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Autobiographical memory deficits in remitted patients with bipolar disorder I: The effect of impaired memory retrieval

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ABSTRACT

Autobiographical memory (AM) has been studied extensively in different psychiatric disorders. However, less is known about AM in bipolar disorder (BD). Aim of the present study was to investigate BD patients' ability to recall episodic and semantic autobiographical memories after controlling for the effect of other possible neurocognitive deficits. Participants included 30 clinically remitted outpatients with BD type I and 30 healthy controls, matched for age, gender and educational level. Autobiographical memory was examined by the Questionnaire of Autobiographical Memory. Premorbid intellectual functioning, verbal memory, verbal fluency, attention and working memory were also assessed. Bipolar patients were impaired in both episodic and semantic AM, compared with healthy individuals. Deficits involved recall of memories from childhood-adolescence, early adulthood and recent life. Additionally, patients were impaired in verbal memory compared with controls. Differences between study groups in both episodic and semantic AM remained significant even after controlling for the effect of verbal memory deficits. Remitted BD-I patients showed deficits in recalling personal episodic memories and facts dating to three different life periods. These deficits were independent of patients' lower verbal memory performance. Additional research is required to gain a better understanding of the pattern and the mechanisms underlying AM impairment in BD.

1. Introduction

Autobiographical memory (AM) is a cognitive process that involves recollection of personal information associated with one's past life (Kopelman and Kapur, 2001; Holland and Kensinger, 2010) and consists of two parts, episodic and semantic AM (Tulving et al., 1988). Episodic AM, or "autobiographical incident memory" (Kopelman et al., 1989), involves recollection of personal events and experiences that occurred at specific time and place, e.g. memory of the first meeting with the spouse (Philippi et al., 2014). Episodic autobiographical memories may vary in level of specificity (Barsalou, 1988). Specific autobiographical memories have been defined as memories of personal events and experiences that occurred at a particular location and lasted less than a day, e.g. recalling a particular conversation with a friend. Specific are distinguished from overgeneral autobiographical memories, that is, memories summarising repeated events over extended time periods (Williams et al., 2007). On the other hand, semantic AM, or "personal semantic memory" (Kopelman et al., 1989), involves recollection of personal facts and general knowledge about one's past, e.g. birthplace. Although semantic AM is linked to a feeling of ''knowing" or familiarity (Wheeler et al., 1997), semantic memories lack temporal and spatial details (King et al., 2013). Altogether, the ability to recall autobiographical memories is of fundamental significance for the development of personality, the awareness and maintenance of one's personal narrative (Philippi et al., 2014), as well as the continuity of the "sense of self" (Conway and Pleydell-Pearce, 2000). Moreover, AM contributes to the enhancement of social functioning (Alea and Bluck, 2003), and to the formation of future plans through problem solving and implementation of appropriate behaviors (Pillemer, 2003).

Undoubtedly, AM plays a crucial role in daily life. Thus, deficits in AM have been investigated and confirmed in several psychiatric disorders. For instance, patients suffering from depression (Sumner et al., 2010; Liu et al., 2013; Ahern and Semkovska, 2017), post-traumatic stress disorder (Ono et al., 2016) and schizophrenia (Berna et al., 2015) demonstrated a tendency to recall general rather than specific memories, a phenomenon known as "overgeneral memory" (Williams et al., 1996; Conway and Pleydell-Pearce, 2000). Overgeneral memory style is reported to have clinical implications. Research data have showed that

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it potentially contributes to the onset and maintenance of affective disorders (Sumner et al., 2010), affects psychological functioning (Williams et al., 2007) and constitutes a vulnerability factor in suicide attempts (Rohrer et al., 2006). In this light, initial studies of AM in BD type I (BD-I) and type II (BD-II) focused on whether autobiographical memories are accessed at a specific or overgeneral level. For this purpose, researchers have applied the Autobiographical Memory Test (AMT), a measure based on the cuing methodology that was designed to assess specificity of episodic memories, rather than the episodic and semantic components of AM (Williams and Broadbent, 1986). Preliminary study outcomes indicated that euthymic BD-I patients generated markedly more overgeneral memories of both positive and negative past events, compared with healthy controls (Scott et al., 2000), remitted BD-I patients showed a greater overgeneralised recollection of negative memories only, compared with patients with remitted unipolar depression (Mansell and Lam, 2004) and reduced AM specificity in BD-I patients was enhanced by cognitive behavioural therapy (Tzemou and Birchwood, 2007). Accordingly, a more recent study of BD-I and BD-II patients reported deficits in AM specificity, irrespective of patients' history of childhood trauma (Mowlds et al., 2010). Contrary to previous findings, the latest study of AM specificity in euthymic and mildly depressed BD (type not defined) patients did not observe any differences between patients and healthy controls (Quinlivan et al., 2017).

To the best of our knowledge, only two studies assessed both components of AM in BD patients. The first one assessed episodic and semantic AM by the Autobiographical Memory Interview (AMI) in BD-I patients at different phases of the disorder, compared with healthy controls. Among others, the study investigated the age effect on AM, dividing participants into "younger" and "elder" (over 40 years old). According to the results, patients were selectively impaired in episodic AM, while semantic AM remained intact. In regard with the temporal gradient, deficits involved memories recalled from four different chronological periods, extending from childhood to recent years. Still, deficits were even more profound in older patients and in regard with memories dating to recent life periods. This finding was contradictory to the "recency effect" (i.e. retention of recent episode memories) that is normally expected with aging (Piolino et al., 2002). Therefore, it was suggested that deterioration in recent episodic AM with aging in BD-I may be associated with disorder's clinical course, since it is likely that older patients may have suffered a more prominent neurobiological damage, due to multiple episodes and longer duration of illness (Shimizu et al., 2009). The second study investigated episodic and semantic AM by another measure, the Autobiographical Interview (AI), in BD-I and BD-II patients at different phases of the disorder, compared with healthy controls. Study results indicated that patients exhibited a selective impairment in episodic AM, specifically in detailed recall of events dating to the manic phases of the disorder (King et al., 2013).

Autobiographical memory has been related to other cognitive functions (Rubin, 2005), such as language (Nelson and Fivush, 2004), verbal memory (Janssen et al., 2015), verbal fluency (Piolino et al., 2010), working memory capacity and inhibition (Ros et al., 2010). Neurocognitive deficits in a wide range of cognitive domains, among which attention, verbal memory and executive functions, have been considered a core feature of BD (Robinson et al., 2006; Bourne et al., 2013). Therefore, an issue warranting further investigation is whether AM impairment in BD may be mediated by a broader deficit in patients' cognitive functioning. Current knowledge about the effects of a more general cognitive dysfunction on AM performance derives from only a few preliminary data. One study of euthymic BD-I patients reported that overgeneral recall of both positive and negative events remained higher compared with healthy controls, even when the intelligence quotient was taken into account (Scott et al., 2000). A second study investigated AM in relation to a wide range of cognitive functions, including attention, verbal memory, visual memory, verbal fluency, executive functions and overall intelligence in BD-I patients. Based on results, patients' deficits in AM specificity were correlated with impaired executive function, assessed by the Wechsler Adult Intelligence Scale (similarities) and the Wisconsin Card Sorting Test (Kim et al., 2014). Lastly, a more recent study of euthymic and mildly depressed BD (type not defined) patients found a correlation between AM specificity and verbal memory, executive functions and attention (Quinlivan et al., 2017). Altogether, the association between AM and cognitive functioning in BD warrants further research.

BD patients exhibit impairments not only to core cognitive functions (Mann-Wrobel et al., 2011), but also to psychosocial function (Wingo et al., 2009), to the formation of future events (Boulanger et al., 2013) and to their problem solving skills (Veeh et al., 2017). Taking into account the fact that AM consists a ''higher- level'' cognitive process, which serves these functions, its importance in daily life as well as its clinical implementations, it is clear that further investigation of AM in BD is needed. The present study attempted to fill in some piece of information missing in the scientific literature, that is the investigation of both episodic and semantic AM after controlling for the effect of other possible neurocognitive deficits. In particular, focus was placed on the temporal distribution of AM deficits, as well as on the mediating effects of premorbid intellectual functioning and other neurocognitive functions, that is, verbal memory, verbal fluency, attention and working memory, assessed by a comprehensive neuropsychological test battery. To the best of our knowledge, this is the first study that examined semantic AM, in relation with the effect of other cognitive deficits in BD. Previews findings in this issue concerns only episodic AM (e.g. Kim et al., 2014). Moreover, we tried to improve the methodology of previews studies, which have already investigated both episodic and semantic AM in BD (King et al., 2013. Shimizu et al., 2009). Opposed to them, our sample comprised only clinically remitted BD-I patients. Based on available literature, the following hypotheses were formulated: (a) patients would demonstrate deficits in AM, particularly in episodic AM, compared with healthy controls; (b) patients would display deficits in some, or all of the aforementioned cognitive domains; (c) patients' deficits in AM would remain significant, even after controlling for the effect of other neurocognitive deficits.

2. Methods

2.1. Participants

Patients strictly diagnosed with BD-I according to DSM-IV-TR were recruited from the outpatients' clinic of the 1st and 2nd Department of Psychiatry, Aristotle University of Thessaloniki. Diagnosis was confirmed with the Greek version (translation-adaptation to the Greek language by S. Beratis) of the Mini International Neuropsychiatric Interview (4.4) (MINI) (Sheehan et al., al.,1998). Prior to enrolment, patients were clinically evaluated by the Young Mania Rating Scale (YMRS) (Young et al., 1978), as well as the Montgomery-Asberg Depression Scale (MADRS) (Montgomery and Asberg, 1979), to verify clinical remission. Inclusion criteria were formulated as follows: (i) YMRS score $\leq$ 7; (ii) MADRS score $\leq$ 9; (iii) clinical stability based on aforementioned cut-off point scores for a period of at least 12 weeks; (iv) stable medication during the last 12 weeks; (v) no hospitalisation during the last 12 weeks / outpatient status. Additional inclusion criteria were age 18–60 years and Greek as native language. Exclusion criteria were formulated as follows: (i) diagnosis of neurodevelopmental and neurodegenerative disorders; (ii) history of head trauma; (iii) alcohol and illicit drug abuse during the last six months prior to testing; (iv) diagnosis of any serious central nervous system or other physical illness that may affect cognitive performance.

Among screened patients, 30 fulfilled inclusion criteria and were enrolled. All patients were receiving medication during their assessment. Most of them (90%) were be treated with atypical antipsychotics, with antiepileptics (50%), with antidepressants (26,7%) and with lithium (13,3%), either as monotherapy or as combination treatment.

In addition to patients, 30 healthy controls (HCs) were recruited from the community to match patients' status in regard with age, gender and educational level. Healthy controls were screened with a semi-structured interview. Inclusion criteria were: (i) age 18–60 years; (ii) Greek as native language. Exclusion criteria were: (i) history or current diagnosis of a psychiatric disorder, including alcohol and illicit drug abuse; (ii) family history of BD or any psychotic disorder at first degree relatives; (iii) diagnosis of any serious central nervous system or other physical illness that may affect cognitive performance.

The study was approved by the Aristotle University of Thessaloniki Ethics Committee. All study participants provided written informed consent.

2.2. Measures

2.2.1. Sociodemographic data and clinical assessments

Sociodemographic data were recorded based on a semi-structured interview. Psychiatric history, including period of diagnosed BD-I, number and type of episodes, history of psychotic features and suicidal behaviour, number of psychiatric hospitalisations, medical history and family history of psychiatric disorders were recorded based on a semi-structured interview and patients' medical records.

Mania was assessed by the Young Mania Rating Scale (YMRS) (Young et al., 1978), a clinician-rated 11-item instrument evaluating patients' clinical state over the last two days. The YMRS has been commonly used in Greek populations (Bozikas et al., al.,2007; Ioannidi et al., 2015). Depression was evaluated by the Montgomery-Åsberg Depression Rating Scale (MADRS) (Montgomery and Asberg, 1979), a clinician-rated 10-item instrument assessing symptoms over the last week on a 6-point scale. The MADRS has been commonly used in Greek populations (Bozikas et al., 2018; Stamouli, 2010).

2.2.2. Autobiographical memory

Autobiographical memory was assessed by the Questionnaire of Autobiographical Memory (QAM) (Alexiadou et al., 2009), a research tool that was developed according to the Autobiographical Memory Interview (AMI) (Kopelman et al., 1989). The questionnaire consists of two subscales: (i) The Autobiographical Incident scale, assessing episodic AM; (ii) The Personal Semantic Memory scale, assessing semantic AM. Additionally, QAM was developed to investigate personal memories from three different life periods: (i) childhood-adolescence (from birth to the age of 18); (ii) early adulthood (from the age of 18 until "recent life"); (iii) recent life (last three years) [readers are addressed to (Alexiadou et al., 2018) for a more detailed description of QAM].

2.2.3. Premorbid intellectual functioning

Premorbid intellectual functioning was assessed by the Greek Accentuation Test (GAT) (Giaglis, 2008). The test is based on a list of words lacking the accent mark, a crucial punctuation mark for the correct pronunciation of Greek words. Participants are asked to fill out the tonal mark, while task difficulty gradually increases. Final score is calculated by adding up the number of correct answers.

2.2.4. Verbal memory

Verbal memory was assessed by the Greek Verbal Learning Test (GVLT) (Vlahou et al., 2012). The format of this test was based on the shopping list design of the original California Verbal Learning Test (CVLT) (Delis et al., 1987) and CVLT revised form (CVLT-II) (Delis et al., 2000). The following six test variables were utilised: (i) learning (total score of trials 1–5); (ii) immediate free recall; (iii) immediate cued recall; (iv) delayed free recall; (v) delayed cued recall; (vi) recognition. A composite GVLT index was formed using the Z-scores of all six variables [(learning + immediate free recall + immediate cued recall + delayed free recall + delayed cued recall + recognition)/6].

2.2.5. Verbal fluency

Verbal fluency was assessed by the Greek Verbal Fluency Task (GVFT) (Kosmidis et al., 2004). This test consists of: (i) a semantic verbal fluency test, requiring participants to generate as many different words as possible, corresponding to three semantic categories, i.e. animals, fruits and objects; (b) a phonological verbal fluency test, requiring participants to generate as many different words as possible, beginning with three different Greek letters, i.e. X ("hi"), Σ ("sigma") and A ("alpha"). Total score is calculated by adding up the sum of correct answers in both fluency tasks.

2.2.6. Attention and working memory

Attention and working memory were assessed by the Digit Span Task of the revised form of the Wechsler Memory Scale (WMS-R) (Wechsler, 1997). More specifically, attention was evaluated by the forward, while working memory by the backward Digit Span Task. Both tasks include seven pairs of random digit sequences, which are read aloud by the examiner at a rate of one digit per second. The forward test requires participants to repeat digit sequences exactly as they are given. The backward test requires participants to repeat digit sequences in reverse order. The number of digits increase by one until participants consecutively fail two trials of the same digit span length. Total score for each task is calculated by adding up the number of the correct repeated sequences.

2.2.7. Procedures and statistical analysis

Initially, participants were provided with information about the study and were shortly interviewed in order to assess their ability to cooperate. If they agreed to participate in the study, they were asked to sign an informed consent form. At first, sociodemographic data were recorded. Subsequently, YMRS and MADRS was conducted by the fifth author (ES), a trainee psychiatrist. Neuropsychological tests were administered in the following order: (i) Greek Verbal Learning Test; (ii) Greek Verbal Memory test, (iii) Greek Verbal Fluency Test; (iv) Digit Span forward-backward (v) Greek Accentuation Test, and (vi) Questionnaire of Autobiographical Memory. Participants were assessed individually in a quiet, distraction-free room. The completion of the whole test battery (including AM assessment) took approximately 2 hours and was administered in one session.

Statistical analyses were performed by SPSS statistical package version 25.0. Sociodemographic and clinical characteristics were processed by Pearson's chi-square test, student's *t*-test and frequency analysis. Group differences in autobiographical memory and in other neurocognitive functions were estimated with student's *t*-test. The effect of other neurocognitive functions on autobiographical memory was calculated with multivariate analysis of variance (MANOVA).

3. Results

3.1. Sociodemographic and clinical characteristics

Participants' demographic and patients' clinical characteristics are presented in Table 1. There were no statistically significant differences in regard with gender [$\chi^2(1) = 1.42$, $p = 0.22$], age [$t(58 = 1.27$, $p = 0.21$], years of education [$t(58) = 1.01$, $p = 0.315$] and premorbid intellectual functioning [$t(58) = 1.45$, $p = 0.519$].

3.2. Autobiographical memory and other neurocognitive performance

Means, standard deviations of scores obtained from QAM, GVLT, GVFT and Digit Span forward-backward, and group differences are presented in Table 2. With respect to autobiographical memory there were statistically significant differences between study groups for both personal semantic memory and autobiographical incidents for all the examined time periods. Regarding neurocognitive performance, analysis showed that there was a statistically significant difference in GVLT

Table 1
Participants' demographic characteristics and patients' clinical characteristics.

Study group	BD-I (N = 30)	HCs (N = 30)	Sig.
Sociodemographic characteristics			
Gender*:			
Male	5 (16.7%)	9 (30%)	0.22
Female	25 (83.3%)	21 (70%)	
Age (years)**	41.16 (SD = 1.83)	38.5 (SD = 7.83)	0.21
Educational level (years)**	13.3 (SD = 2.2)	12.7 (SD = 2.4)	0.32
Marital status*:			
Single	14 (46.7%)	9 (30.0%)	
Married	16 (53.3%)	20 (66.7%)	
Divorced	–	1 (3.3%)	
Employment status*:			
Employed	14 (46.7%)	–	
Unemployed	16 (53.3%)	–	
Clinical characteristics			
Period of diagnosed BD (years)**	12 (SD = 7.34)	–	
Number of manic/ hypomanic episodes**	2.2 (SD = 1.29)	–	
Number of depressive episodes**	2.4 (SD = 1.40)	–	
YMRS score**	1.17(SD = 1.59)	–	
MADRS score**	3.2 (SD = 2.71)		
History of psychotic features*:			
Present	21 (70.0%)	–	
Absent	9 (30.0%)		
Premorbid intellectual functioning	75.23 (SD = 13.06)	77.3 (SD = 11.56)	p = 0.519

YMRS: Young Mania Rating Scale; MADRS: Montgomery-Åsberg Depression Rating Scale.

composite index between study groups, that is, patients performed worse than HCs. On the other hand, patients and HCs did not differ significantly in verbal fluency, attention and working memory. Additionally, there were no significant differences in autobiographical memory and other neurocognitive performance between males and females in both study groups.

3.3. Autobiographical memory in relation to verbal memory

Multivariate analysis of variance was conducted to assess if there were differences in autobiographical memory recall between study groups on a linear combination, taking into account the GVLT composite index, the only neuropsychological variable with statistically significant difference between patients and HCs. Three separate analyses were conducted for the three different time periods, that is, recall of memories from childhood-adolescence, early adulthood and recent life, while GVLT composite index was included as a control variable.

Significant differences were found between patients and HCs in combined semantic and incident memories recalled from: (i) childhood-adolescence [$F(2,55) = 36.93$, $p < 0.001$, $\eta_p^2 = 0.57$]; (ii) early adulthood [$F(2,55) = 58.06$, $p < 0.001$, $\eta_p^2 = 0.68$]; (iii) recent life [$F(2,55 = 58.71$, $p < 0.001$, $\eta_p^2 = 0.68$]. This denoted that the combination of scores in autobiographical memory was dependent of group membership. Effect sizes (η_p^2) were large, demonstrating a statistically significant difference. The difference regarding GVLT composite index at all three time periods was examined, to find whether AM was linearly associated with this index. Furthermore, the interaction between patient status and GVLT composite index was examined, to find whether neurocognitive baseline differences were affecting autobiographical memories. For childhood-adolescence, the effect of GVLT composite score was significant [$F(2,55) = 4.12$, $p = 0.021$, $\eta_p^2 = 0.13$], while the combined effect of group x GVLT composite score not [$F(2,55) = 2.36$, $p = 0.104$, $\eta_p^2 = 0.08$]. For early adulthood, the effect of GVLT composite score was significant [$F(2,55) = 4.97$, $p = 0.01$, $\eta_p^2 = 0.15$],while the combined effect of group x GVLT composite score not [$F(2,55) = 2.07$, $p = 0.135$, $\eta_p^2 = 0.07$]. Lastly, for recent life, the effect of GVLT composite score was again significant [$F(2,55) = 2.95$, $p = 0.061$, $\eta_p^2 = 0.10$], while the combined effect of group x GVLT composite score not [$F(2,55) = 1.95$, $p = 0.151$, $\eta_p^2 = 0.07$]. Differences in individual GVLT composite scores had statistically significant effects on autobiographical memories from childhood-adolescence and early adulthood, though not from recent life. Differences between patients and HCs in GVLT composite scores were not associated with differences in AM. Hence, although baseline differences in GVLT composite scores did affect results in autobiographical recall, those effects were independent of being a patient or a control.

Furthermore, ANOVAs indicated that the effect of patient status was significant for both episodic and semantic autobiographical memories recalled for all three different life periods (Tables 3–5). Patients scored consistently lower in all cases. Effect sizes (η_p^2) varied from small (personal semantic memory) to large (autobiographical incidents), denoting a statistically significant difference between patients and HCs. The GVLT composite index scores seemed to affect performance in autobiographical memories recalled from all three periods of life. Effect size was in general very small. The combined effect of Group x GVLT composite index did not carry statistical significance.

Table 2
Means, standard deviations (SD) and group differences in autobiographical memory and neuropsychological tests.

Variables	BD-I M (SD)	HCs M (SD)	t (58)	Sig.
QAM-Childhood personal semantic memory	18.40 (SD = 3.29)	20.65 (SD = 0.98)	−3.59	**0.001**
QAM-Childhood autobiographical incidents	5.83 (SD = 0.99)	8.57 (SD = 1.22)	−9.53	**<0.001**
QAM-Early adulthood personal semantic memory	17.23 (SD = 3.41)	19.72 (SD = 0.72)	−3.90	**<0.001**
QAM-Early adulthood autobiographical incidents	5.47 (SD = 1.53)	8.70 (SD = 0.70)	−10.54	**<0.001**
QAM-Recent life personal semantic memory	11.53 (SD = 2.57)	12.9 (SD = 0.31)	−2.83	**0.005**
QAM-Recent life autobiographical incidents	3.37 (SD = 1.10)	5.9 (SD = 0.55)	−11.38	**<0.001**
GVLT learning	53.5 (SD = 11.6)	57.9 (SD = 7.77)	−1.72	0.09
GVLT immediate free recall	11.83 (SD = 2.9)	13.1 (SD = 2.01)	−1.97	0.055
GVLT immediate cued recall	12.27 (SD = 2.63)	14.13 (SD = 1.85)	−3.18	**0.002**
GVLT delayed free recall	11.9 (SD = 3.03)	12.9 (SD = 2.35)	−1.43	0.159
GVLT delayed cued recall	12.43 (SD = 2.8)	13.73 (SD = 1.98)	−2.08	**0.042**
GVLT recognition	14.53 (SD = 1.63)	15.27 (SD = 1.11)	−2.03	**0.047**
GVLT composite index*	−0.26 (SD = 0.97)	0.26 (SD = 0.68)	−2.38	**0.021**
GVFT	78.97 (SD = 22.20)	88.67 (SD = 24.05)	−1.62	0.110
Digit Span forward	8.53 (SD = 2.56)	8.77 (SD = 1.76)	−0.41	0.682
Digit Span backward	5.90 (SD = 2.55)	6.47 (SD = 2.06)	−0.95	0.348

QAM: Questionnaire of Autobiographical Memory; GVLT: Greek Verbal Learning Test; GVFT: Greek Verbal Fluency Task; GAT: Greek Accentuation Test.
*GVLT Composite score = (learning + immediate free recall + immediate cued recall + delayed free recall + delayed cued recall + recognition)/6.

Table 3
Effects of patient status and GVLT composite score on autobiographical memories from childhood.

	Dependent variables	*F* (1,56)	Sig.	η_p^2
Group	QAM-Childhood personal semantic memory	8.13	**0.006**	0.13
	QAM-Childhood autobiographical incidents	75.00	**<0.001**	0.57
GVLT composite index	QAM-Childhood personal semantic memory	5.23	**0.025**	0.09
	QAM-Childhood autobiographical incidents	5.46	**0.023**	0.09
Group x GVLT composite index	QAM-Childhood personal semantic memory	0.52	0.476	0.01
	QAM-Childhood autobiographical incidents	3.20	0.079	0.05

QAM: Questionnaire of Autobiographical Memory; GVLT: Greek Verbal Learning Test.

4. Discussion

4.1. Autobiographical memory

The present study examined both episodic and semantic autobiographical memories from three different life periods in remitted patients with BD-I. Results revealed that patients exhibited an overall AM deficit, as their performance was significantly lower in both autobiographical incident memory (episodic AM) and personal semantic memory (semantic AM), compared with healthy individuals. Furthermore, current results showed that AM deficits were present in regard with memories recalled from childhood-adolescence, early adulthood and recent life.

Previous studies investigated mainly episodic AM in BD patients. In particular, focus was placed on specificity of AM recollections using AMT, a measure based on a word-cuing technique (Williams and Broadbent, 1986). Patients with BD showed an overgeneralised retrieval, recalling less specific memories in response to both positive and negative cues (Scott et al., 2000; Tzemou and Birchwood, 2007), or only negative cues (Mansell and Lam, 2004; Boulanger et al., 2013). The present study investigated episodic AM using a different tool, QAM (Alexiadou et al., 2018). This tool, together with AMI (Kopelman et al., 1989), was not developed to investigate specificity. However, scoring criteria applied for the evaluation of autobiographical incident memory (ranging from 0 to 3) provide information about the overgeneral retrieval style, that is, lower scores reflect more abstract memories, deprived of details. Therefore, current results are in accordance with preceding studies.

In regard with the ability to retrieve memories of past personal facts (semantic AM), BD-I patients were again impaired. Although effect sizes (see Tables 3–5) pointed to a greater deficit in episodic, rather than in semantic AM, both AM components were deteriorated. There were only two studies investigating both episodic and semantic AM in BD (Shimizu et al., 2009; King et al., 2013), both of which reported a selective impairment in episodic AM. Discrepancy between previous and current results may be attributed to different study methodology and populations. The first study (Shimizu et al., 2009) administered AMI, therefore AM assessment was in accordance with present study's AM measurement. However, the patient group consisted of BD-I patients at different clinical states, ranging from mild depression to mania. As a result, patient group was heterogeneous compared with current patient group, consisting strictly of clinically remitted patients. Based on a meta-analysis, neurocognitive deficits in BD may be moderated by state factors (Kurtz and Gerraty, 2009), something that could be valid for AM as well. Although Shimizu et al. performed a separate analysis in euthymic patients, confirming a selective deficit in episodic AM, patient number was relatively small ($n = 7$) to permit definite conclusions. The second study (King et al., 2013) evaluated AM by the Autobiographical Interview (Levine et al., 2002), a tool assessing episodic and semantic AM via qualitative classification of recalled details. On the contrary, the tool administered in the current study, QAM (Alexiadou et al., 2018), includes two separate subscales assessing episodic and semantic AM via quantitative classification. In addition, King et al. asked patients to recall a single event from the last two years dating to a manic, depressed and euthymic mood state. Retrieval of only one event per mood state may be easier, as this event may be the most accessible. As a result, the event is more likely to be recalled in detail. Furthermore, the latter study employed patients diagnosed with BD-I, as well as BD-II. Up to date there are no studies comparing AM deficits between BD-I and BD-II patients. Still, two studies of episodic memory reported more severe deficits in BD-I, compared with BD-II (Torrent et al., 2006; Simonsen et al., 2008). Similarly, severity of AM deficits may be different between BD-I and BD-II patients, that is, BD-I patients alone may display a broader deficit, affecting both episodic and semantic AM. This issue warrants further clarification.

Conway's model of AM (Conway and Pleydell-Pearce, 2000) may explain concurrent deficits in episodic and semantic AM. According to this model, AM is organised into hierarchical levels of self-knowledge, starting with general knowledge about events and life periods and moving on to the most concrete and specific life episodes. Therefore, a specific autobiographical episode can be retrieved only after more general and abstract personal knowledge has been accessed.

4.2. Other neurocognitive functioning

Since AM performance has been related to other cognitive functions (Rubin, 2005; Nelson and Fivush, 2004; Janssen et al., 2015; Ros et al., 2010), and neurocognitive deficits have been considered a core feature of BD (Robinson et al., 2006; Bourne et al., 2013), current study aimed at investigating AM in relation to other neuropsychological domains. Therefore, premorbid intellectual functioning, verbal memory, verbal fluency, attention and working memory were assessed in BD-I patients in comparison with healthy individuals. Based on results, patients displayed deficits only in regard with verbal memory. This outcome does

Table 4
Effects of patient status and GVLT composite score on autobiographical memories from early adulthood.

	Dependent variables	*F* (1,56)	Sig.	η_p^2
Group	QAM-Early adulthood personal semantic memory	10.71	**0.002**	0.16
	QAM-Early adulthood autobiographical incidents	98.47	**< 0.001**	0.64
GVLT composite index	QAM-Early adulthood personal semantic memory	8.74	**0.005**	0.14
	QAM-Early adulthood autobiographical incidents	8.07	**0.006**	0.13
Group x GVLT composite index	QAM-Early adulthood personal semantic memory	3.86	0.054	0.06
	QAM-Early adulthood autobiographical incidents	0.73	0.397	0.01

QAM: Questionnaire of Autobiographical Memory; GVLT: Greek Verbal Learning Test.

Table 5
Effects of patient status and GVLT composite score on autobiographical memories from recent life.

	Dependent variables	*F* (1,56)	Sig.	η_p^2
Group	QAM-Recent life personal semantic memory	5.49	**0.023**	0.10
	QAM-Recent life autobiographical incidents	111.65	**<0.001**	0.67
GVLT composite index	QAM-Recent life personal semantic memory	4.06	**0.049**	0.07
	QAM-Recent life autobiographical incidents	4.68	**0.035**	0.08
Group x GVLT composite index	QAM-Recent life personal semantic memory	3.98	0.051	0.07
	QAM-Recent life autobiographical incidents	0.84	0.364	0.02

QAM: Questionnaire of Autobiographical Memory; GVLT: Greek Verbal Learning Test.
$p < 0.05$.

not support existing evidence for broad neurocognitive impairment in BD (Robinson et al., 2006; Bourne et al., 2013). On the other hand, literature does not consistently support neurocognitive impairment in BD (Bortolato et al., 2015). Therefore, one could assume that neurocognitive function may be impaired in some, but not all BD patients, since many different factors have been implicated in BD patients' neurocognitive deficits, among which early onset of the disorder, duration of illness, medication effects, as well as comorbidity with alcohol and/or illicit substance abuse (Bortolato et al., 2015; Robinson and Ferrier, 2006; Torres et al., 2012).

4.3. Effect of verbal memory on autobiographical memory

Since patients showed deficits only in verbal memory, this was the only variable examined in relation to AM. Based on this study approach, the group difference in both episodic and semantic memories from all three life periods remained significant. This finding denoted that patients' impairment in AM was not mediated by a general deficit in verbal memory. To the best of our knowledge this was the first study investigating the effect of verbal memory impairment on AM in BD. Up to date, information about the relationship between AM and neuropsychological performance in BD is scarce. There was evidence that euuncited thymic BD-I patients showed an overgeneral recall of episodic memories that remained significant even after taking general intellectual functioning into account (Scott et al., 2000). Furthermore, overgeneral memory in BD-I patients was correlated with impaired executive functions (Kim et al., 2014). In accordance, better performance in executive functions, verbal memory and attention was correlated with more detailed recall of episodic autobiographical memories in both mixed BD-I and BD-II patients and healthy individuals (Quinlivan et al., 2017). It should be noted though that the latter study did not find significant differences in AM specificity and cognitive performance between patients and controls.

Altogether, current study results outlined a global AM deficit in BD-I patients. Poor AM performance may be related to retrieval processes pertaining specifically to AM. In regard with memories encoded at life periods following disease onset, AM deficits may additionally reflect defective encoding processes. There is evidence for impaired verbal memory retrieval (Krabbendam et al., 2000; Martínez-Arán et al., 2004) and encoding of verbal information in BD patients (Martínez-Arán et al., 2004; Bearden et al., 2006). The frontal lobes are considered a key region for memory functions, operating retrieval processes. They initiate, guide and organise memory search, while monitoring retrieved content (Rosenbaum et al., 2004). Considering structural and functional frontal lobe abnormalities in BD patients (Arnone et al., 2009; Maletic and Raison, 2014), the inability to recall autobiographical memories may be associated with impaired strategic processes during retrieval and/or encoding due to frontal/executive dysfunction. Unfortunately, assessment of executive functions was not included in the current study and it is not feasible to further investigate this hypothesis.

4.4. Study's usefulness and limitations

Up to date, research of AM in BD is limited. Therefore, current study aimed at contributing to this field. To the best of our knowledge, this was the first investigation of AM in BD-I after controlling for patients' verbal memory deficits. The ability to recall autobiographical memories is crucial for the development of personal identity and the sense of self continuity, processes that may be disrupted in BD patients (Inder et al., 2008). Furthermore, AM was associated with a social and directive function (Vranić et al., 2018), contributing to successful problem solving, adaptation (Pillemer, 2003) and possibly well-being. Two meta-analyses have highlighted the negative impact of AM dysfunction on the course of depression (Sumner et al., 2010) and schizophrenia (Berna et al., 2015). Studies of life review training in schizophrenia patients (Ricarte et al., 2012), memory specificity training in depression (Neshat-Doost et al., 2013;) and specific cueing method in schizophrenia patients (Potheegadoo et al., 2014) revealed that AM performance may improve. Therefore, current findings support the important issue of cognitive remediation therapy in BD.

Still, the present study has some limitations: (i) A significant proportion of patients (70%) had a previous history of psychotic symptoms. Due to evidence for more severe cognitive impairment in BD with psychotic features (Glahn et al., 2007; Simonsen et al., 2009), results are limited to this specific study group; (ii) Blinding AM assessor in regard with participants' status was not feasible, since patients were unable to conceal their status, revealing their psychiatric history; (iii) All participants received pharmacological treatment. Unfortunately, a medication effect on AM could not be investigated due to large diversity in types and doses of drugs; (iv) additionally, interrater reliability was not tested.

4.5. Conclusions

Autobiographical memory has been studied in BD patients mainly in regard with specificity of recalled personal events. The present study controlled BD-I patients' AM deficits for the influence of verbal memory impairment. Results indicated that patients performed worse than healthy controls with respect to memories of both autobiographical incidents and facts dating to childhood-adolescence, early adulthood and recent life. Current findings support the presence of AM deficits beyond patients' verbal memory dysfunction, suggesting that they do not merely reflect a general memory deficit linked to BD. Since enrolled patients were clinically remitted, AM deficits may constitute a trait, rather than a state depended cognitive impairment. Future longitudinal and imaging studies are necessary for elucidating the pattern, as well as the underlying mechanisms of AM dysfunction in BD.

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