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The contributions of risk-taking and impulsivity to jumping to conclusions in the psychosis spectrum

Tana Gabbert [a], Jakob Scheunemann [a], Ryan P. Balzan [b], Niels Doehring [c], Julia Elmers [d], Steffen Moritz [a,*]

[a] Department of Psychiatry and Psychotherapy, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[b] Flinders Institute for Mental Health and Wellbeing, Flinders University, Adelaide, South Australia, Australia
[c] Department of Neuropsychology and Behavioral Neurobiology, University of Bremen, Germany
[d] Cognitive Neurophysiology, Department of Child and Adolescent Psychiatry, Faculty of Medicine of the TU Dresden, Germany

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ABSTRACT

The jumping to conclusions (JTC) bias has been linked to the formation and maintenance of delusions across the psychosis spectrum. However, it remains unclear whether this bias reflects a primary cognitive deviation or is secondary to other cognitive processes. To this end, we investigated the relationship between JTC, risk-taking, impulsivity, and sensation seeking in individuals with psychotic-like experiences (PLEs) and controls.

A large online community sample ($N = 1151$) completed the Fish Task as a measure for the JTC bias, as well as the Balloon Analogue Risk Task (BART) and the Brief Risk-Taking Propensity Scale (R-1) as measures of the propensity to take risks. Measures assessing impulsivity (Impulsive Behavior Scale-8, I-8), sensation seeking (Brief Sensation Seeking Scale, BSSS-4), and verbal intelligence (12-item Wordsum test) were also administered. We dichotomized the sample into extreme groups based on the positive subscale of the Community Assessment of Psychotic Experiences (CAPE).

The present study confirms the existence of a JTC bias in psychosis-prone individuals. Of note, PLE-high individuals self-reported higher risk-taking propensity in the R-1 while at the same time displaying higher objective risk aversion in the BART relative to controls, speaking for a dissociation of subjective versus objective risk-taking behavior. PLE-high individuals showed deviances in other psychological traits (impulsivity, sensation seeking), but these were not associated with hasty decision-making as measured by JTC or risk-taking propensity. The results speak against impulsivity, sensation seeking, or verbal intelligence as driving mechanisms of JTC and risky decision-making.

1. Introduction

Cognitive biases are implicated in the formation and maintenance of positive symptoms (McLean et al., 2017). The jumping to conclusions (JTC) bias (Dudley et al., 2016; So et al., 2016) is one of the most prominent biases in psychosis and is defined as the tendency to gather insufficient evidence before making a decision.

Research on schizotypy is aimed at improving our understanding of the etiology of the psychosis spectrum. Schizotypy is phenomenologically similar to schizophrenia but the symptoms are attenuated; individuals commonly have psychotic-like experiences (PLEs) along with other symptoms (Lenzenweger, 2018). Past findings suggest that individuals high in PLEs display a significantly greater JTC bias compared to controls low in PLEs in probabilistic decision-making tasks such as the Beads or Fish Task (Andreou et al., 2013; Pytlik et al., 2020). However, such tasks have yielded inconsistent findings, with some studies even reporting *reduced* JTC bias in people with higher PLEs (Balzan et al., 2017; Moritz et al., 2020). Thus, we designed this study to assess the JTC bias in two different tasks to gain a better understanding of the underlying mechanisms of JTC.

The aim of this study is to explore whether JTC in psychosis proneness is associated with risk-taking as well as the related constructs of sensation seeking and impulsivity. We used the Balloon Analogue Risk Task (BART; Lejuez et al., 2002) as an experimental measure of risk-taking propensity. Comparing participants' performance on the Fish Task and the BART may help to clarify whether JTC in psychosis

* Corresponding author.
E-mail address: moritz@uke.de (S. Moritz).

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proneness represents a (i) dysfunctional proneness to data gathering or (ii) a tendency to take greater risks. Interestingly, JTC and risk-taking propensity predict divergent patterns of data gathering—fewer draws in the Fish Task but more inflations in the BART. A second objective of this study was to further investigate the extent to which impulsivity and sensation seeking are related to data gathering in individuals with psychosis proneness.

2. Methods

2.1. Recruitment

Participants were recruited from the general population via Amazon Mechanical Turk using CloudResearch (see Supplementary material for inclusion and exclusion criteria). The research was conducted in accordance with the Declaration of Helsinki (ethical approval from the local hospital [LPEK-0193]).

2.2. Participants

Data sets of 1151 individuals were considered for the analyses (see Supplementary material for further information). Participants were allocated into a PLE-high (n = 64) or a PLE-low (n = 902) group according to their score on the positive symptoms subscale of the CAPE-42 (PLE-high: ≥2 *SD* above mean, PLE-low: <0.5 *SD* above mean [see Lenzenweger and Korfine, 1994; Moritz et al., 2017a]; participants scoring between 0.5 and 2 *SD* above the mean in the positive subscale of the CAPE-42 were thus discarded from the analysis).

2.3. Behavioral measures

For the Fish Task (Moritz et al., 2012), participants were shown a man fishing exclusively from one of two lakes with orange and gray fish and were told that the two lakes contained fish in opposite color ratios (80:20 and 20:80; see Supplementary material for detailed task instructions). The Fish Task aims at measuring JTC by counting the number of catches until a decision is made (DTD; no decision = 11) as well as the decision threshold (DTh, i.e., the subjective probability at the time of a decision).

The Balloon Analogue Risk Task (BART; Lejuez et al., 2002) measures risk-taking propensity. We shortened the task and adapted it for online application (see Supplementary material). The total number of burst balloons was taken as the primary outcome (see Schmitz et al., 2016). Participants who inflated all balloons until they burst were omitted from the analysis (n = 3).

2.4. Self-report measures

The Community Assessment of Psychic Experiences-42 (*CAPE-42*) measures the lifetime prevalence of PLEs in the general population (Konings et al., 2006; Stefanis et al., 2002) and captures three dimensions (positive, negative, and depressive).

Impulsivity was assessed with the Impulsive Behavior Scale I-8 (Kovaleva et al., 2014) across four facets: urgency, intention, perseverance, and risk-taking propensity.

The Brief Sensation Seeking Scale (BSSS-4; Hoyle et al., 2002) measures four dimensions of sensation seeking: experience seeking, boredom susceptibility, thrill and adventure seeking, and disinhibition. Each dimension is represented by one item.

The Brief Risk-Taking Propensity Scale-1 (R-1) is a single-item self-report measure of risk-taking propensity (Beierlein et al., 2014).

The 12-item Wordsum vocabulary test (Siegel, 2017) served as a measure of verbal intelligence (VI), a domain of intelligence.

3. Results

Primary analyses were conducted for the two extreme groups (n = 64 vs. n = 902). The groups did not differ significantly in gender or level of education. However, the PLE-high group was significantly younger and had significantly lower VI than the PLE-low group (see Supplementary material). We therefore reanalyzed the data with matched samples; each of the 64 PLE-high participants was matched in pairwise fashion with a PLE-low participant with a similar sociodemographic background based on gender, age, and level of education, blind to results. Results of these

Table 1
Main analysis: means and standard deviations (in parenthesis) of measures.

	PLE-low (n = 902)	PLE-high (n = 64)	Group differences	Significance, effect size
CAPE				
Positive	25.35 (3.33)	49.70 (5.50)	Welch's $t(66.33) = 35.02$	$p < .001$, $d = 6.93$
Depressive	14.67 (3.67)	19.50 (4.21)	Welch's $t(69.97) = 8.95$	$p < .001$, $d = 1.30$
Cognitive bias				
JTC[a]	0.53 (0.50)	0.81 (0.39)	Welch's $t(78.14) = 5.36$	$p < .001$, $d = 0.56$
DTD	2.81 (2.25)	1.44 (1.40)	Welch's $t(88.34) = 7.24$	$p < .001$, $d = 0.62$
DTh	78.46 (16.79)	70.89 (17.91)	$t(944) = 3.44$	$p < .001$, $d = 0.45$
Risk-taking				
BART	2.00 (0.92)	1.70 (0.92)	$t(964) = 2.53$	$p = .011$, $d = 0.33$
R-1	4.11 (2.52)	6.42 (2.47)	$t(964) = 7.10$	$p < .001$, $d = 0.92$
Impulsivity (I-8)				
Urgency	2.26 (0.94)	3.42 (0.94)	$t(964) = 9.81$	$p < .001$, $d = 1.27$
Intention	4.01 (0.71)	4.03 (0.72)	$t(964) = 0.20$	$p = .840$, $d = 0.03$
Perseverance	3.62 (0.89)	3.70 (0.85)	$t(964) = 0.62$	$p = .538$, $d = 0.08$
Risk	2.57 (1.01)	3.59 (0.96)	$t(964) = 7.86$	$p < .001$, $d = 1.02$
Sensation Seeking (BSSS-4)				
Experience	3.38 (1.17)	3.80 (1.06)	$t(964) = 2.80$	$p = .005$, $d = 0.36$
Thrill	2.01 (1.02)	3.09 (1.23)	Welch's $t(69.31) = 6.86$	$p < .001$, $d = 1.04$
Disinhibition	2.45 (1.13)	3.59 (1.08)	$t(964) = 7.81$	$p < .001$, $d = 1.01$
Boredom	2.50 (1.04)	3.28 (1.27)	$t(964) = 5.71$	$p < .001$, $d = 0.74$
Verbal intelligence (Wordsum)				
Sum score	8.62 (2.12)	6.08 (3.04)	Welch's $t(67.44) = 6.56$	$p < .001$, $d = 1.16$

Note. If the assumption of homoscedasticity was violated, Welch's *t*-test was conducted.
PLE = Psychotic-like experience, CAPE = Community Assessment of Psychic Experiences, JTC = jumping to conclusions bias, DTD = draws to decision, DTh = decision threshold, BART = Balloon Analogue Risk Task, BSSS= Brief Sensation Seeking Scale, Risk = risk-taking, Experience = experience seeking, Thrill = thrill and adventure seeking, Boredom = boredom susceptibility.
[a] JTC = 1; no JTC = 0.

secondary analyses (see Table A1) are mentioned in case of a substantial deviation from the main analyses.

As anticipated, significant group differences in the expected directions were obtained for all dependent measures in the Fish Task (see Table 1). Relative to controls the PLE-high individuals displayed the JTC bias more frequently as well as lower DTD (i.e., greater JTC bias) and a lower DTh. Results for the matched sample revealed similar results for the JTC and DTD measures. While PLE-high participants still showed a significantly lower decision threshold, the effect size was reduced to a small effect (see Supplementary material). Group differences remained significant ($p = .001$) after controlling for risk-taking (R-1; BART) and impulsivity (I-8). We further correlated DTD with VI for PLE-high and PLE-low individuals, revealing a small correlation for the entire sample. However, group differences remained significant when we controlled for VI.

Significantly lower risk-taking propensity (i.e., fewer burst balloons) in the BART was observed in the PLE-high group relative to the PLE-low group at a medium effect size (see Table 1). PLE-high individuals demonstrated a significantly higher risk-taking propensity on the R-1 than PLE-low individuals, with a large effect size.

The PLE-high group showed higher scores than the PLE-low group on two subscales for impulsivity and all four subscales for sensation seeking (Table 1). The largest differences were observed for urgency and risk-taking, with large effect sizes. Analyses for the matched sample showed similar results except for the subscale intention (see Supplementary material). For sensation seeking, the largest differences were observed in the disinhibition and the thrill and adventure seeking subscales, with a large effect size. No significant group differences were detected for the subscale experience seeking in the matched sample.

The subscales perseverance and urgency showed the strongest predictive power for JTC and were consequently included as independent variables in a linear regression model with JTC as the outcome variable. Yet, they only explained 4.2 % of the variance for JTC (see Supplementary material). In another regression analysis of the BART, the subscales risk-taking propensity and perseverance predicted BART scores but explained only 1.5 % of the variance of burst balloons in the BART (see Supplementary material).

4. Discussion

The present study examined possible underlying mechanisms involved in the JTC bias in individuals scoring high versus low on PLEs. In line with meta-analytic findings (Dudley et al., 2016; Livet et al., 2020), the PLE-high group demonstrated the JTC bias more frequently as well as lowered DTD and a lower DTh compared to the PLE-low group, consistent with the liberal acceptance account (Moritz et al., 2017b). Results on matched samples corroborated the results.

PLE-high individuals showed significantly more risk-averse behavior on the BART, as indicated by a lower number of burst balloons in comparison to PLE-low individuals. In contrast to this observed (objective) risk aversion, PLE-high individuals reported significantly higher subjective risk-taking propensity (R-1) than PLE-low individuals. Hence, subjective and objective assessments did not correspond, corroborating findings by Reddy et al. (2014). We hypothesize that these discrepancies reflect a more generalized disturbance of metacognitive awareness in psychotic individuals (van der Meer et al., 2013).

Our results also showed significantly higher levels in certain aspects of impulsivity and sensation seeking in PLE-high individuals (see also Katz et al., 2017), in line with findings in those with manifest schizophrenia (Reddy et al., 2014). As described, PLE-high individuals showed significantly more risk-averse behavior on the BART. However, impulsivity and sensation seeking showed poor association with JTC. Results thus speak against the hypothesis that JTC is an epiphenomenon of risky decision-making. In line with this, the JTC bias in PLE-high individuals was not abolished when taking risk-taking propensity or impulsivity into account. Further, although earlier studies found an association between IQ and JTC in psychosis (Langdon et al., 2014; Tripoli et al., 2021), verbal intelligence did not explain the JTC bias in the PLE-high group in the present study. Additionally, by excluding inattentive participants from the sample (see Supplementary material), we also ruled out the possibility that JTC in our study simply reflects an artifact of inattentiveness or careless responding (Sulik et al., 2023).

Based on our findings that JTC may primarily reflect abnormal data gathering, the BART has the potential to be used as another tool to examine risky decision-making behaviors in schizophrenia/psychosis research—a research field that is currently plagued by equivocal findings (Balzan et al., 2012; Moritz et al., 2020). Additionally, future research could consider further investigating the influence of personality traits on JTC. For example, while one study ruled out an association between JTC and openness to experience (Menon et al., 2013), it is conceivable that JTC might be mediated by paranoia proneness (Freeman et al., 2013; Irwin et al., 2014; Prike et al., 2018), elevated neuroticism, low conscientiousness, or other frequently observed personality constructs in psychosis (Franquillo et al., 2021).

4.1. Limitations

Although the study included a sizable sample of 1151 participants, only 64 of these were detected as PLE-high individuals. Following pairwise matching, results of the main analysis could be essentially replicated. Our results cannot be fully generalized to individuals with schizophrenia. In addition, this study was not pre-registered.

5. Conclusion

The present study supports the notion of a JTC bias in PLE-high individuals. Interestingly, PLE-high individuals showed more risk aversion in the BART compared to PLE-low individuals, as indicated by fewer burst balloons; in the case of higher risk-taking, more burst balloons would have been expected for the PLE-high participants. Our results support the claim that the JTC bias in psychosis proneness is related to data gathering and not due to risk-taking propensity, impulsivity, sensation seeking, attention, or VI.

We recommend further exploration of personality profile deviation in individuals with PLEs as well as manifest schizophrenia in view of our still fragmented understanding of how cognitive biases contribute to schizophrenia. Identifying dysfunctional decision-making strategies as well as aberrant personality features may inform clinicians of new treatment targets, for example in the framework of augmented social skills training.

CRediT authorship contribution statement

Tana Gabbert: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jakob Scheunemann:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Ryan P. Balzan:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Niels Doehring:** Writing – original draft, Conceptualization. **Julia Elmers:** Conceptualization, Software, Writing – original draft, Writing – review & editing. **Steffen Moritz:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

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Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2024.04.025.

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