



## Research paper

## Mania risk is characterized by an aberrant optimistic update bias for positive life events

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## ABSTRACT

**Background:** Early cognitive models of mania posit that a cognitive triad consisting of unrealistically optimistic beliefs about the self, world and future may predispose vulnerable individuals to develop manic symptoms. Hypomanic personality traits (HYP) pose such a vulnerability factor in the etiopathogenesis of mania.

**Methods:** To test the cognitive tenet of overly optimistic views of the future, 24 individuals with high-HYP and 24 age- and sex-matched controls (low-HYP) performed a belief update paradigm, during which they estimated their personal chances to experience future positive and negative life events. Afterwards, they were presented with the statistical likelihood of each event occurring to a peer living in the same socio-cultural environment and given the chance to adjust their initial estimates.

**Results:** High-HYP individuals exhibited an asymmetric belief revision for positive events, reflected by an exaggerated incorporation of better-than-expected and an impaired integration of worse-than-expected information, relative to their low-HYP control counterparts. The strength of this optimistic update bias was linked to the trait sensitivity of the behavioral approach system. Furthermore, high-HYP individuals demonstrated a more optimistic initial prediction bias, characterized by greater overestimations of their likelihood to experience positive events, and reported enhanced trait optimism.

**Limitations:** The cross-sectional study relied on an extreme-group design to define mania risk.

**Conclusions:** Due to the crucial role of future-oriented beliefs in guiding decision-making and goal-directed behavior, this optimistic update bias for positive events may cognitively underpin the mania-typical engagement in highly pleasurable activities despite warnings for harmful consequences.

## 1. Introduction

An aberrant elevated and expansive mood accompanied by increased goal pursuit and energy characterizes episodes of hypomania/mania that, in turn, constitute the cardinal diagnostic feature of bipolar disorders (BD; American Psychiatric Association, 2013). During (hypo) manic mood, individuals with BD display a range of cognitive and behavioral abnormalities, for example inflated self-esteem, beliefs of grandiosity and a reckless engagement in pleasurable, highly rewarding activities (e.g., excessive shopping, sexual promiscuity) despite serious risks for harmful consequences (Fletcher et al., 2013). Among the repercussions of mania-related behavior are criminal justice problems, financial debts, family conflicts and feelings of guilt or shame (Fletcher et al., 2013; McCabe et al., 2013).

In view of this burden, it is crucial to progress in developing models that help us to identify mechanisms that underlie the development of

mania. One existing model highlights the role of the behavioral approach system (BAS) and its hyperreagibility in individuals with a predisposition to develop BD (Alloy and Abramson, 2010; Johnson et al., 2012b). According to this vulnerability-stress approach, the trait-like hypersensitive BAS becomes excessively activated once high-risk individuals are faced with rewarding, attainment-related life events, yielding an increased positive affect and goal-directed motor activity (Alloy and Abramson, 2010). Manic symptoms are regarded as an extreme form of BAS activation with several longitudinal studies confirming the notion that manic symptoms increase after patients with BD encountered positive and goal-striving life events, such as college exams or marriage (Johnson et al., 2008; Koenders et al., 2014; Nusslock et al., 2007). Importantly, individuals with and those vulnerable to develop BD have been shown to exhibit BAS-specific cognitive styles (Alloy et al., 2009; Stange et al., 2013). For example, people at risk for mania have been found to endorse extremely high future-

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oriented goals targeting at fame, political influence and wealth (Gruber and Johnson, 2009; Johnson et al., 2012a, 2009) and they showed overly optimistic expectations to reach future academic and occupational success (Meyer and Krumm-Merabet, 2003).

These findings point to the crucial role of dysfunctional cognitive processes in the etiology of mania, especially future-oriented optimistic misbeliefs. So far, only a few cognitive models of mania have been proposed (Alloy et al., 2006; Chen and Johnson, 2012; Mansell et al., 2007) that all commonly emphasize cognitive vulnerability factors that are argued to interact with stressful life events to generate manic symptoms. Mirroring the negative triad of depression, Beck's early cognitive extension to mania posits that individuals at risk for mania own a set of unrealistic positive views about the self, the world and the future (Beck, 1967). As support of this cognitive tenet, a sense of a hyper-positive self (e.g., being creative, adorable) among patients with BD has been found to predict relapses into mood episodes (Lam et al., 2005) and a cross-sectional study found mental imagery of future-oriented, positive life events to be much more vivid, pleasurable and exciting for patients with BD than those with unipolar depression (Ivins et al., 2014). Relatedly, Alloy and colleagues (2006) advanced the hopelessness theory of depression (Abramson et al., 1989) to account for mania and hypothesized that individuals cognitively vulnerable to mania inherit an optimistic inferential style characterized by internal, stable and global attributions of positive events, leading to enhanced self-esteem and 'rosy' expectations for the future. Such an overconfident attributional style may promote risky decision-making and initiates an active striving to achieve (BAS-related) goals, whilst warnings of risk and negative interpersonal feedback are ignored. Strikingly, despite these theoretical models that propose over-optimistic future beliefs as a cognitive vulnerability factor to mania, there is a scarce of experimental studies elucidating a potential excess in cognitive biases, such as the optimism bias, and the resistance to adjust such misbeliefs following disconfirming evidence in individuals at risk for or affected from bipolar mania.

The optimism bias (or unrealistic optimism) refers to a cognitive bias (Kahneman, 2011), whereby individuals tend to underestimate their risk to experience future misfortune but to overestimate their chances to encounter future positive events (Weinstein, 1980). An excess of this erroneous belief has been associated with a heightened risk for detrimental consequences as underestimating negative outcomes hampers precautionary endeavors (e.g., safe sex) and promotes destructive behaviors (e.g., risky financial investment) (Sharot, 2011). Importantly, the engagement in such risky-impulsive behaviors is a diagnostic criterion of mania (American Psychiatric Association, 2013) and numerous further commonalities exist between mania and the optimism bias: A key feature of the optimism bias is an asymmetry in belief updating with people learning to a greater extent following good (better-than-expected) than bad (worse-than-expected) information (Sharot et al., 2011). Critically, risk for mania is related to a comparable pattern with a heightened sensitivity to reward but a discount of punishment (Mason et al., 2012). In addition, neuroimaging work revealed attenuated left inferior frontal gyrus activity during the performance of such an optimistic update bias paradigm (Sharot et al., 2011) and similarly during manic mood (Rubinsztein et al., 2001). From a pharmacological perspective, dopaminergic dysfunction appears to be involved in both (Cousins et al., 2009; Sharot et al., 2012). Given these linkages, the current study aimed at investigating, for the first time, this cognitive bias in a sample at risk for BD (Walsh et al., 2015), using an optimistic belief update paradigm (Sharot et al., 2011).

To this end, we recruited individuals with low- versus high-hypomanic personality traits by means of the Hypomanic Personality Scale (Eckblad and Chapman, 1986). Longitudinal research has identified high-scorers on this questionnaire to convey an increased risk for the future development of BD with up to 75% developing (hypo)manic episodes at a 13-year follow-up (Kwapil et al., 2000). In our task, we

asked such a high-risk group and their controls to estimate their personal likelihood that positive and negative life events would occur to them in the next 20 years. After each estimation, they were confronted with the statistical probabilities of the events happening to an average peer in their sociocultural environment and subsequently given the chance to adjust their initial estimations. This enabled us to address three major issues: First, we tested whether individuals with high-, relative to low-, hypomanic personality traits show a stronger initial prediction bias in a more optimistic direction (i.e., greater over-estimations of experiencing positive and greater under-estimations of encountering negative events). Second, we investigated whether this optimistic future outlook is maintained in mania-prone individuals by the tendency to update such beliefs more after receiving positive information and/or to a diminished extent after receiving negative information (i.e., optimistic update bias). Third, we further sought to examine whether the optimistic prediction error and update bias is related to the trait sensitivity of the BAS and/or current manic symptoms.

## 2. Methods

### 2.1. Participants

To enroll a sufficient number of mania-prone participants, undergraduates of different academic disciplines completed a paper-pencil-version of the Hypomanic Personality Scale (HPS; Eckblad and Chapman, 1986; German version: Meyer et al., 2000) during regular university lectures. In addition, volunteers of an existing in-house database were invited to a web-based survey. This yielded to a total of 1204 participants (381 male) for the pool of eligible participants that were between age  $\geq 18$  and  $\leq 30$  years. The age range was restricted as prevalence rates of life events accumulate as a function of age and age influences the degree of optimism bias (Chowdhury et al., 2014). Individuals with high- versus low-hypomanic personality traits were defined as scoring in the upper ( $HPS \geq 27$ ) and lower ( $HPS \leq 6$ ) decile of the HPS distribution.

The final sample consisted of 24 healthy students with high-hypomanic personality traits (high-HYP) and an equal number of control subjects with low-hypomanic personality traits (low-HYP) matched for age ( $\pm 3$  years), education and sex (see Table 1, for demographic and psychometric characteristics). Potential participants underwent an extensive telephone screening to determine the presence of exclusionary criteria (i.e., neurologic/cardiac diseases, lifetime diagnosis of a mental disorder, prior psychotherapy, psychotropic medication intake, lack of fluency in German). Ethics approval for the study protocol was granted by the local ethics committee of the Institute for Psychology, Johannes Gutenberg-University Mainz.

### 2.2. Experimental stimuli

The selection of life events relied on normative data that were gathered online for 200 event stimuli using community convenience samples (see Supplementary material for a detailed description). Life events with normative values for emotional valence between 1 and 4 (as assessed with the Self-Assessment Manikin Scale (SAM) ranging from 1 = unpleasant to 9 = pleasant; Bradley and Lang (1994)) were categorized as negative and those with values of 6–9 were classified as positive events. For the statistical event probabilities, very seldom (< 5%) and very frequent (> 75%) life events were excluded from the stimulus set alongside with events with considerable sex differences regarding normative valence ratings (< 0.5 points on the 9-point SAM scale) or event probabilities (> 10%). For the final stimulus set, strong effort was made to include a broad range of semantic categories, yielding 54 positive events including domains of personal achievement, exciting sports, vacations, family or social relationships and monetary gain (valence ratings:  $M_{POS} = 7.18$ ,  $SD = 0.65$ ) as well as 54 negative

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