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Running title: BADE AND PSYCHOTIC EXPERIENCES IN ADOLESCENCE

Psychotic experiences associate with a bias against disconfirmatory evidence
(BADE) in adolescence

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A Bias Against Disconfirmatory Evidence (BADE) refers to a tendency to dismiss information that disconfirms one's existing assumptions. In adults, BADE is associated with delusion-related symptoms in clinical disorders such as schizophrenia (Riccaboni et al., 2012, Speechley et al., 2012, Woodward et al., 2006, Veckenstedt et al., 2011, but see Moritz and Woodward, 2006), and with delusion-related traits in the community (Bronstein and Cannon, 2017, Woodward et al., 2007). We hypothesised that this association between BADE and psychotic experiences would also be evident in adolescents, given that psychotic experiences are present in this age group (Ronald et al., 2014). Epidemiological studies indicate that psychotic experiences, especially persistent psychotic experiences, confer a risk for psychotic disorders and other psychiatric disorders (Dominguez et al., 2011, McGrath et al., 2016).

In our study, psychotic experiences were measured in a non-clinical adolescent population using the Specific Psychotic Experiences Questionnaire (SPEQ) (Ronald et al., 2014). SPEQ contains five self-report subscales: paranoia, hallucinations, grandiosity, cognitive disorganisation and anhedonia. Considering the evidence in adult populations, we hypothesised that adolescents would show individual differences in BADE, and that a greater bias would be associated with paranoia and hallucinations but not with the other types of psychotic experiences. We had approval from Birkbeck Psychological Sciences departmental ethics committee (Reference: 171859).

Participants were recruited through secondary schools in England and data were collected in small groups in classrooms ($N = 69$, M age = 16.75 years, $SD = 0.55$, 45% male). A computer-based BADE paradigm was used (Woodward et al., 2006). Individuals were shown 24 sets ("trials") of three sequentially presented statements, which progressively disambiguated a scenario (shown in box in Figure 1). In each trial, participants evaluated the likelihood of four interpretations of the scenario being true considering the currently visible scenario statements. Initially only scenario statement 1 ("Jenny can't fall asleep" in Figure 1's example) was shown, for which the participant rated four interpretations. Next, both statements 1 and 2 were shown together, and the four interpretations were again rated. Finally, the participant was shown all three statements, and again rated the four interpretations. Ratings were always based on the *cumulative* information presented about the scenario.

The four interpretations were designed such that two were initially plausible, but became less so when all 3 scenario statements were revealed (the "Lures" in Figure 1). One interpretation was consistently implausible ("Absurd"). One becomes the most plausible when the participant can see all 3 scenario statements ("True"). The BADE score was calculated by subtracting the third ratings of Lures (when all three statements are visible) from the first (where only statement 1 is visible) and averaging across all trials. This change score quantifies the extent to which participants incorporated disconfirmatory evidence (scenario statements 2 and 3) into their interpretations of the scenarios, i.e. by changing the ratings of the two Lure statements after seeing all 3 scenario statements. Negative BADE scores were expected if beliefs about Lures were adjusted over the course of the trial. A score closer to zero indicated a greater BADE because it signified unwillingness to change the rating following disconfirmatory evidence.

Minor modifications were made to the original BADE task such as adapting text for UK participants (e.g. “candy” replaced with “sweets”). Distractor trials were excluded to avoid confusion about instructions, and two new control trials were added to disrupt potential repetitive response patterns.

Hypothesised associations between BADE and psychotic experiences were examined by fitting two regression models. Paranoia and Hallucinations were entered into one regression model. Cognitive Disorganisation, Grandiosity and Anhedonia were entered into a second. Age and gender were added subsequently as covariates.

The first model explained 10% of variance in BADE ($R^2 = .10$, $F(2, 66) = 3.84$, $p=0.026$). Of these two predictors, only hallucinations was a significant predictor of the BADE outcome variable ($\beta = 0.37$, $t(66) = 2.72$, $p=0.008$). Adding age and gender to the model did not significantly improve it (R^2 change = $.033$, $F = 1.216$, $p = .303$). The second regression model, using the other three SPEQ scales, did not significantly predict BADE ($R^2 = .11$, $F(3, 65) = 2.63$, $p = .057$). On the request of a reviewer, a follow up simple regression analysis was conducted to investigate the relationship between Paranoia and BADE. No significant association was found ($R^2 = .004$, $F(1, 67) = 0.260$, $p=0.612$).

These data support the hypothesis that BADE shows individual differences in adolescence and is associated with degree of hallucinations when measured as a trait in the community. The association was found in relation to hallucinations, but not paranoia. The small sample size relative to other studies on adults could explain this. While there are no previous studies on adolescence, one larger study in adults found a stronger relationship between BADE and hallucinations than paranoia (Bronstein and Cannon, 2017). Future research could explore the associations examined here in larger samples of adolescents, and explore how this bias develops during adolescence in relation to other cognitive processes.

Figure 1. Screenshot of the BADE task with annotations indicating the scenario statements and the interpretations. This shows one of the 24 different trials used, each of which consisted of a different scenario and corresponding statements. Participants used the sliders below each interpretation statement to rate it, with the number to the right of the slider indicating their rating (to one decimal place).

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