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Autobiographical Memory in Bipolar Disorder and Its Link to Neuropsychological Functioning

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Keywords
Bipolar disorder · Autobiographical memory · Neuropsychological functioning · Executive functions · Rejection

Abstract
Objective: The aim of this study was to examine the specificity of autobiographical memory (AM) in bipolar disorder (BD) and to investigate the association between AM and neuropsychological functions. ***Method:*** Twenty bipolar patients and 22 matched healthy controls (HCs) were included in this study. AM was assessed with an extended version of the Autobiographical Memory Test (AMT) including rejection cue words. A neuropsychological test battery was used to examine verbal memory, executive functions, and attention. ***Results:*** Across both groups, the number of specific memories in the AMT was significantly smaller in response to rejection cue words and positive cue words than in response to negative cue words. Participants with BD and HCs did not differ significantly in neuropsychological measures. Across both groups, scores of verbal memory, executive functions, and attention were significantly correlated with specificity of retrieved memories. ***Limitations:*** Although our clinical sample consisted of clinically stable outpatients, 6 out of 20 patients were not rated as euthymic but as mildly depressed. All BD patients were medicated. ***Conclusion:*** Contrary to previous results, patients with BD did not differ in the number of specific memories compared to an HC group. Our findings suggest that neuropsychological functioning is associated with AMT specificity. Further research is required to gain a better understanding of the underlying mechanisms which may influence the ease of memory retrieval.

Introduction

Individuals with bipolar disorder (BD) are confronted with many challenges in leading a stable life. Mood instability and interpersonal sensitivity are typical characteristics of BD [1–4]. In comparison to other mood and anxiety disorders, patients with BD suffer from a greater severity of disability [5]. Approximately 30–50% of remitted patients do not regain their premorbid level of psychosocial functioning. Research on neurocognitive functioning and emotion regulation may provide further knowledge about mechanisms underlying poor social functioning in BD [6, 7]. This paper represents part of a larger project investigating underlying psychological mechanisms of

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psychosocial impairment in BD. Our goal was to gain insight into whether deficits in social problem solving are common in BD, and if so, establish an understanding of the neuropsychological basis for the deficits. Our main aim in the BiSoM project (Bipolar Disorder: Social Problem Solving and Autobiographical Memory) is to show a link between social problem solving and autobiographical memory (AM). This connection is well established in a number of mental diseases, but to a limited extent in BD [8–11]. The current paper reflects the first step in the BiSoM project and focuses on pilot data relating to AM and its association with neuropsychological functioning in BD.

AM is the recollection of one's own personal experience of events from the past. It holds a number of important interpersonal and intrapersonal functions, such as social interaction [12], mood regulation, and problem solving [13–15]. Previous research revealed that the way people remember their own autobiography, i.e., the specificity of their memories, can seriously affect their psychosocial functioning. The specificity of AM also plays a significant role in the maintenance of affective disorder, because specific memories influence how current problems are coped with [16]. Williams and Broadbent [17] reported that patients who attempted suicide by drug overdose generated less specific memories to cue words compared to a group of patients with physical illness. They referred to this phenomenon as overgeneral AM (OGM). A growing body of studies reported OGM as a characteristic feature in depression [18–20] and posttraumatic stress disorder [21]. There is also evidence for OGM in individuals with eating disorders [22] and borderline personality disorder [13, 14]. It has been described as a vulnerability factor involved in the maintenance of depression [13, 23] and indeed as a crucial predictor of instability. Previous research identified OGM to also be closely associated with other important aspects of psychological functioning such as impaired problem solving, problems in imagining future events and delayed recovery from episodes of affective disorders [13]. Only few studies examined OGM in individuals with BD [8–11] using the Autobiographical Memory Test (AMT) in its original version involving positive and negative cue words [17]. They observed more OGM in BD patients than in a nonclinical control group, especially for negative cue words [8, 9, 11]. It may be of some interest to develop a deeper understanding of the different aspects of negative associated contents.

For the first time, this study examines not only positive and negative cue words, but also rejection-related cue words related to the AM specificity of a BD sample. Experiencing rejection has disturbing effects and can impact interpersonal functioning. Therefore, avoiding rejection is central to maintain subjective well-being and balance [24]. Some people are especially vigilant regarding potential signals of rejection [25, 26]. When confronted with those signals, they may tend to overact, thereby damaging their well-being and relationships. This behavior is referred to as rejection sensitivity. Several studies examined this phenomenon in different mental disorders. Rosenbach and Renneberg [25] identified rejection sensitivity as an interpersonal risk factor for depression. Moreover, it has been proposed to play a crucial role in the etiology and maintenance of mental disorders [25]. Recent investigations found that rejection sensitivity was more often observed in depressed bipolar patients in comparison to unipolar depression [27, 28] and dysthymia [27]. To date, there is a gap in the empirical research base regarding the function of rejection in BD. The current study investigates this characteristic using the example of rejection. Therefore, the adapted version of the AMT including rejection cue words [26] could be a promising tool to enhance our knowledge regarding OGM in response to negatively toned words in a BD sample.

To date, a controversial discussion exists regarding whether or not neuropsychological functioning may be harmed in patients with BD. A considerable number of studies observed cognitive deficits in individuals with BD [7, 29, 30]. In particular, the proposal of deficits in executive functions in BD has gathered some empirical support to date [31–34].

Theoretical approaches claim different processes underlying OGM, one of them being executive control [13]. Deficits in executive functions may explain impairments in retrieval processes of AM [35]. Finding a specific memory requires holding the task instruction and maintaining and updating the retrieval model in working memory [36]. Accordingly, OGM has been found to be associated with difficulties in inhibition [37, 38], working memory capacity [38, 39] and verbal fluency [37, 40]. It is possible that a further number of neuropsychological functions might also influence the retrieval process. To date, results from studies investigating the associations between overgeneral retrieval and more general cognitive deficits like attention, verbal memory, and intelligence are inconsistent [13]. Park et al. [41] found a negative correlation between IQ and the number of categoric memories as one aspect of overgeneral memory retrieval in adolescents with major depressive disorder. Several studies reported a connection between age, education, and general mem-

ory deficits and OGM [19, 42, 43]. However, Wessel et al. [44] demonstrated that neuropsychological tests on semantic and episodic memory could not additionally explain variance in the prediction of OGM. Correspondingly, De Decker et al. [45] reported a nonsignificant correlation between immediate and delayed recall and AM specificity. It remains unclear to which extent OGM is associated with neuropsychological functioning. Insights regarding the relationship of AM and neuropsychological performance in BD are rare [8].

The primary aim of the present study was to investigate the specificity of AM in order to establish a deeper insight into the nature of negatively toned memories in BD by including rejection cue words. Second, we aimed to examine the relationship between AM and neuropsychological function in BD. We firstly hypothesized that individuals with BD would generate less specific AM than healthy controls (HCs). We predicted this result for negative and also rejection cue words on the basis that previous research with bipolar samples observed OGM in response to negative cue words [8, 9, 11]. In view of previous findings that rejection sensitivity is more prevalent in patients with bipolar rather than unipolar depression, we wanted to investigate rejection cue words in a euthymic and mildly depressed BD sample. Secondly, we hypothesized that individuals with BD would show poorer performance on verbal memory, attention and executive functions than a control group as has been detected by several previous studies [31–34]. Thirdly, we hoped to expand the knowledge of AM specificity and its relationship to neuropsychological performance in BD [8]. We hypothesized that reduced memory specificity in BD patients would be associated with poorer performance in executive functions and verbal memory.

Materials and Methods

Participants

A total of 20 outpatients with BD participated in the study. All patients were interviewed by a trained psychologist using the German version of the Structured Clinical Interview for DSM-IV (SKID I) [46]. The residual manic symptom was assessed by the Young Mania Rating Scale (YMRS) [47]. Severity of depression was quantified using the Hamilton Rating Scale for Depression (HAM-D) [48], and the Beck Depression Inventory [49, 50].

All participants were currently assessed as euthymic or mildly depressed. All patients completed both the AMT and a 2-h comprehensive neuropsychological battery test. Patients had been medicated with mood stabilizers for at least 3 months; the last change of dosage was at a minimum of 2 weeks prior to testing. Exclusion criteria for the study were: experiencing a current manic or hypomanic episode (YMRS ≥12), a mixed episode (HAM-D 21 ≥10; YMRS ≥12), existing psychotic symptoms, alcohol or substance dependence according to DSM-IV or having had an electroconvulsive treatment in the last 6 months.

Table 1. Demographic and clinical characteristics of patients with bipolar disorder (BD) and healthy controls (HCs) (mean ± SD)

	BD ($n = 20$)	HCs ($n = 22$)	t or χ^2	p
Sex male, *n* (%)	9 (45)	9 (40.9)	0.072	0.78
Age, years	44.25±11.73	40.36±13.59	0.99	0.33
Years of education	14.95±2.68	13.86±2.80	1.28	0.21
Number episodes	16.67±12.63	–		
Age of onset, years	25.30±10.03	–		
Prior suicide attempts	0.25±0.55	–		
BDI	10.65±10.74	4.59±4.70	2.33	0.03*
HAM-D	10.35±7.9	–	–	–
YMRS-D	0.74±1.20	–	–	–

BDI, Beck Depression Inventory; HAM-D, Hamilton Rating Scale for Depression; YMRS-D, Young Mania Rating Scale. * $p < 0.05$ (2-tailed).

Additionally, 22 healthy controls were recruited via advertisements online. In a telephone screening the German version of the Mini International Neuropsychiatric Interview for DSM-IV [51] was applied to ensure the absence of clinical symptoms. Controls were excluded in the case of a current or past mental illness. Demographic and clinical characteristics of the two groups are shown in Table 1. The institution's local ethical committee approved the study, and all participants provided written informed consent prior to the study.

Autobiographical Memory Test

The AMT [17] uses emotional cue words to assess the specificity of autobiographical memories. The applied version of the AMT contains 15 cue words, 5 words relevant to rejection (rejected, neglected, ignored, declined, unwanted), 5 positively toned words (happy, successful, interested, carefree, safe), and 5 negatively toned words (angry, lonely, awkward, hurt, sad). In our study the instruction was to provide a specific memory to each cue word. Participants were asked to describe the event as precisely as possible. An example was presented before the start of the AMT. In the present study the AMT was adapted for computer presentation. Participants wrote their answer into the software program directly after each cue word. Memories were coded as specific if they referred to a particular event with duration of less than a day. Two raters, blinded to the participants' group membership, coded memories independently. Interrater reliability was satisfactory, with $\kappa = 0.76$.

Neuropsychological Assessment and IQ Estimates

Twenty patients and 22 matched controls completed neuropsychological tests examining verbal memory, executive functions, attention and intelligence. Verbal memory was assessed by the German verbal learning and memory test (Verbaler Lern- und Merkfähigkeitstest, VLMT) [52] and the Digit span forward as a subtest

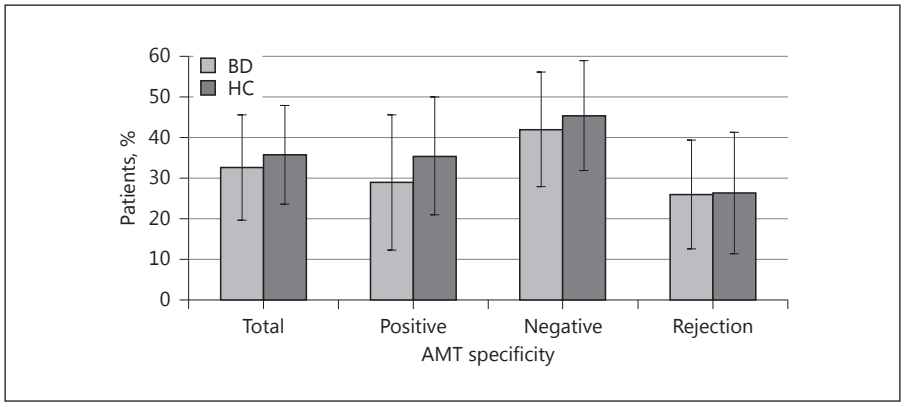

Fig. 1. Mean specificity of AMs of bipolar disorder patients (BD) and healthy controls (HCs). AMT, Autobiographical Memory Test.

of the German version of the Wechsler Memory Scale [53]. Executive functions were tested by a German word fluency task (Regensburger Wortflüssigkeitstest, RWT) [54], a German version of the word color interference test according to the Stroop paradigm (Stroop Color-Word Test; SCWT) [55] and digit span backwards as a subtest of the Wechsler Memory Scale. Alertness and divided attention as subtests of a widely used German computerized test battery (Testbatterie zur Aufmerksamkeitsüberprüfung, TAP) [56] were included to measure different facets of attention and executive functions. Intelligence was assessed by a multiple choice vocabulary test (Mehrfach Wortschatz Test, MWT-B) [57] and the subtest LPS3 of a German intelligence test battery (Leistungsprüfsystem, LPS) [58]. A well-trained psychologist delivered the comprehensive neuropsychological battery.

Statistical Analysis

Independent *t* tests were conducted to compare demographic and clinical characteristics as well as neuropsychological measures in BD patients and HCs.

In order to analyze differences between groups on number of specific memories on the AMT, a 2 (group: bipolar, control) × 3 (cue type: rejection, positive, negative) ANOVA with repeated measures on the second factor was conducted. The Pearson correlation coefficient was calculated for number of specific memories in the AMT and clinical characteristics in individuals with BD. Pearson correlation coefficients were computed to examine the association of AM specificity with the various neuropsychological measures. A stepwise regression analysis was performed across the whole sample to take the interrelationships among the neuropsychological test scores into account. The AMT specificity score was the dependent variable, and all neuropsychological test scores (VLMT learning, VLMT free recall, digit span forward, TAP alertness, TAP divided attention, RWT animals, RWT s-words, SCWT, digit span backwards, LPS3, MWT-B) and group (BD vs. control) were entered as independent variables.

All analyses were conducted using the R project for Statistical Computing Version 3 for Mac OS. Power analysis was performed using "G*Power: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences" [59], a tool to compute statistical power analysis. The level of significance was set at $p < 0.05$.

Results

Specificity of AMs

With regard to our first hypothesis investigating the specificity of AM, there was a significant main effect for cue type [$F(2, 80) = 9.78$, $p < 0.001$, $\eta^2 = 0.20$], but not for group [$F(1, 40) = 0.20$, $p = 0.66$, $\eta^2 = 0.01$]. Specifically, all participants reported more specific memories in response to negative cue words than to positive or rejection cue words. There was no interaction between group and cue type (Fig. 1). Post hoc statistical power estimates revealed a power of 0.11.

In the BD group, possible associations between the number of specific memories in the AMT and clinical characteristics were assessed. There was no significant correlation of the AMT specificity score with age of onset, number of episodes and number of suicide attempts. However, analyses revealed a trend for a moderately negative correlation between HAM-D score and AMT score ($r = -0.42$, $p = 0.06$).

Neuropsychological Measures

We expected the healthy control group to perform better than those with BD on verbal memory, attention and executive functions. With the exception of the LPS3, there were no significant differences between the 2 groups on their performance on the various neuropsychological measures. The mean score on LPS3 was significantly higher in the control group than in the patient group [$t(40) = -2.24$, $p = 0.03$] (Table 2).

Association between Specific Memories and Neuropsychological Measures

Our third hypothesis stated that reduced memory specificity is associated with poorer performance on ex-

Table 2. Neuropsychological measures of patients with bipolar disorder (BD) and healthy controls (HCs) (mean ± SD)

	BD	HCs	*t*	*p*
Verbal memory				
VLMT learning	52±9.51	53.55±8.29	–0.56	0.58
VLMT free recall	11.10±2.40	11.59±2.79	–0.61	0.55
Digit span forward	8.2±1.20	8.0±1.75	0.43	0.67
Attention				
TAP alertness	261.65±73.39	260.00±53.42	0.08	0.93
TAP divided attention	1.5±1.15	1.73±1.91	–0.47	0.64
Executive functions				
RWT animals	23.2±7.35	27.00±5.98	–1.85	0.07
RWT s-words	15.15±6.78	17.77±3.82	–1.52	0.14
SCWT	79.95±16.67	76.45±17.70	0.66	0.52
Digit span backwards	6.45±2.06	6.36±1.73	0.15	0.88
Intelligence				
MWT-B	30.5±4.20	29.95±2.87	0.50	0.62
LPS3	24.55±4.59	28.18±5.77	–2.24	0.03*

VLMT, verbaler Lern- und Merkfähigkeitstest; RWT, Regensburger Wortflüssigkeitstest; SCWT, Farbe-Wort-Interferenztest; TAP, Testbatterie zur Aufmerksamkeitsüberprüfung; MWT-B, Mehrfachwortschatz Intelligenztest; LPS3, Leistungsprüfsystem Untertest 3. * $p < 0.05$ (2-tailed).

Table 3. Pearson correlation between scores of the Autobiographical Memory Test and neuropsychological measures in all participants, bipolar disorder patients (BD), and healthy controls (HCs)

	All	BD	HCs
Memory			
VLMT learning	0.50**	0.44	0.56**
VLMT free recall	0.52**	0.53*	0.52**
Digit span forward	0.14	–0.27	0.42
Attention			
TAP alertness	–0.17	–0.21	–0.04
TAP divided attention	–0.32*	–0.62**	–0.18
Executive functions			
RWT animals	0.28	0.05	0.54**
RWT s-words	0.60**	0.57**	0.71**
SCWT	–0.55**	–0.59**	–0.51*
Digit span backwards	0.17	0.14	0.21
Intelligence			
LPS3	0.40**	0.35	0.45*
MWT-B	0.28	0.47*	0.03

VLMT, verbaler Lern- und Merkfähigkeitstest; RWT, Regensburger Wortflüssigkeitstest; SCWT, Stroop Color-Word Test. TAP, Testbatterie zur Aufmerksamkeitsüberprüfung; MWT-B, Mehrfachwortschatz Intelligenztest; LPS3, Leistungsprüfsystem Untertest 3. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed).

ecutive functioning and verbal memory. Across both groups, scores of VLMT learning and free recall, TAP divided attention, RWT s-words, SCWT, and LPS3 were significantly correlated with the AMT score (Table 3).

Further, a stepwise regression analysis was performed to take into account the intercorrelations among the neuropsychological test scores. The AMT score was the dependent variable, and all neuropsychological test scores and group membership (BD vs. control) were entered as independent variables. Backward analysis resulted in a model that contained RWT s-words, VLMT free recall, and SCWT as predictors but not the group membership. The model was statistically significant [$F(1, 38) = 12{,}48$, $p < 0.001$] and accounted for approximately 50% of the variance in the AMT score ($R^2 = 0.50$, adjusted $R^2 = 0.45$). Higher AMT scores were primarily predicted by higher test scores on RWT s-words, and to a smaller extent by higher scores on VLMT free recall, and lower scores on SCWT (Table 4).

Discussion

To our knowledge, this is the first study investigating the link between neuropsychological functions and AM using an extended version of the common AMT with re-

Table 4. Stepwise regression analysis using neuropsychological measures as predictors and specificity of the Autobiographical Memory Test as the outcome

Predictor	R^2	ΔR^2	β
Step 1			
RWT s-words	0.36		0.60**
Step 2			
RWT s-words			0.45**
VLMT free short recall	0.44	0.08	0.32**
Step 3			
RWT s-words			0.30*
VLMT free short recall			0.31**
SCWT	0.50	0.06	–0.28**

VLMT, verbaler Lern- und Merkfähigkeitstest; RWT, Regensburger Wortflüssigkeitstest; SCWT, Stroop Color-Word Test. * $p < 0.1$ (2-tailed), ** $p < 0.05$ (2-tailed).

jection cue words. Contrary to our expectation, patients with BD did not differ from the HC group in specificity of AM. Our hypothesis stating that reduced memory specificity is associated with poorer performance on neuropsychological tests was supported. Consequently, better executive function and verbal memory were associated with a higher number of specific memories.

Specificity of Autobiographical Memories

Contrary to our expectations and to previous results, patients with BD did not differ from HCs in their number of specific memories. A possible explanation may be that patients in the current study were euthymic or, at most, mildly depressed. Diagnosis of depression has been observed as a moderator of AMT performance [20] and, accordingly, self-rated depression as a predictor of the effect size of OGM in individuals with affective disorders [60]. The lack of OGM in our BD sample may therefore be explained by their low level of depressive symptoms (mean Beck Depression Inventory = 10). Furthermore, current results revealed a trend indicating that the number of specific memories decreased with higher depression scores. Consequently, it is still unclear whether OGM exists in euthymic BD. To our knowledge, only 2 studies [8, 11] investigated OGM with the AMT in euthymic bipolar individuals or those with few symptoms. Contrary to our results, these studies found significantly fewer specific memories in those with BD than in HCs; however, group differences reflected only medium effect sizes (Cohen d = 0.53 [8]; Cohen d = 0.59 [11]).

Interestingly, across both groups in our study we observed a significantly smaller number of specific memories in response to rejection and positive cue words than in response to negative cue words. Surprisingly, we discovered a difference between rejection and negative cue words in spite of their assumed common negative valence. This result illustrates the innovative extension of the AMT by differentiating negative and rejection cues [26]. A further noteworthy clinical observation pertains to how the rejection cues indicate the salience of these memories and their relevance to the patients' well-being. Further research is required to gain a better understanding regarding the role of rejection for those with BD, as well as what features of cue words impact on how easy or difficult memory retrieval is.

Neuropsychological Measures

Although individuals with BD tended to show poorer outcomes on several neuropsychological measures than the HC group, there were no significant group differences observed in this regard. The only significant difference was found in scores on LPS3, a measure of fluid intelligence. Whether or not neuropsychological functions are limited in BD has always drawn scientific interest: research groups have identified subgroups of individuals with BD with no neurocognitive deficits at all [61] as well as no patient-control differences regarding different longitudinal cognitive outcomes [62]. Our study further adds to this discussion by contradicting a wide range of results that found broad cognitive impairments in BD [7, 63], even during phases of euthymic mood [29]. In agreement with our observations, Doruk et al. [63] did not find group differences on measures of memory, learning, information processing and attention between remitted BD and HCs. They concluded that cognitive impairments are isolated to manic and depressive phases of BD. The ambiguous findings may reflect methodological differences in neuropsychological measures [63, 64] or confounding variables such as age, residual mood symptoms, history of psychotic symptoms, clinical course, illness duration, and medication [29, 30, 65]. However, many studies do not sufficiently take these variables into consideration [66, 67] which may explain the divergence of findings. Controlling for these variables may lead to the observation of smaller impairments in BD [68]. Although this study contributes to a clearer understanding of neuropsychological functioning in euthymic BD, it remains difficult to draw conclusions about phase-dependent and persistent cognitive functioning in BD. Further research, in particular longitudinal studies using standardized neuro-

psychological measures, is required to inform a comprehensive understanding of this issue.

At last, it is remarkable that the results of neuropsychological measures match the results of AM specificity. Both number of specific memories in response to negative and rejection cue words and scores in neuropsychological measures were expected to be impaired in BD when compared to HCs. However, in neither measure did we find significant group differences indicating an inherently high level of cognitive functioning of our clinical sample.

Relationship of Specific Memories with Neuropsychological Measures

In accordance with our third hypothesis, the present results indicate that the inhibition component of executive functions, verbal fluency and verbal memory contributed independently to AM specificity. Our results show an association of better performance in tests of executive function and verbal memory and a higher number of specific memories. These findings are consistent with previous research concerning the role of executive functions on OGM in different clinical populations. Recently published studies reported significant correlations between different measures of executive functions and AM specificity in their BD groups [8, 9]. In contrast to our results, the BD group in both studies performed significantly worse in the AMT and on neuropsychological measures than HCs. In addition, Kim et al. [8] observed significant correlations between memory specificity and measures of verbal memory in the control group. However, our analysis considered the redundancy of different measures of neuropsychological measures. On that account, the present study extends the knowledge about the role of different aspects of executive functions and verbal memory in OGM. Current results demonstrate that different neuropsychological functions are independently associated with memory specificity. Two components of executive function obviously play a role in AM retrieval: inhibition (as measured by the SCWT) and word fluency (as measured by the RWT-s).

Our results do not allow for any causal explanation. It remains unclear whether OGM originates from deficits in executive functions or verbal memory. However, it is remarkable that the present findings indicate executive functions and verbal memory to be important mechanisms contributing to OGM. In regression analyses 50% of AMT specificity scores were explained by measures of executive functions and verbal memory. The role of executive functions seems therefore to be particularly important for specificity of AM.

Limitations

Several limitations of the present study are worthy of discussion. Similar to previous studies [8], unfortunately the sample size of our study was modest. Second, it is worth considering that it might be more difficult to generate specific memories in response to rejection cue words than to negative cue words, as rejection situations are more specific in nature and in theory also fall under the umbrella of negative situations. Although our clinical sample consisted of clinically stable outpatients, 6 out of 20 patients were not rated as euthymic but as mildly depressed. As outlined, the clinical state and mood symptoms may influence AMT specificity. There was a trend for a negative correlation of depressive symptoms and AMT specificity in our sample. It should also be taken into account that all individuals in the clinical sample were medicated. This may have had an influence on cognitive performance and AMT [69].

Conclusion

This study did not confirm OGM and poorer performance in different domains of neuropsychological functioning in stable, mostly euthymic patients with BD. However, additional evidence has been found for the role of neuropsychological deficits, especially executive functions and verbal memory abilities, in AM retrieval. Thus, our findings underline the importance of neuropsychological functioning in the retrieval of specific AM events. Future research should address OGM in euthymic BD using larger study samples and statistically controlling for effects of residual mood symptoms and other possible confounding variables such as education.

Disclosure Statement

All authors had neither an actual nor potential conflict of interest including any financial, personal or other relationships with other people or organizations within 3 years of beginning this work that could inappropriately influence, or be perceived to influence, our work. There was no extramural funding for the current study.

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