis (8, 9) and may be observed also among patients at risk for psychosis (10–12). Koren et al. (13), in a study of non-psychotic help-seeking adolescents, showed that SD and subclinical psychotic symptoms constitute related but distinct dimensions of potential risk. Furthermore, SD has been found to be related to psychotic-like experiences (PLEs) in non-clinical samples (14–18). These studies, indicating that SD, along with PLEs, are present both in non-clinical and clinal samples, are in line with the hypothesis of a continuous distribution of psychotic symptoms in the general population (19).

Despite SD great importance to the conceptualization of psychosis, there is still insufficient empirical data on the mechanisms underlying these experiences. Recent studies have shown (16, 17) that cognitive biases, that is, dysfunctional information processing patterns leading to maladaptive conclusions and emotional dysregulation, are related to SD. Nelson et al. (20) introduced a theoretical model in which source monitoring deficits are proposed as one of the neurocognitive correlates of SD, especially in the sense of "ownership" of experiences. Source monitoring is a cognitive bias that involves difficulties in making attributions about the origins of experience, for example, whether an event happened to us, whether we just imagined it or someone told us about it. The recent study by Nelson et al. (21) confirmed the relationship between source monitoring, assessed using a variety of neurocognitive and neurophysiological tasks, and SD in patients with early psychosis. The cognitive model of positive symptoms of psychosis (22) emphasizes the importance of cognitive distortions in generating anomalous conscious experiences as well.

Another contributor to SD could be traumatic experiences. Recently, growing evidence suggests that traumatic life events play a significant role in the development of psychosis (23–25). Exposure to trauma is not only significantly more frequent in schizophrenia spectrum disorders than in the general population (25, 26), but also early adverse life events increase the frequency of PLEs in non-clinical individuals (27–29). However, the mechanisms of the relationship between trauma and psychosis still needs further investigation. Sass and Borda (30) proposed that schizophrenia spectrum disorders manifest through SD that could be *primary* or *secondary* in nature. *Primary* SD reflect disturbances in early neurodevelopment, whereas *secondary* SD appear later as *defensive-compensatory reactions* to other factors such as childhood adversities, social stress and marginalization. Haug et al. (31) found that traumatic events are indeed significantly associated with higher levels of SD in patients with schizophrenia, but only in women. Recent studies have shown that SD mediate the relationship between traumatic-life events and psychosis proneness in the general population (16, 17). These results suggested that trauma may affect the risk of psychosis through alterations in the basic sense of self.

Based on the above-mentioned literature, the aim of the current study was to test the hypothesized model of cognitive biases and exposure to traumatic life events being related to the frequency of SD which, in turn, contribute to the frequency of PLEs. Therefore, we expected an indirect effect of traumatic experiences and cognitive biases on PLEs through SD. We focused on positive PLEs, since the assumed relationships between variables of interest concern primarily this dimension of psychotic experiences. This model is an extension of one that was previously proposed and tested in a sample of university students (16). The current study was conducted amongst people drawn from the general population (i.e., a non-clinical population) who experience frequent PLEs and therefore are at psychometric risk of developing psychosis. The selected group was evaluated in terms of meeting clinical criteria of ultra-high risk (UHR) of psychosis. The goal of this strategy was to estimate the prevalence of clinical risk of psychosis among people from the general population who are not seeking help. For the measurement of cognitive biases, we used both self-report questionnaires and performance-based behavioral tasks, as they can possibly represent somewhat different constructs (32).

## MATERIALS AND METHODS

### Participants

Our study was conducted in two stages (see **Figure 1**). First, a total sample of 6,264 Polish young adults (3,932 females) aged between 18 and 35 years (M = 26.51, SD = 4.76) were screened for psychometric risk of psychosis using the Prodromal Questionnaire (PQ-16) (33). Screening was carried out via Internet in collaboration with an external company specializing in acquiring for research purposes large population samples and conducting online surveys. Completing the online survey took about 20–30 min. Participants were enrolled from three large Polish cities: Warsaw (1,700,000 inhabitants), Krakow (770,000 inhabitants) and Wroclaw (640,000 inhabitants). Those who scored within 7%[1] of top results on the PQ-16 (i.e., had frequent PLEs) and met inclusion criteria were approached to participate in the second stage of the study conducted through face to face assessment. Exclusion criteria for participants were screened with self-report questions which included: a history of any psychotic or neurological diagnosis, history of antipsychotic medication treatment and substance dependence disorder in the previous 6 months. Other psychiatric diagnoses such as major depressive disorder (without psychotic symptoms), bipolar disorder (without psychotic symptoms), personality disorders or anxiety disorders were not considered as exclusion criteria. Four hundred thirty-eight people met inclusion criteria, however 245 respondents could not be contacted or refused to participate in the second stage of the study. The final sample consisted of 193

[1]We planned to recruit approximately 200 participants from approximately 6000 subjects (3.3% of the sample studied) who would achieve scores on the PQ-16 within the top 10%. We chose a wider percentage of the highest scores to recruit from, expecting that not all participants would meet the inclusion criteria and would be willing to take part in the second stage of the study. Finally, we examined 193 people whose results on the PQ-16 against the entire sample turned out to be in the top 7%.

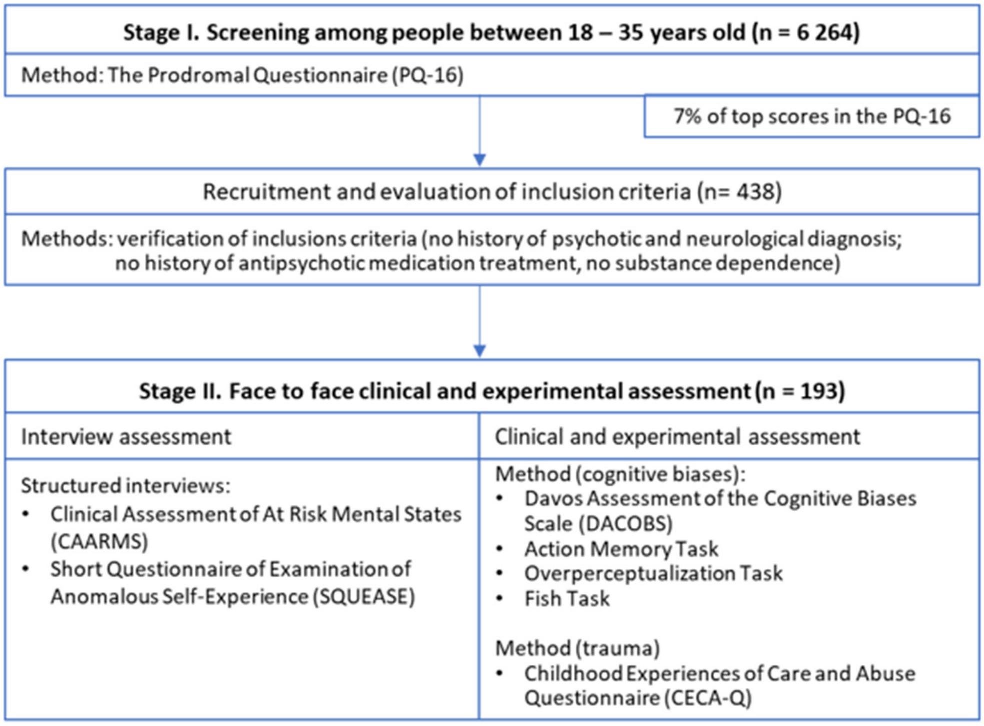


**FIGURE 1 |** Consort flow-chart presenting the course of the study.

individuals (111 females, age M = 25.36, SD = 4.69). Face to face assessment in the second stage of the study involved assessment of SD, PLEs, exposure to traumatic life events and cognitive biases. The participants' informed consent was obtained and the ethics committee of the Medical University of Warsaw approved the study.

## Measures

### Psychotic-Like Experiences

To assess PLEs in the screening stage of the study we used the sixteen-item Prodromal Questionnaire (PQ-16) (33). The PQ-16 is a self-report questionnaire to screen for psychosis risk operationalized as a presence of PLEs. It is a shortened version of the 92-item PQ and consists of items that assess perceptual abnormalities and hallucinations, unusual thought content, delusional ideas, and paranoia as well as negative symptoms on a scale: present vs. non-present –(true vs. false) which we modified to better reflect the frequency of PLEs. Specifically, we used a four-point scale: "never", "sometimes", "often", and "almost always". The scores range from 0 to 48 points. Most of the items in the PQ-16 refer to attenuated positive psychotic symptoms. The PQ-16 has satisfactory psychometric characteristics in the assessment of PLEs with a specificity and sensitivity of 87% in discriminating patients meeting the criteria of UHR from those who do not meet UHR criteria (33). The scale was validated also in non-help-seeking populations (34, 35). We used a Polish version of the questionnaire (17). Cronbach's alpha for the total score was 0.82.

To evaluate PLEs for their clinical relevance in the second stage of the study we used the Comprehensive Assessment of At-Risk Mental States (CAARMS) (36), for the Polish version see: Jaracz et al. (37). The CAARMS is a semi-structured interview designed to investigate different aspects of attenuated psychopathology and functioning factors over time. The CAARMS consists of seven subscales: positive symptoms (subclinical delusions and hallucinations); negative symptoms (anhedonia, blunted affect, social withdrawal); cognitive changes; behavior changes; motor or physical changes; emotional disturbances; general psychopathology. This instrument allows for assessment of clinical state of UHR of psychosis. Symptoms are evaluated for their severity and frequency on scales ranging from 0 to 6. In our study, we focused on the severity and frequency of the positive symptom subscale that includes: unusual thought content, non-bizarre ideas, perceptual abnormalities, and disorganized speech. The positive symptoms subscale served as an indicator of psychosis proneness (with the combined score for the frequency and the severity subscales from 0 to 48). Cronbach's alpha for this subscale calculated in our sample was 0.82.

### Self-Disturbances

To evaluate SD we used the SQUEASE (Møller, private materials). This is a short version of the Examination of Anomalous Self-Experience (EASE), which is a semi-structured phenomenological interview developed by Parnas et al. (38) to examine a wide variety of anomalies considered to be

**TABLE 1** | Sample characteristics.

| | *N* (%) | | Mean (SD)/Score range |
|---|---|---|---|
| Gender | | Age | 25.36 (4.69) |
| Male | 82 (42.5%) | PQ-16 (screening) | 23.06 (4.49)/0–48 |
| Female | 111 (57.5%) | SQUEASE (total score) | 16.12 (11.97)/0–52 |
| Professional situation | | CECA.Q | |
| Study | 97 (50.3%) | Mother antipathy | 20.33 (7.59)/8–40 |
| Work | 130 (67.4%) | Mother neglect | 14.92 (6.13)/8–40 |
| Unemployed | 7 (3.6 %) | Father antipathy | 21.14 (9.13)/8–40 |
| Rent | 3 (1.6%) | Father neglect | 21.36 (6.91)/8–40 |
| Education | | Mother psychological abuse | 18.55 (15.06)/0–85 |
| Primary | 11 (5.7%) | Father psychological abuse | 16.23 (17.80)/0–85 |
| Secondary | 1 (0.5%) | Role reversal | 53.58 (10.60)/17–85 |
| Vocational | 87 (45.1%) | Physical abuse | 0.41 (0.49)/0–1 |
| Incomplete higher | 31 (16.1%) | Sexual abuse | 0.35 (0.85)/0–3 |
| Higher | 63 (32.6%) | CAARMS (total score) | 61.89 (36.18)/0–324 |
| Psychiatric diagnosis | 46 (23.8%) | Positive symptoms | 9.88 (7.48)/0–48 |
| Anxiety disorder | 23 (11.9%) | SOFAS | 79.71 (12.54)/0–100 |
| Depression | 30 (15.5%) | DACOBS (total score) | 162.41 (27.61)/42–294 |
| Bipolar disorder | 3 (1.6%) | Jumping to conclusion | 27.04 (5.11)/7–42 |
| Obsessive-compulsive disorder | 1 (0.5%) | Belief inflexibility | 18.87 (5.42)/7–42 |
| Eating disorder | 4 (2.1%) | Attention to threat | 27.30 (5.27)/7–42 |
| Personality disorder | 9 (4.7) | External attribution | 22.45 (5.81)/7–42 |
| Other | 3 (1.6%) | Social cognition problems | 26.12 (6.33)/7–42 |
| | | Subjective cognitive problems | 26.26 (7.18)/7–42 |
| | | Safety behaviors | 14.36 (6.17)/7–42 |
| | | Fish Task | |
| | | JTC 80:20 | 5.29 (2.52)/1–10 |
| | | JTC 60:40 | 7.93 (2.71)/1–10 |
| | | Action Memory Task | |
| | | Incorrect recognitions | 4.06 (2.44)/0–36 |
| | | Overperceptualization Task | |
| | | False auditory perceptions | 13.59 (15.11)/0–72 |

*PQ-16, Prodromal Questionnaire; SQUEASE, short version of Examination of Anomalous Self-Experience; CECA.Q, Childhood Experience of Care and Abuse Questionnaire; CAARMS, Comprehensive Assessment of At-Risk Mental States; DACOBS, Davos Assessment of the Cognitive Biases Scale; Fish Task JTC, number of fish needed to make decision; Action Memory Task incorrect recognitions, number of incorrect recognition of both performed and imagined actions. The score for CAARMS is the sum of severity and frequency scales. The score for SQUEASE is the sum of frequency scale.*

disorders of basic or "minimal" self. The construction of EASE was based on self-descriptions obtained from patients suffering from schizophrenia spectrum disorders. The EASE was used also in non-clinical populations (14, 39). The short version (the SQUEASE) was created by Møller, one of the co-authors of EASE. The SQUEASE consists of 13 items that are grouped into four sections: (1) Cognition and Stream of Consciousness (items include: disorder of short-term memory, attentional disturbances, ruminations-obsessions, thought interference, thought pressure, loss of thought ipseity) (2) Self-Awareness and Presence (items include: distorted first-person perspective, diminished sense of basic self, hyperrefl ectivity, derealization (3) Bodily Experiences (items include: mirror-related phenomena), (4) Existential Reorientation (items include: existential or intellectual change, feeling as if the experienced world is not truly real). These items evaluate SD for their frequency and level of presence on scales ranging from 0 to 4. The possible result for the frequency scale is in the range from 0 to 52. Cronbach's alpha calculated in our sample for the frequency scale was 0.84.

## Exposure to Traumatic Life Events

Childhood Experiences of Care and Abuse Questionnaire (CECA.Q) (40) was used to investigate traumatic life events retrospectively such as lack of parental care (neglect and antipathy), parental psychological abuse, role reversal, parental physical abuse, and sexual abuse from an adult before the age of 17. The CECA.Q has been validated among psychotic patients (41) as well as in non-clinical samples (42, 43). It consists of different types of trauma subscales that allow for a wide assessment of traumatic life events. Cronbach's alpha for the total score in our sample was 0.96.

### Social Functioning

Social and Occupational Functioning Assessment Scale (SOFAS) (44) is a one-item rating of an individual's functioning scored 0–100. It is intended to assess social and occupational functioning independently of the overall severity of symptoms.

### Self-Report Cognitive Biases

The Davos Assessment of Cognitive Biases Scale (DACOBS) (45), for the Polish version, see: Gaweda et al. (46) is a self-report scale that assesses cognitive biases associated with psychosis. The questionnaire contains 42 items to be scored on a 7-point Likert scale, therefore the scores range from 42 to 294 points. All items are grouped into seven subscales and three clusters related to different types of biases: (1) specifically associated with psychosis: jumping to conclusions bias, belief inflexibility bias, attention to threat bias, external attribution bias, (2) associated with cognition: social cognition problems and subjective cognitive problems, and (3) related to coping strategies: safety behaviors. Cronbach's alpha for the total score was 0.89.

### Performance-Based Cognitive Biases

Three computer-based tasks were used to assess different cognitive biases:

*Overperceptualization bias* was measured with a computer-based task of auditory false perceptions—Overperceptualization Task (47). The overperceptualization paradigm assesses the process by which individuals recognize auditory stimuli when in fact they are not present. In this task participants are presented with stimuli in the form of words in three conditions: (1) words can only be heard (audio condition, 60 trials), (2) words can be spoken by a lector who is heard and simultaneously seen on the screen (video condition, 60 trials), (3) before the lector appears on the screen, participants see a board with the word that will be spoken (board condition, 60 trials). Each word is accompanied by background noise making the word difficult to recognize. In 40% of stimuli in each of the three conditions, the lector does not read the word, but only moves his mouth; thus only noise can be heard. Participants have to decide after each word whether they heard a word or not and determine the degree of certainty in their decision. Subjects are instructed to respond as quickly as possible. False auditory perceptions (i.e., hearing a word when it was not spoken) serve as an indicator of overperceptualization bias (ranging from 0 to 72).

*Source monitoring deficits* were evaluated with Action Memory Task (AMT). The AMT is a computer-based task (48), for Polish version see: Gaweda et al. (49) comprising of 36 actions that are described to participants through text messages (18) or shown through images (18). Each action is imagined or performed by participants. Imagined actions are presented with a red frame, actions that have to be performed have a green frame. Each action is presented for 10 s. The memory retrieval phase starts after a short break. All imagined and performed actions are shown to the participants in random succession, as well as new ones (56 actions in total). In a recognition part of the study, participants are asked to attribute all actions as they were presented. The sum of performed actions recognized as imagined and imagined actions recognized as performed was used as an indicator of source monitoring deficits (ranging from 0 to 36).

*Jumping to conclusions bias* was measured with Fish Task (50). This task is a revised and computerized version of the beads task (51, 52) which differs from the original task in that a different scenario (lakes with fish instead of jars with beads) is presented. We used two versions of the probabilistic reasoning task which varied in terms of the discrimination ratio. The first version had a high discrimination ratio (80:20) with unambiguous evidence, whereas the second was more difficult with fish in low discriminability (60:40), representing more ambiguous evidence. The instructions were standardized and presented on a computer screen. After each fish was "caught" participants were required to make two judgments: (1) a probability judgment about the likelihood that the fish was caught from either lake A or lake B, and (2) judgment as to whether the available amount of information would justify a decision or not. The number of draws (from 1 to 10) needed to make a decision was an indicator of jumping to conclusion bias (with fewer draws indicating increased jumping to conclusions bias).

## Statistical Analysis

All statistical analyses were performed with SPSS version 25.0 and Amos version 25.0.

First, we tested for correlations among the variables of interest by calculating Pearson's correlational coefficients. SD and their relationship with exposure to traumatic life events are at the center of our interest, thus we explored this association in more detail by checking which traumatic events are related to SD. Then, we performed confirmatory factors analysis (CFA) of the latent variable of self-report cognitive biases to verify the original structure of this measure. For performance-based cognitive biases, we aimed to build a factorial model consisting of the results of three tasks: Action Memory, Overperceptualization and Fish Task. PLEs, SD and exposure to traumatic life events were represented in our model by single indicator variables. This decision was dictated by the absence of an established factorial model for positive symptoms in CAARMS, SQUEASE and CECA.Q measures. It also enabled conserving free parameters and increased stability of the parameter estimates for the models.

In the next step, we evaluated hypothesized associations with the structural equation model (SEM) in a series of path analyses to test our theoretical model. Therefore, we tested for the indirect effect of traumatic life events through SD and cognitive biases to PLEs. For this purpose, we used the bootstrap method as recommended by Preacher and Hayes (53). Due to different measurement methods (questionnaire vs. computer-based tasks) we aimed to perform path analyses separately for self-report and performance-based cognitive biases.

The goodness of fit to the data for both analyses (CFA and path analyses) were estimated with the maximum likelihood estimation procedure with the Bollen-Stine bootstrap ($n$ = 2,000) procedure of correction for non-normal distribution. We verified goodness of model fit following the guidelines from literature (54): RMSEA < 0.06 (The Root Mean Square Error of Approximation); SRMR < 0.08 (The Standardized Root Mean

**TABLE 2 |** Correlational analysis.

| Variable | SQUEASE self-disturbance | CAARMS positive symptoms | DACOBS total score | Jumping to conclusion | Belief inflexibility | Attention to threat | External attribution | Social cognition problems | Subjective cognitive problems | Safety behavior | JTC 80:20 | JTC 60:40 | Action Memory Task | Overpercept Task |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mother antipathy | 0.043 | 0.016 | 0.265*** | 0.036 | 0.251*** | 0.095 | 0.273*** | 0.197** | 0.160* | 0.207** | −0.40 | −0.031 | 0.010 | −0.116 |
| Mother neglect | 0.051 | 0.025 | 0.202** | 0.018 | 0.216** | 0.055 | 0.231** | 0.134 | 0.202** | 0.064 | 0.013 | −0.003 | 0.104 | −0.041 |
| Father antipathy | 0.080 | 0.025 | 0.187** | 0.090 | 0.102 | 0.095 | 0.258*** | 0.131 | 0.110 | 0.086 | −0.037 | −0.061 | −0.089 | −0.043 |
| Father neglect | 0.097 | 0.023 | 0.151* | 0.026 | 0.002 | 0.093 | 0.239** | 0.098 | 0.138 | 0.087 | 0.039 | −0.029 | −0.072 | −0.049 |
| Mother psychological abuse | 0.127 | 0.038 | 0.210** | 0.050 | 0.104 | 0.120 | 0.246** | 0.148* | 0.136 | 0.164* | 0.074 | −0.029 | −0.032 | −0.150* |
| Father psychological abuse | 0.168* | 0.066 | 0.212** | 0.090 | 0.026 | 0.178* | 0.250*** | 0.173* | 0.146* | 0.119 | −0.012 | −0.088 | −0.081 | −0.017 |
| Role reversal | 0.081 | 0.068 | 0.149* | 0.149* | 0.031 | 0.153* | 0.159* | 0.136 | 0.027 | 0.063 | 0.013 | −0.07 | −0.171* | 0.028 |
| Physical abuse | −0.012 | −0.060 | −0.006 | 0.035 | 0.002 | −0.030 | 0.130 | −0.046 | −0.069 | −0.027 | 0.028 | −0.015 | −0.077 | −0.082 |
| Sexual abuse | 0.091 | 0.108 | 0.134 | 0.077 | 0.075 | 0.116 | 0.135 | 0.036 | 0.090 | 0.102 | −0.038 | −0.081 | −0.104 | −0.124 |
| Self-disturbances | | 0.629*** | 0.275*** | −0.095 | 0.154* | 0.142* | 0.169* | 0.225** | 0.354*** | 0.250** | −0.017 | 0.033 | −0.069 | 0.032 |
| DACOBS total | 0.275*** | 0.322*** | | 0.230** | 0.700*** | 0.732*** | 0.763*** | 0.816*** | 0.708*** | 0.664*** | −0.138 | −0.093 | 0.155* | 0.132 |
| Jumping to conclusion | −0.095 | −0.053 | 0.230** | | 0.183* | 0.240** | 0.128 | −0.031 | −0.134 | −0.097 | −0.118 | −0.156* | 0.027 | 0.059 |
| Belief Inflexibility | 0.154* | 0.246** | 0.700*** | 0.183* | | 0.348*** | 0.437*** | 0.518*** | 0.413*** | 0.383*** | −0.215** | −0.074 | 0.195** | 0.099 |
| Attention to threat | 0.142* | 0.144* | 0.732*** | 0.240** | 0.348*** | | 0.513*** | 0.528*** | 0.365*** | 0.466*** | −0.085 | −0.122 | 0.096 | 0.081 |
| External attribution | 0.169* | 0.174* | 0.763*** | 0.128 | 0.437*** | 0.513*** | | 0.585*** | 0.481*** | 0.386*** | −0.057 | −0.044 | 0.221** | 0.087 |
| Social cognition problems | 0.225** | 0.321*** | 0.816*** | −0.031 | 0.518*** | 0.528*** | 0.585*** | | 0.596*** | 0.501*** | −0.179* | −0.082 | 0.002 | 0.155* |
| Subjective cognitive problems | 0.354*** | 0.295*** | 0.708*** | −0.134 | 0.413*** | 0.365*** | 0.481*** | 0.596*** | | 0.377*** | 0.048 | 0.073 | 0.036 | 0.034 |
| Safety behavior | 0.250** | 0.311*** | 0.664*** | −0.097 | 0.383*** | 0.466*** | 0.386*** | 0.501*** | 0.377*** | | −0.075 | −0.077 | 0.118 | 0.110 |
| CAARMS positive symptoms | 0.629*** | | 0.322*** | −0.053 | 0.246** | 0.144* | 0.174* | 0.321*** | 0.295*** | 0.311*** | 0.002 | 0.064 | −0.056 | 0.092 |
| JTC 80:20 | −0.017 | 0.002 | −0.138 | −0.118 | −0.215** | −0.085 | −0.057 | −0.179* | 0.048 | −0.075 | | 0.463*** | 0.010 | −0.106 |
| JTC 60:40 | 0.033 | 0.064 | −0.093 | −0.156* | −0.074 | −0.122 | −0.044 | −0.082 | 0.073 | −0.077 | 0.463*** | | 0.058 | −0.071 |
| Action Memory Task | −0.069 | −0.056 | 0.155* | 0.027 | 0.195** | 0.096 | 0.221** | 0.002 | 0.036 | 0.118 | 0.010 | 0.058 | | 0.123 |
| Overpercept Task | 0.032 | 0.092 | 0.132 | 0.059 | 0.099 | 0.081 | 0.087 | 0.155* | 0.034 | 0.110 | −0.106 | −0.071 | 0.123 | |

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

*SQUEASE, short version of Examination of Anomalous Self-Experience; CAARMS, Comprehensive Assessment of At-Risk Mental States; DACOBS, Davos Assessment of the Cognitive Biases Scale; JTC, Jumping to Conclusion Fish Task.*

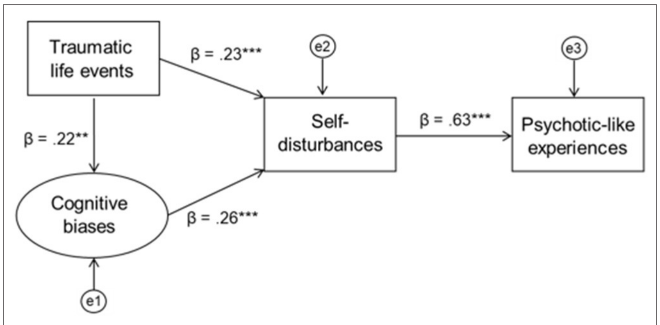


**FIGURE 2 |** The model of the direct relationship between self-disturbances and psychotic-like experiences with childhood trauma and self-report cognitive biases as the potential contributors to self-disturbances.

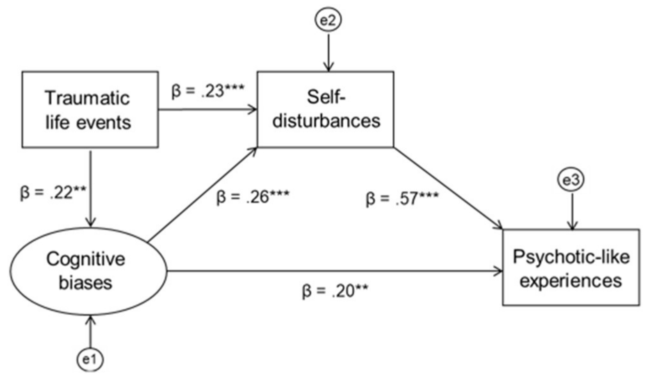


**FIGURE 3 |** The model of the indirect relationship between childhood trauma and psychotic-like experiences with self-disturbances and cognitive biases as the potential mechanisms underlying this relationship.

Square Residual); CFI > 0.95 (Confirmatory Fit Index) and TLI > 0.95 (Tucker- Lewis Index).

# RESULTS

## Characteristics of the Sample

The sample characteristics are presented in **Table 1**. Fifty-one participants from the sample of 193 individuals (26.4%) met the symptom criteria for UHR status after being interviewed with the CAARMS. However, full criteria for UHR status were not met as the group was not help-seeking and their social functioning, as measured using the SOFAS, did not meet UHR functional decline/chronic low functioning requirements.

## Correlational Analysis

**Table 2** presents the results of the correlational analysis. The strongest significant relationship was found between SD and PLEs ($r = 0.629$, $p < 0.001$). SD correlated significantly also with self-report cognitive biases and psychological abuse from the father. Except for physical and sexual abuse, all other types of traumatic life events significantly correlated with self-report cognitive biases. It is of note that no subscale of CECA.Q was significantly related to PLEs. These statistically significant relationships among variables of interest allowed for further testing of our hypothesized model with SEM. Surprisingly, no significant relationships were found between performance-based cognitive biases and SD as well as PLEs, thus planned path analysis with these variables was not performed. Furthermore, we found a highly significant correlation between self-report cognitive biases and PLEs. Thus, we decided to investigate an additional model including this path. Gender was not included in path analyses as it was not significantly related to exposure to trauma and other variables of interest. Age significantly correlated with SD ($r = -0.176$, $p < 0.05$), PLEs ($r = -0.181$, $p < 0.05$) and cognitive biases ($r = -0.162$, $p < 0.05$). However, those paths turned out to be insignificant thus we did not include them in the final analyses.

## Measurement Model

Due to the inability to confirm the original latent structure of the 42-item DACOBS questionnaire measuring cognitive biases, we decided to use as indicator variables the sum of the points obtained in each subscale instead of all single items. We removed only jumping to conclusion subscale because of its insignificant loading. Thus, the final latent structure for self-report cognitive biases consisted of six indicators (belief inflexibility, attention to threat, external attribution, social cognition problems, subjective cognitive problems, and safety behaviors) and fit the data well [$\chi 2$ (7) = 2.791, $p > 0.05$; RMSEA = 0.00 (90% CI = 0.000–0.037), CFI = 1.00, TLI = 1.023, SRMR = 0.014]. For PLEs, SD and traumatic life events, we used single indicator variables, which was the sum of the frequency and severity scales obtained for all items in the positive symptoms subscale of CAARMS and in father psychological abuse subscale of CECA.Q. In the case of SD we used only the sum of the frequency scale, as the level of presence is a qualitative scale.

## Path Analyses

Results of first path analysis suggested a model that fit the data well [$\chi 2$ (23) = 33.780, $p = 0.068$; RMSEA = 0.049 (90% CI = 0.000–0.083), CFI = 0.980, TLI = 0.968, SRMR = 0.044]. However, the path from father psychological abuse to SD turned out to be insignificant. A detailed model is presented in the **Supplementary Figure 1**. Therefore, we checked for correlations between SD and all single items representing trauma. We selected 12 specific items measuring trauma that were significantly related to SD and used their sum as an indicator variable of exposure to trauma in further path analyses. Those items originally constituted psychological abuse (nine items), role reversal (two items) and parental care (one item) subscales. Detailed correlational analysis between the SQUEASE and CECA.Q items is presented in **Supplementary Table 1**.

The first model with initially hypothesized relationships is depicted with its standardized path coefficients (standardized regression weights) in **Figure 2**. The bootstrapping estimate revealed a significant standardized indirect effect of traumatic life events through SD and cognitive biases to PLEs (β = 0.181, 95% CI = 0.102–0.267, $p = 0.001$). This model explained 39.6% of the variance in PLEs. All of the model fit indices were satisfactory: $\chi 2(24) = 40.847$; $p = 0.017$; RMSEA = 0.060 (90% CI = 0.025–0.091), CFI = 0.968, SRMR = 0.059, TLI = 0.953.

The second model includes an additional path from self-report cognitive biases to PLEs and is presented in **Figure 3**. Standardized indirect effect of traumatic life events through SD and cognitive biases to PLEs was significant ($\beta = 0.207$, 95% CI = 0.126–0.293, $p = 0.001$). The percentage of the variance explained in PLEs was equal to 43.1%. The model has a good fit: $\chi 2(23) = 31.201$; $p = 0.118$; RMSEA = 0.043 (90% CI = 0.00–0.078), CFI = 0.985, SRMR = 0.041, TLI = 0.976.

## DISCUSSION

In the current study, we focused on the relationship between SD and PLEs with exposure to traumatic life events and cognitive biases as potential mechanisms underlying SD. All of the hypothesized associations were found to be statistically significant and the model fit the data well. SD along with its postulated mechanisms explained a substantial part of the variance in PLEs, pointing to the importance of this construct in elucidating and understanding psychosis risk. Results of our study, although obtained in a non-clinical sample, are in line with the basic-self-disorder model of schizophrenia (5, 55).

Several points should be noted regarding the results of our study. First, we found a statistically significant indirect effect of trauma on PLEs, which is consistent with many theoretical and empirical accounts on the role of trauma in shaping psychosis risk (56–59). However, the strength of this relationship was smaller than we expected. One of the possible reasons could lie in the nature of our sample. Although participants in the study reported the highest frequency of PLEs from the screening sample, they functioned well-socially and professionally. In fact, one-quarter of them met the symptomatic criteria for UHR and it was a relatively high level of their functioning that excluded a full diagnosis of this kind. It is likely that individuals with higher social and professional functioning have been less frequently exposed to traumatic-life events (60).

Moreover, we did not find a direct relationship between trauma and PLEs, which contradicts the results obtained in other research (61–63). However, de Vos et al. (64) in their recent study among UHR for psychosis youth acquired similar outcomes, that is, childhood trauma appeared to be unrelated to attenuated psychotic symptoms. In fact, some researchers found the relationship between maltreatment and PLEs to be fully mediated by various mechanisms such as borderline personality features, dissociation, perceived stress, negative-other beliefs or external locus of control (16, 65–67). Those results are consistent with the postulate that trauma alone is not a sufficient factor to cause PLEs (68). The results of our study suggest that to provoke PLEs exposure to trauma first may need to disturb the basic sense of self and trigger dysfunctional changes in information processing from the environment. According to Sass and Borda (30) the relationship between trauma and SD could be explained by dissociative reactions. They introduced the concept of *secondary* diminished self-presence, one of the aspects of SD, that could be the result of defensive—and in this sense secondary—dissociative reactions to traumatic situations (55). Indeed, the associations between trauma and SD or trauma and dissociation were found in both clinical (31, 69) and non-clinical (16, 17, 66) samples. It has also been shown that dissociative processes are related to childhood adversity in patients with schizophrenia spectrum disorders (69, 70) and in psychosis proneness (71).

The role of the second possible mechanism of SD—cognitive biases—is somewhat more difficult to interpret. Although self-report cognitive distortions showed an association between trauma and PLEs, this was not the case for *performance*-based cognitive biases. None of the tasks we used in our study was significantly related to neither SD nor PLEs. Moreover, even the correlations between the two distinct measures of cognitive biases turned out to be much smaller and less numerous than we expected. It is possible that self-report and behavioral tasks assess two different aspects of cognitive biases, that is, the first may capture subjective opinion and be a more or less stable, trait-like construct, whereas the second is the objective measure of distortions that are present here and now (i.e., more state like) and in relation to specific perceptual material. Therefore, performance in behavioral tasks may be more influenced by immediate context and affective state for example, whether the person is feeling stressed, relaxed, distracted at the time of testing. This discrepancy between self-report measures and objective neuropsychological results has been observed in previous studies (72, 73). Another possible reason is that behavioral tasks could be less sensitive measures for capturing biased cognitive processes in non-clinical samples. Future studies should investigate the relationship between objective and subjective measures of information- processing biases in more detail and in clinical groups.

It is worth noting that although we hypothesized cognitive biases affect PLEs solely through SD, correlation analysis clearly indicated a highly significant direct relationship between cognitive biases and PLEs. Path analyses suggest that although there is an indirect effect of trauma on PLEs, our results suggest cognitive biases also make a direct and unique contribution to PLEs that goes beyond the presence of SD. This is in line with a cognitive model of psychosis (22, 74) which assumes that biased information processing can directly give rise to psychotic symptoms. Indeed, previous studies have shown that delusions or delusional ideation, for example, are associated with attributional biases (75, 76) or an exaggerated tendency to pay attention to threat (77–79). It has been postulated that exposure to traumatic events in childhood distorts cognitive schemas in a way that people view the world as threatening and attribute negative events and experiences to external factors (17, 29, 66, 80). These distorted cognitive schemas are then used to interpret and explain new experiences in a paranoid framework (56).

Our model may have clinical implications. Different risk factors such as a history of exposure to trauma, cognitive biases and SD should be considered jointly in screening procedures to maximize chances for identifying people who are at the highest risk for psychosis. As SD was the variable that had the highest regression coefficient with PLEs, particular attention should be paid to identify these anomalous self-experiences when detecting individuals at risk and preventing the development of full-blown psychosis (8). Cognitive biases that were found in our study to be both directly and indirectly associated with PLEs can be successfully addressed in cognitive-behavioral therapy (CBT), for example through metacognitive training (81, 82). Furthermore, Škodlar et al. (83) provided a compelling theoretical account of how psychotherapy may be targeted to the amelioration of SD.

The results of the study should be interpreted in light of its strengths and limitations. The strengths of the study lie in the combination of different levels of measures, namely self-report, clinical interviews and behavioral tasks. To the best of our knowledge, this is the first study simultaneously examining trauma exposure and different types of cognitive biases and their relation to SD and PLEs in a non-clinical sample. However, the cross-sectional design of the study precludes causal inference. Therefore, future longitudinal studies in clinical samples are needed to address causality and capture the change in SD and PLEs over time. Further validation of our model should be carried out using the full version for the clinical interview of SD, the EASE (38). This would allow for an examination of relationships between specific aspects of SD and other variables of interest. Moreover, it should be noted that we focused only on positive PLEs, therefore our results do not relate to the entire range of PLEs, such as negative or disorganized PLEs. Lastly, as our model was tested in a specific sample of people with frequent PLEs, thus the results should not be generalized to the clinical risk of psychosis or people with low or medium frequency of PLEs.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the ethics committee of the Medical University of Warsaw, Poland. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

ŁG and RP-U: conceptualization and writing. RP-U: data curation, formal analysis, roles/writing—original draft, and visualization. ŁG: funding acquisition. RP-U, AC, DF, and ŁG: investigation. ŁG, DF, and AC: methodology, project administration, resources, and software. LG: supervision. All authors review & editing.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2021.611069/full#supplementary-material

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# The Relationship Between Different Aspects of Theory of Mind and Symptom Clusters in Psychotic Disorders: Deconstructing Theory of Mind Into Cognitive, Affective, and Hyper Theory of Mind

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**Background:** Several meta-analyses highlight pronounced problems in general Theory of Mind (ToM), the ability to infer other persons' mental states, in patients with psychosis in comparison to non-clinical controls. In addition, first studies suggest associations between Hyper-ToM, an exaggerated inference of mental states to others, and delusions. Research on different ToM subtypes (Cognitive ToM, Affective ToM, and Hyper-ToM) and symptom clusters of psychosis (positive, negative, and disorganized symptoms) have gathered conflicting findings. Thus, the present study examined group differences between patients with psychosis and non-clinical controls concerning Cognitive ToM/Affective ToM and Hyper-ToM. Further, the association between ToM subtypes and symptom clusters (positive, negative, and disorganized symptoms) were examined.

**Methods:** Patients with psychotic disorders ($n$ = 64, 1/3 with present delusions indicated by a minimum score of four in the *PANSS* P1 item) and non-clinical controls ($n$ = 21) were examined with assessments of Cognitive ToM and Affective ToM abilities and Hyper-ToM errors using the Frith-Happé animations. Psychopathology was assessed using the Positive and Negative Syndrome Scale.

**Results:** Patients with psychosis presented more pronounced problems in Cognitive and Affective ToM in comparison to non-clinical controls, whereas there were no group differences with regard to Hyper-ToM errors. Furthermore, deficits in Cognitive ToM were associated with general delusions, whereas problems in Affective ToM were associated with negative and disorganized symptoms. In addition, there was no association between Hyper-ToM errors and any symptoms when controlling for years of education.

**Conclusions:** Our findings suggest that deficits in ToM subtypes might not be directly related to delusions and positive symptoms and are in line with more recently developed cognitive models of delusions. In addition, our results support the well-established finding of associations between ToM alterations and negative or disorganized symptoms. Our results shed light on the role of different dimensions of ToM in specific symptoms of psychosis.

**Keywords: psychosis, delusion, cognitive biases, theory of mind, social cognition, Frith-Happé animations**

## INTRODUCTION

Theory of Mind (ToM) is defined as the ability to infer other persons' mental states, including their thoughts, intentions, and emotions (1). Frith (2) was the first one to link problems in ToM with psychosis, and he postulated ToM deficits as a predisposing cognitive factor for delusions. Delusions are defined as abnormal beliefs that are believed with absolute conviction, experienced as self-evident truths, and not modifiable by experience (3). Deficits in ToM are one out of five core components of social cognitions (ToM, social perception, social knowledge, attributional bias, emotional processing) (4) and have since then been widely studied in patients with psychotic disorders (5). Social cognition is defined as 'the mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviors of others' (4). Thus, deficits in ToM are closely related to problems in social functioning (6–8) and a lower quality of life in patients with psychosis (8).

Several meta-analyses indicated deficits in the overall ToM ability in psychotic patients, their ToM performance was on average more than one standard deviation below the performance of non-clinical controls (9–12). In addition, problems in ToM depend on patients' phase of illness: patients with an acute psychotic episode show more pronounced ToM deficits in comparison to patients with remitted symptoms of schizophrenia (9). Thus, ToM deficits were intensely discussed within theoretical models of psychosis as a potential risk factor (13–17).

To investigate how ToM deficits in individuals are associated with specific symptoms of psychosis, several earlier studies subdivided the symptoms of patients with psychosis into symptom clusters: symptoms of disorganization, positive symptoms ("reality distortion"), and negative symptoms (18). In a recent meta-analysis that summarized these findings, patients with disorganized symptoms were most impaired in ToM, followed by patients with negative symptoms and then patients with positive symptoms (11, 18). Thus, ToM in general as a cognitive correlate of symptom clusters in psychosis is well studied, but we know little about specific associations between ToM and psychotic symptom subdomains as negative or positive symptoms (e.g., delusions and hallucinations).

Concerning the relationship between specific positive symptoms such as delusions (of persecution) and ToM, several studies summarized in a review (17) found correlations between ToM deficits and more pronounced persecutory delusions (19–22) and general delusions (21), whereas other studies did not find an association (23, 24). In their review, Garety and Freeman assumed that about half of the studies found associations between problems in ToM and delusions, whereas the other half of the studies did not report associations and this observation led the authors to exclude ToM from their current theoretical models of the formation and maintenance of delusions (16).

One explanation for these inconsistent findings might be the fact that a large number of previous studies that assessed ToM deficits in patients with psychosis used a simple dichotomous right-or-wrong answer format. In these studies, wrong answers were typically interpreted as reduced ToM/undermentalizing. In terms of reduced ToM, it seems necessary to distinguish between deficits in more cognitive or more affective ToM abilities, which could lead to a differentiated understanding of the association between psychotic symptoms and reduced ToM subtypes. Whereas, cognitive ToM requires a cognitive understanding of the other person's mental state including their thoughts and intentions, affective ToM is defined as an empathic evaluation of the other person's emotional state (25). Nevertheless, only a small number of studies investigated cognitive and affective ToM separately in patients with psychosis (21, 25, 26). Results of these studies indicate that deficits in cognitive ToM were associated with positive symptoms (21, 26), whereas problems in affective ToM were linked with more pronounced negative symptoms (25, 26). Thus, these findings suggest that both ToM abilities may be involved in different cognitive processes, so overall, to better understand the relationship between reduced ToM abilities and specific psychotic symptoms, it is important to consider and assess both reduced ToM abilities: cognitive ToM and affective ToM (27).

An additional explanation for the heterogeneous results regarding the relationship between ToM and positive symptoms/delusions in psychotic patients is the Hyper-ToM/overmentalizing approach according to Frith (2) and Abu-Akel (28), which complements previous research on reduced ToM/undermentalizing. Hyper-ToM is defined as an excessive attribution to other people's state of mind, and this excessive attribution leads to inaccurate conclusions about their mental state (28, 29). Thus, ToM problems can be viewed on a continuum from reduced ToM to Hyper-ToM and both can lead to errors in ToM tasks, but a differential error analysis would reveal these distinct error types. Therefore, the concept of Hyper-ToM has not always been sufficiently considered in previous research, while more recent studies focus increasingly on Hyper-ToM (30–33). Interestingly, Frith proposed that patients with delusions present more problems in Hyper-ToM/overmentalizing in comparison to undermentalization (34). In support of this assumption, the first results suggest an association between Hyper-ToM errors and more pronounced positive symptoms (19, 26, 32, 33) and delusions in particular

(19, 26). Thus, Hyper-ToM errors, rather than general deficits in ToM, may play an important role in the formation and maintenance of delusions and positive symptoms of psychosis.

In summary, the present study aims to investigate the relationship between problems in different subtypes of ToM (cognitive ToM, affective ToM, and Hyper-ToM) and various symptom clusters of psychosis (positive, negative, and disorganized symptoms) in a large sample of patients with psychosis using a reliable and valid ToM assessment. In specific, we hypothesized that patients with psychosis are more severely impaired in cognitive ToM and affective ToM and show more pronounced Hyper-ToM errors compared to non-clinical controls (1). We further assumed that those deficits in cognitive ToM are associated with more pronounced positive symptoms and, in particular, with delusions (2), whereas deficits in affective ToM are associated with negative symptoms and symptoms of disorganization (3). In addition, we assumed that more pronounced Hyper-ToM errors are associated with positive symptoms in general and delusions in particular (4).

# MATERIALS AND METHODS

## Participants

Participants were 64 patients diagnosed with a psychotic disorder (schizophrenia $n = 54$; schizoaffective disorder $n = 8$; delusional disorder $n = 1$; acute psychotic disorder $n = 1$) and 21 non-clinical controls. Inclusion criteria were a psychotic disorder verified by the *Structured Clinical Interview for DSM IV (SCID-IV)* (35). Additional inclusion criteria were age between 18 and 65 years and adequate language skills. Exclusion criteria for patients were the presence of a borderline personality disorder, dementia, or substance use disorder in the last six months (verified by the *SCID-IV* and patient files). Exclusion criteria for the non-clinical controls were a psychotic disorder in their lifetime or another mental disorder within the last ten years (verified by the *SCID-IV*).

## Recruitment and Procedure

Eligible patients were contacted via their attending physicians/therapists and then informed about the study by the study assistant and signed the informed consent form. Non-clinical controls were recruited via notices on public places and mailing lists for University students and matched with the first 21 patients already recruited in terms of age, gender, and educational level (3:1 matching due to inadequate funding). As compensation, patients received a financial payment (20€). Non-clinical controls received either a financial payment (20€) or, if desired, a certificate of attendance to meet their curriculum requirements (e.g., ECTS), as 11 of the 21 non-clinical controls were students. All participants gave a written declaration of informed consent. The present study was approved by the local ethics committee.

In the first session, trained raters conducted the *SCID-IV* interview (35) and the *PANSS* interview [*Positive and Negative Syndrome Scale,* (36)]. In the second appointment, participants filled out questionnaires on sociodemographic data and verbal IQ. Then, a study assistant conducted the *Frith-Happé animations paradigm* (37). Due to the length of the interviews, the patients' assessments took place at two different appointments to avoid concentration problems.

## Instruments

Verbal intelligence was estimated using the German IQ test *Mehrfachwahl-Wortschatztest* [*MWTB*; (38)]. The MWTB is a vocabulary IQ test and consists of 37 tasks, in which the participant is asked to distinguish one target word from four distracting non-words. The authors described the MWTB as a reliable and valid instrument.

Positive symptoms, negative symptoms, and general psychopathology were assessed using the *Positive and Negative Syndrome Scale* (36), a semi-structured interview, in which 30 symptoms are measured on a seven-point Likert scale. The PANSS rating was based on the German version of the Structured Clinical Interview for PANSS (39). The PANSS ratings were carried out by trained raters who received ten training units to conduct and evaluate the PANSS interview. The inter-rater reliability (ICC, corr. $R^2$) was satisfactory to high (between 0.74 and 0.91). In the statistical analyses, we used the 20-item, five-factor PANSS model proposed by Wallwork and colleagues (40), which presented the best model fit in factor analyses (41) and consists of the factors: positive, negative, disorganized, excited, and depressed factor. In the present study, we used the positive, negative and disorganized symptom factors. In addition, general delusions were assessed with the PANSS item P1 and persecutory delusions were assessed with the PANSS item P6. To ensure that the results we obtained regarding associations between psychopathology and ToM scores were independent of the PANSS factor model, we also used the PANSS factor model proposed by van der Gaag and colleagues (42) and the PANSS negative symptom factors by Liemburg and colleagues (43), the results are provided in the **Supplementary Material**.

Theory of Mind was assessed using the advanced multiple-choice version (37) of the *Frith-Happé animations paradigm* (44), an objective and standardized test (37). Abell and colleagues (44) developed the test in its original version, which White (37) found to be time-consuming and subjective. Therefore, she developed a more objective and feasible evaluation method through a series of multiple-choice questions, which was used in the present study. The authors identified the Frith-Happé animations as a sensitive and reliable instrument (37).

The Frith-Happé animations consist of twelve short animated videos of two triangles performing three different kinds of movements: (1) they either move randomly and do not seem to interact with each other (random condition), (2) they move in a goal-directed manner and one triangle responds and interacts with the physical actions or behavior of the second triangle (goal-directed condition) or (3) their movements indicate that one triangle infers the mental state of the second triangle and reacts on it (ToM condition) (37). After two practice animation trials including feedback by the experimenter, the videos were presented in a pseudo-randomized order. The participants watched the videos and were then asked to first categorize them in a multiple-choice format either as indicating random movement (RD), goal-directed movement (GD), or movements of the triangles indicating that one triangle reacted on the other triangle's putative mental state (*Cognitive ToM*). If an animation was correctly identified as indicating Cognitive ToM, participants were then asked at the end of the animation to rate the feelings of the triangles towardz each other by selecting the appropriate feeling out of five suggested feelings in a multiple-choice format (*Affective ToM*). To assess Hyper-ToM errors, we developed an additional scoring, comparable to previous studies (45). A weighted score with a maximum total score of 12 was determined, consisting of eight possible errors in categorizing random videos as either goal-directed (score = 1) or as ToM (score = 2) or goal-directed videos were categorized as ToM (score = 1), these incorrect categorizations were classified as *Hyper-ToM errors*.

## Statistical Analyses

Analyses were conducted using SPSS for Windows (Version 25). Outlier analysis was performed using boxplots. The data were then winsorized, with outliers being replaced by the next highest value in the sample that was not identified as an outlier (46).

Concerning all statistical analyses, the assumed significance level was set at $p < 0.05$. Analysis of the data distribution showed that ToM data and data of *PANSS* symptom factors were not normally distributed, as determined by the Shapiro-Wilk test. In addition, since the range of test scores of the Frith-Happé animations was rather small, ToM data were analyzed using non-parametric tests, as recommended by the test authors (37). Before group comparisons, we checked whether variances are homogenous using Levene tests. If results of Levene tests suggested homogenous variances, groups were compared using ANOVAs, even if variables were not normally distributed, as parametric tests present more pronounced statistical power compared to non-parametric tests (47). If Levene tests suggested heterogeneous variances, we used non-parametric tests.

First, patients with psychosis and non-clinical controls (NC) were compared with regard to sociodemographic and clinical variables using either univariate ANOVAs or Mann-Whitney-*U*-tests depending on preconditions, as outlined above. Chi$^2$ tests were performed to compare the groups in nominal data. In case of statistically significant group differences, we analyzed whether the specific variables were related to Cognitive ToM/Affective ToM/Hyper-ToM, using Pearson correlation coefficients or Spearman correlation coefficients (two-tailed) (depending on the distribution of the data). If there were statistically significant correlations, these variables were included as covariates in further analyses.

Second, patients with psychosis and non-clinical controls were compared in Cognitive ToM/Affective ToM and Hyper-ToM (hypothesis 1), using ANCOVAs, controlling for group differences in sociodemographic data. In case of statistically significant Levene tests, we performed a non-parametric or rank analysis of covariance [ "Quade's test," (48)], which included three steps: First, we transformed ToM scores and data of the covariate to rank data, using the default settings in the SPSS RANK procedure. Second, we performed a linear regression analysis using the rank data of the ToM scores as dependent variable and rank data of the covariates as independent data and saved the unstandardized residuals of the dependent variable. Third, we performed an ANOVA, using the residual data as the dependent variable and the variable group (patients and non-clinical controls) as the criterion variable.

Third, we examined bivariate correlations to investigate the relationship between Cognitive ToM/Affective ToM and symptoms (positive, negative, and disorganized symptoms; general/persecutory delusions) using either Spearman correlation coefficients or Pearson coefficients depending on the presence/absence of normally distributed variables (two-tailed, hypothesis 2 and 3). Finally, we investigated the association between Hyper-ToM errors and delusions (general/persecutory delusions) and positive, negative, and disorganized symptoms using Pearson or Spearman correlations (two-tailed, hypothesis 4). In addition, in the case of statistically significant Levene tests, we performed partial rank correlation analyses to control for group differences in sociodemographic data, which included two steps: First, we performed a non-parametric Spearman rho correlation analysis between ToM scores and symptom data and saved the variables of Spearman rho correlations as the current data set. Second, we computed partial correlations using these correlation variables as the input data and sociodemographic variables as covariates.

# RESULTS

## Sample Characteristics

**Table 1** depicts sociodemographic and clinical variables of patients with psychosis ($n = 64$) and non-clinical controls ($n = 21$). Twenty two of the patients (34.4%) were recruited in an inpatient unit, 32 patients (50%) in an outpatient treatment center, and eight additional patients (12.5%) were recruited via public advertisement. About half of the patients (55%) were female; the mean age was 37.5 years. The mean years of education in the patient group was 13.7 years, and the highest level of education was a graduate degree. Patients with psychosis reported a relatively long duration of their psychotic illness (mean score: 14 years) and a mean number of six psychotic episodes. 41% of the patients were in a remitted phase of their psychotic disorder as indicated by Andreasen (49) and about one-third of the patients ($n = 24$) had acute delusions indicated by a minimum score of four in the *PANSS* (36) P1 item (general delusions).

There were no statistically significant group differences between patients with psychosis and non-clinical controls with regard to age [$F_{(1, 83)} = 0.17, p = 0.68$], gender [$\chi^2_{(1)} = 1.83, p = 0.18$], and estimated verbal IQ [$F_{(1, 83)} = 2.93, p = 0.09$]. Results of an univariate ANOVA indicated statistically significant group differences with regard to years of education [$F_{(1, 80)} = 16.37, p < 0.001$]. In the next step, associations between years of education and ToM variables (Cognitive ToM, Affective ToM and Hyper-ToM) were tested, using Spearman correlation coefficients. There was a statistically significant association between Hyper-ToM errors and years of education ($r_s = -0.33, p = 0.02$), whereas all other associations were not statistically significant [Cognitive ToM ($r_s = 0.23, p = 0.07$); Affective ToM ($r_s = 0.15, p = 0.24$)]. Thus, all further analyses on Hyper-ToM were controlled for years of education.

**TABLE 1 |** Sociodemographic and clinical characteristics of patients with psychosis and non-clinical controls.

| Demographic variables | Patients with psychosis ($n = 64$) M (SD) | n | Non-clinical controls (NC) ($n = 21$) M (SD) | n | Test statistics |
|---|---|---|---|---|---|
| Age (years) | 37.5 (13.2) | 64 | 36.10 (13.15) | 21 | $F_{(1,83)} = 0.17, p = 0.68$ |
| Gender | | | | | |
| Males *N* (%) | 35 (45.3) | 64 | 15 (71.4) | 21 | $\chi 2_{(1)} = 1.83, p = 0.18$ |
| Females *N* (%) | 29 (54.7) | | 6 (28.6) | | |
| Years of Education | 13.7 (4.5) | 62 | 18.6 (5.4) | 20 | **$F_{(1,80)} = 16.37, p < 0.001$** patients < HC** |
| IQ (MWTB) | 105.2 (13.5) | 64 | 111.29 (16.05) | 21 | $F_{(1,83)} = 2.93, p = 0.09$ |
| Clinical variables | | | | | |
| Duration of illness (years) | 14.1 (10.1) | 53 | – | – | |
| Psychotic episodes (number) | 5.9 (6.9) | 57 | – | – | |
| Age of onset of psychotic disorder (years) | 24.6 (10.1) | 41 | – | – | |
| PANSS positive symptom factor (40) | 9.33 (3.77) | 63 | – | – | |
| PANSS negative symptom factor (40) | 12.38 (5.04) | 63 | – | – | |
| PANSS disorganized symptom factor (40) | 5.48 (2.09) | 63 | – | – | |
| PANSS total score | 59.5 (14.6) | 63 | – | – | |
| Andreasen's remission rate *N* (%) | 26 (40.6) | 64 | – | – | |

*M, Mean; SD, Standard deviation; MWT-B, Mehrfachwahl-Wortschatztest (38); PANSS, Positive and Negative Syndrome Scale (36); Remission rate defined according to Andreasen (scores of the PANSS items P1, P2, P3, N1, N4, N6, G5, and G9 item ≤ 3, respectively) (49); One patient perceived the PANSS interview as too stressful, and interrupted the interview, PANSS scores are partially missing for one person. Statistical significance is indicated by bold values.*

## Group Comparisons in Cognitive ToM, Affective ToM, and Hyper-ToM

The results of the group comparisons between patients with psychosis and non-clinical controls (NC) are depicted in **Table 2**. Group comparisons were performed as Mann-Whitney-*U* tests, as all ToM variables were not normally distributed and Levene tests suggested heterogeneous variances. Results indicated that patients with psychosis were more severely impaired in both Cognitive ToM ($U = 444.0$, $z = -2.37$ $p = 0.02$) and Affective ToM ($U = 412.0$, $z = -2.69$ $p = 0.01$) in comparison to the non-clinical controls. Group comparisons in Hyper-ToM were performed as "Quades test" and results suggested no statistically significant group differences [$F_{(1, 73)} = 0.017, p = 0.90$].

## Association Between Cognitive ToM, Affective ToM, Hyper-ToM, and Psychotic Symptoms

The results of Spearman correlation analyses are depicted in **Table 3**. As hypothesized, there was a statistically significant correlation between poorer Cognitive ToM performance and more pronounced general delusions (PANSS P1; $r_s = -0.299$, $p = 0.02$). Cognitive ToM was neither significantly associated with other positive symptoms (Wallworks' PANSS positive factor: $r_s = -0.196$, $p = 0.12$), nor with persecutory delusions (PANSS P6: $r_s = -0.173$, $p = 0.18$). There was a statistically significant association between lower scores in Affective ToM and more pronounced negative symptoms (Wallworks' PANSS negative factor: $r_s = -0.332$, $p < 0.01$) and disorganized symptoms (Wallworks' PANSS disorganized factor: $r_s = -0.286$, $p = 0.02$). Finally, as Hyper-ToM errors were associated with years of education, the association between Hyper-ToM errors and symptoms was controlled for years of education, using a partial Spearman correlation analyses (see **Supplementary Table 1** in the **Supplementary Material**). Results revealed no statistically significant correlation between more pronounced Hyper-ToM errors and disorganized symptoms (Wallworks' PANSS disorganized factor: $r_s = 0.215$, $p = 0.12$) if years of education was included as a covariate. In contrast to our hypotheses, there were no statistically significant associations between Hyper-ToM errors and neither positive symptoms (Wallworks' PANSS positive factor: $r_s = 0.151$, $p = 0.28$), nor delusions (general delusions, PANSS P1: $r_s = 0.187$, $p = 0.18$; persecutory delusions, PANSS P6: $r_s = 0.051$, $p = 0.72$).

## Additional Exploratory Analyses

In additional exploratory analyses, we investigated whether our results might differ if the well-known PANSS factors according to van der Gaag and colleagues (42) were included in the analysis instead of the factor developed by Wallwork (40). Furthermore, we examined the relationship between ToM and the additional negative factors "expressive deficits" and "social amotivation" proposed by Liemburg (43). The results of additional Spearman correlation analyses are depicted in **Supplementary Table 2**. Exploratory analyses revealed that there were no differences in results if analyses were repeated using the PANSS factors proposed by van der Gaag et al. (42) regarding Cognitive ToM, except for the association between Cognitive ToM and the PANSS disorganized factor. Symptoms of disorganization (PANSS disorganized factor) were associated with Cognitive ToM ($r_s = -0.31$, $p = 0.01$). Concerning Affective ToM,

**TABLE 2 |** Comparisons between patients with psychosis and non-clinical controls in Cognitive ToM, Affective ToM, and Hyper-ToM errors.

| | **Patients with psychosis ($n = 64$)** | **Non-clinical controls NC ($n = 21$)** | **Test statistics Mann-Whitney-*U*** |
|---|---|---|---|
| **Frith-Happé animations** | ***M (SD)*** | ***M (SD)*** | |
| Cognitive ToM | 8.88 (1.90) | 9.81 (2.02) | **$U = 444.0$, $z = -2.37$ $p = 0.02$ Patients < NC** |
| Affective ToM | 3.69 (2.11) | 4.86 (1.35) | **$U = 412.0$, $z = -2.69$ $p = 0.01$ Patients < NC** |
| Hyper-ToM | 2.46 (1.78) | 1.95 (1.79) | $F_{(1,73)} = 0.017$, $p = 0.90$ |

*M, Mean; SD, Standard deviation; U, Mann-Whitney-U test; F, "Quades test"; Scoring, For the multiple-choice cognitive ToM, a total score of 12 was the maximum, divided into a maximum of four for each of the animation types. Participants could score a total of 8 for the multiple-choice Affective ToM, corresponding to two possible correct answers for each of the ToM animations. According to previous studies (45), we developed an additional scoring to assess Hyper-ToM. A weighted value was determined with a maximum total score of 12, consisting of eight possible errors when categorizing random videos in goal-directed (value = 1) or in ToM (value = 2) and goal-directed videos in ToM (value = 1). Statistical significance is indicated by bold values.*

**TABLE 3 |** Spearman correlation coefficients between Cognitive ToM, Affective ToM, Hyper-ToM, and clinical symptoms in patients with psychosis.

| | | | **Frith-Happé Cognitive ToM** | **Frith-Happé Affective ToM** | **Frith-Happé Hyper-ToM** |
|---|---|---|---|---|---|
| | **M** | **SD** | **$r_s$ (*p*)** | **$r_s$ (*p*)** | **$r_s$ (*p*)** |
| PANSS positive symptom factor (40) | 9.33 | 3.77 | −0.196 (0.12) | −0.188 (0.14) | 0.169 (0.22) |
| PANSS negative symptom factor (40) | 12.38 | 5.04 | −0.044 (0.73) | **−0.332 (<0.01)** | −0.095 (0.49) |
| PANSS disorganized symptom factor (40) | 5.48 | 2.09 | −0.239 (0.06) | **−0.286 (0.02)** | **0.320 (0.02)** |
| General delusions (PANSS P1) | 2.94 | 1.31 | **−0.299 (0.02)** | −0.234 (0.07) | 0.214 (0.12) |
| Persecutory delusions (PANSS P6) | 2.83 | 1.43 | −0.173 (0.18) | −0.183 (0.15) | 0.051 (0.71) |

*M, Mean; SD, Standard deviation; $r_s$, Spearman correlation; p, significance; PANSS, Positive and Negative Syndrome Scale (36). Statistical significance is indicated by bold values.*

in contrast to our previous results, there was no statistically significant association between Affective ToM and negative symptoms [ "social amotivation" ($r_s = -0.16$, $p = 0.22$)]. Furthermore, concerning Hyper-ToM, associations between Hyper-ToM errors and the five PANSS factors were comparable.

## DISCUSSION

To the best of our knowledge, the present study is the first study that examined ToM in a sample of patients with psychotic disorders using the more advanced multiple-choice version (37) of the Frith-Happé animations test (44). In the present study, patients with psychosis presented more pronounced deficits in Cognitive ToM and Affective ToM but did not show the expected tendency to Hyper-ToM errors, in comparison to non-clinical controls. Furthermore, our results indicated that deficits in Cognitive ToM were associated with general delusions, while deficits in Affective ToM were associated with negative and disorganized symptoms. Also, there was no statistically significant association between Hyper-ToM errors and any symptoms, if the influence of education was controlled.

Our results regarding patients' deficits in cognitive and affective ToM are in line with various meta-analyses showing a reduced general ToM ability in psychotic patients compared to non-clinical controls (9–11, 18). In addition, Lugnegård and colleagues (50) used an earlier version of the Frith-Happé animation test. In this task, participants' free verbal descriptions of the triangles were evaluated by independent raters. Raters evaluated first on how accurately the description reflected the events in the animation (ToM appropriateness) and then rated whether the participant described the complex, intentional mental states (ToM intentionality). Thus, the ToM scores are more focused on the Cognitive ToM component. In this task, patients with psychosis also were more impaired in comparison to non-clinical controls (12, 50). Furthermore, only a small number of studies (in line with our study) divided ToM into Cognitive and Affective subcomponents and examined both (25, 26). Our results are consistent with one of these studies that used the Movie Assessment of Social Cognition [MASC; (26)], a test presenting videos of social situations, that also reported more severe problems in both Cognitive ToM and Affective ToM in patients with psychotic disorders as compared with non-clinical controls of large effect size (26). Solely in the study of Shamay-Tsoory and colleagues, patients with psychosis showed more problems in affective ToM compared to non-clinical controls, while there were no differences between both groups in cognitive ToM in a ToM test based on computerized cartoons (25), possibly due to the smaller sample size in their study (1/3 of our patient sample). In summary, the findings suggest significant impairments of patients with psychosis in both Cognitive ToM and Affective ToM, which once again illustrate the high clinical relevance of different ToM subdomains in psychosis.

With regard to deficits in Cognitive ToM, our results indicate a correlation of medium size between these deficits and general delusions and thus confirmed our hypothesis. However, it should be noted, that in the present study the correlation was based only on one specific PANSS item (P1 general delusions), the interpretation is therefore limited. Unexpectedly, however, there was no association between problems in cognitive ToM and positive symptoms in general, which contradicts the results of some previous studies (21, 25, 26, 51). Interestingly, Blikstedt and colleagues (52) found that first-episode patients with a high level of positive symptoms showed the least severe level of deficits in cognitive ToM, when these patients simultaneously were found to present a lower level of negative symptoms (53). A large number of earlier ToM studies have focused especially on patients' problems in cognitive ToM [e.g. by using the hinting task; (54)] or first/second-order false belief test (55), and some of them found an association between problems in cognitive ToM and positive symptoms (56). Thus, results with regard to associations between cognitive ToM and delusions depend closely on the ToM task and a comparison of the different studies is difficult due to the different task specifics. In addition, meta-analytic evidence of associations between ToM and delusions is also limited, as Ventura and colleagues found an association between cognitive ToM and positive symptoms of small effect size, but did not directly investigate an association between ToM problems and delusions (18).

Concluding, our results suggest that ToM and delusions are associated, but effect sizes seem to be rather small, as several studies did not find an association, possibly due to small sample sizes. This conclusion aligns with the review of Freeman and Garety (16) who criticized that there was little evidence for a specific association between ToM problems due to inconsistent findings, while the results regarding the association between ToM and negative and disorganized symptoms were quite consistent. For this reason, Freeman and Garety even excluded ToM as a possible contributing factor from their current model of the formation and maintenance of (persecutory) delusions (16, 17). In conclusion, Cognitive ToM deficits appear to be overall less associated with delusion or positive symptoms.

In line with our hypotheses, affective ToM was associated with both negative and disorganized symptoms. Studies that assess affective ToM are rare, which limits the possibility to compare our results with other findings. However, our results partially confirm the findings of Shamay-Tsoory (25) and Montag (26), who found an association between deficits in Affective ToM and negative symptoms (assessed using the PANSS and additionally the SANS in the study of Shamay-Tsoory). Contrary to previous findings in correlation studies, our study showed that Affective ToM is associated with disorganized symptoms, which is in line with our hypothesis. Thus, the fact that patients from the symptom cluster with predominantly disorganized symptoms (11, 18) were most severely impaired in their general ToM ability can be partly explained by deficits in Affective ToM.

Moreover, regarding our results, it has to be taken into account that global neurocognitive impairment in psychosis may affect both ToM domains, Cognitive ToM and Affective ToM, as they are related to inferential abilities. It is well known that psychotic patients show neurocognitive impairments, e.g., problems in attention, memory, and IQ (57) besides social-cognitive deficits.

Results of a meta-analysis indicate that both social cognition (e.g., ToM) and neurocognition are associated with functioning (7). Thus, the effects found in the present study may also be partly due to neurocognitive factors rather than psychotic symptoms (58). As we solely assessed verbal IQ with a test that can be viewed as an IQ screening to reduce the burden on the patients, we were not able to control for more global neurocognitive factors. Interestingly, Moritz and colleagues (58) provide several recommendations to address these factors in future studies: they recommend them to "consider mediators that are potentially associated with performance" (e.g., in ToM tasks), second "consider confounder that exists in one group only" (e.g., medication) and third "provide the percentage of participants with impairment." In summary, this approach could offer insights into the specific associations between social and neurocognitive impairments.

It is remarkable that in the present study, with regard to Hyper-ToM, the patients with psychosis did not differ from non-clinical controls. This finding was evident with and without controlling the effect of verbal IQ. A comparable effect was obtained by Blikstedt (59) and Peyroux (33), who both also found no differences in Hyper-ToM errors between patients with psychosis and non-clinical controls controlling for IQ. Peyroux (33) examined Hyper-ToM errors using the MASC (26), a video-based assessment of reduced Cognitive ToM and Affective ToM and Hyper-ToM approximating real-life social interactions. Interestingly, Montag and colleagues (26) also used the MASC and initially showed that patients with psychotic disorders presented more Hyper-ToM errors compared to non-clinical controls, but the effect did not remain significant after controlling for verbal memory (26). Furthermore, contrary to our hypotheses, we found no association between Hyper-ToM errors and either positive or negative symptoms or disorganized symptoms. However, results from previous studies suggested an association between Hyper-ToM errors and positive symptoms (19, 26, 32, 33) and particularly delusions (19, 26), while disorganization was associated with reduced ToM abilities (32). Although we could not verify these findings, the majority of studies seem to support an association between Hyper-ToM errors and positive symptoms.

Regarding the inconsistent results of Hyper-ToM in psychosis, it has to be taken into account, that we measured Hyper-ToM errors indirectly by analyzing errors, whereas in the MASC, Hyper-ToM is measured directly (26). In the present study, we developed an additional Hyper-ToM scoring (see explanation in the Methods section) and in comparison to the other scores in the study, there was only a small number of opportunities to perform a Hyper-ToM error, which limits our results. Nevertheless, this approach is comparable to other studies, which have also evaluated the Frith-Happé animations test concerning an over-attribution/Hyper-ToM that used a comparable scoring (19, 45). Concluding, our study does not provide evidence for more pronounced Hyper-ToM errors in patients with psychosis. Nevertheless, the research question is only partly solved, as some group differences could be explained by intellectual functioning. Thus, future research should further investigate this question assessing Hyper-ToM errors using direct and reliable assessment methods.

## Clinical Implications

Regarding the clinical implications, our findings indicate that patients with psychotic disorders are impaired in both Cognitive ToM and Affective ToM, which raises the question of how ToM deficits as part of social cognition can be treated. The German guidelines for the treatment of schizophrenia [German Society for Psychiatry and Psychotherapy, Psychosomatics and Neurology; (60)] recommend cognitive remediation training (61) for existing impairments of (social) cognitive abilities. Nevertheless, it is first important to regularly assess social-cognitive deficits such as Cognitive ToM and Affective ToM in patients with psychosis, which is not yet common practice in inpatient and outpatient units in Germany. Second, it is important to start appropriate treatment, e.g., social-cognitive remediation training and/or meta-cognitive training (62).

With regard to the appropriate treatment of ToM deficits, various cognitive remediation training programs on social and neurocognition or cognitive biases in psychotic patients that also aim to reduce ToM deficits have been available for several years: the Social Cognition and Interaction Training (63), the Metacognitive Training (62) and the Integrated Neurocognitive Therapy (64). In general, these training report impressive pre-post effectiveness and are quite successful (61). Several trainings focused specifically on ToM deficits: Emotion and ToM Imitation Training (65); Theory of Mind Intervention (66) and Cognitive-Emotional Rehabilitation (67). In most cases, however, these trainings are primarily offered in psychiatric inpatient treatment, but less often in outpatient units, as mentioned by Moritz and colleagues (68). Furthermore, training of ToM abilities is not part of regular Cognitive Behavioral Therapy for psychosis (69). Thus, to ensure that patients can benefit from the treatment of their ToM difficulties beyond inpatient treatment, it is, therefore, necessary to implement ToM training in outpatient treatment and to combine it with CBTp.

## Strength and Limitations

The present study has several strengths: One strength is the assessment of Cognitive ToM and Affective ToM using the multiple-choice version of the Frith-Happé animations, a validated and reliable measurement (37). As discussed previously, our study is the first study that investigates ToM in psychosis using the more advanced version of the Frith-Happé animations, which evaluates the patients' performance in the test using multiple choice questions and therefore, is indicated more objective by the test authors (37). Furthermore, the social interactive stimuli of the animations have the advantage of being more similar to real-life scenarios, as recommended by Brüne (70). Also, concerning our sample, a size of 64 patients appears to be comparatively large, only seven of 36 studies in a review had a larger sample (17). Furthermore, the heterogeneous characteristics of the patient sample are a strength of the study, as evidenced by both demographic and clinical variables (see **Table 1**): the age of the patients ranged from 19 to 61 years, the gender was approximately equally distributed (54.7% are female). In addition, as only a small part of the patients reported a first episode of psychosis ($n = 6$), the mean duration of illness was 14 years and the mean number of psychotic episodes was six episodes, we can assume that our sample consists mainly of chronic psychotic patients with severe impairments. Furthermore, one-third of the patients were in current remission and another third of the patients presented acute delusions, which shows that our sample reflects the diversity of actual clinical symptoms in psychosis.

The present study also has some limitations: One limitation is the cross-sectional study design, which does not allow conclusions about the causality of ToM in psychotic disorders. The comparatively small control group (3:1 ratio of patients: controls) represents another limitation. A methodological limitation is the operationalization and measurement of Hyper-ToM errors using the Frith-Happé animations in this study. As discussed previously, the Hyper-ToM score was developed by the authors; thus, a validation of the evaluation has not yet been carried out. Hyper-ToM should therefore be assessed using a more appropriate validated measurement instrument. With regard to the measurement of psychotic psychopathology, the lack of specific assessment of negative symptoms (e.g., BNSS, SANS) is a shortcoming. The interpretation of the correlations between ToM and delusions is limited, as delusions were only measured with one item. A comprehensive measurement instrument regarding delusions [e.g., Psychotic Symptom Rating Scales (PSYRATS), (71)] would allow more reliable statements to be made. In addition, the between-group results might be influenced by problems in neurocognition/IQ. This effect could not be properly controlled by the verbal IQ assessment in the present study, which makes a comprehensive IQ assessment necessary in future studies.

Finally, effects in pre-registered studies are found to be three times smaller than in studies that were not pre-registered (72). Thus, it would be important to replicate our findings provide a more reliable conclusion about the association of ToM dysfunction and symptoms of psychosis.

# CONCLUSION

Our findings support the established finding of associations between dysfunctions in ToM and negative or disorganized symptoms. Furthermore, the results suggest that deficits in different aspects of ToM may not be directly related to delusions and positive symptoms and are consistent with more recent cognitive models of delusions. However, we found no evidence for more pronounced Hyper-ToM errors in patients with psychosis compared to non-clinical controls and there were no associations between Hyper-ToM errors and psychotic symptoms when controlling for years of education. In sum, our results shed light on the importance of a differentiated consideration of ToM subdomains in the context of psychosis, since the results emphasized the multifaceted relationship of specific ToM dimensions to symptoms in psychosis.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Medical Faculty of the Philipps-University Marburg, Germany. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

LD: conceptualization, methodology, software, formal analysis, investigation, and writing—original draft. NS: recruitment, data collection, and writing—review & editing. FB and IF: writing—review & editing. TK: resources and writing—review & editing. WR: resources, writing—review & editing and supervision. SM: conceptualization, resources, project administration, writing—review & editing, and supervision. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2021.607154/full#supplementary-material

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