British Journal of Clinical Psychology (2017), 56, 329–346

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Positive autobiographical memory deficits in youth with depression histories and their never-depressed siblings

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Objectives. Impaired positive autobiographical memory (AM) is closely linked to emotional disorders. AM impairments are often found in depressed adults and may be related to the difficulties such persons have in regulating their dysphoric mood. By contrast, less is known about AM disturbances among adolescents, or about the functional relationship of AM disturbances to early-onset depression.

Design. A high-risk family design served to compare four groups of youth who differed in depression histories and familial depression risk.

Methods. Thirty-one currently depressed probands, 185 remitted probands, 204 never-depressed siblings of probands, and 180 healthy control youth were induced into a negative mood prior to recalling positive AMs via a novel memory elicitation procedure. Several positive AM characteristics were assessed.

Results. Relative to control youth, unaffected siblings and probands exhibited consistently impaired positive AMs. Moreover, we also found some evidence that probands were more impaired than siblings, who were in turn more impaired than controls, consistent with a gradient effect.

Conclusions. Positive AM disturbances may not only precede the onset of depression in vulnerable youth, but also continue to persist after remission of a depressive episode. Clinical and basic research implications of the findings are discussed.

Practitioner points

- Positive AM impairments may be trait-like, persist in the euthymic phase of depression, and may serve as a risk marker for early-onset depression among vulnerable adolescents.

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DOI:10.1111/bjc.12141

- Disturbances in positive AM may negatively impact the mood-regulatory functions of positive memory recall and contribute to persistent sadness and anhedonia, which are core features of depression.
- Our sample of currently depressed youth was relatively small, tempering our conclusions.
- Although we collected data on some important covariates (e.g., socioeconomic status), we lacked information on other relevant variables such as youths' executive functioning or IQ.

Autobiographical memory (AM) is a memory system comprised of self-relevant events and plays a fundamental role in human functioning (Fivush, 2011). The process of reconstructing, reflecting upon, and relating past events shapes one's identity and self-understanding (Fivush, 2011). Moreover, AM can guide behaviour and regulate emotions (Bluck, Alea, Habermas, & Rubin, 2005). The most salient AMs are often emotionally toned, and one's emotional state often influences which types of memories are retrieved (Kensinger & Schacter, 2008).

Given the importance of AM and its link to emotion, there has been increasing interest in understanding how AM processes contribute to the development of emotional disorders, specifically depression. One major body of research has examined whether vulnerability to depression impairs AM characteristics. The most common finding is that depressed individuals recall vague, script-like AMs – termed non-specific or overgeneral memories (see van Vreeswijk & de Wilde, 2004 and Williams *et al.*, 2007 for meta-analysis and review, respectively). Additional AM deficits include retrieval difficulties (Goddard, Dritschel, & Burton, 1996; Rottenberg, Hildner, & Gotlib, 2006), as well as deficits in memory vividness (Werner-Seidler & Moulds, 2011) and visual perspective (Bergouignan *et al.*, 2008; Lemogne *et al.*, 2006).

The literature on memory processes in depression is increasingly rich and includes studies of neurobiological correlates of impaired AM. For example, recent studies show that regional brain activation patterns among currently and formerly depressed participants (Young, Bellgowan, Bodurka, & Drevets, 2013, 2014; Young *et al.*, 2012), as well as healthy individuals with a positive family history of depression, differ from controls during AM recall. Additional research has highlighted the important role of mental imagery in memory recall in depression, given that similar brain networks are recruited to facilitate mental imagery and memory recall (Schacter *et al.*, 2012). In fact, accumulating evidence implicates mental imagery deficits in the commonly observed phenomenon of overgeneral memory and other problems in AM functioning (see Holmes, Blackwell, Burnett Heyes, Renner, & Raes, 2016 for review).

Despite notable progress in documenting AM impairments in depression, and identifying potential underlying mechanisms, there remain critical gaps. Perhaps most notably, we know relatively little about AM disturbances in adolescents, and how such disturbances relate to early-onset depression. This gap is of concern because adolescence is an important developmental period during which the cognitive abilities that subserve memory dramatically increase, but remain incomplete (Steinberg, 2005). Adolescence is also the period in which first episodes of depression often emerge (Lewinsohn, Rohde, & Seeley, 1998; Rutter, Kim-Cohen, & Maughan, 2006). Moreover, early-onset depression is associated with a worse clinical course than depression that onsets in adulthood (Korczak & Goldstein, 2009; Zisook *et al.*, 2007). Thus, examining AM processes in adolescents may help us understand how AM deficits intersect with the early onset, maintenance, and recurrence of depressive episodes.

Only a handful of studies have examined AM disturbances in youth. The most comprehensive study to date was conducted by Park, Goodyer, and Teasdale (2002), who utilized a sample of adolescents in their first episode of depression, as well as partially and

fully remitted adolescents, and two control groups (psychiatric and healthy controls). Park and colleagues found no differences among currently depressed, partially remitted, and fully remitted youth. However, relative to healthy controls, currently depressed youth retrieved more overgeneral memories to positively and negatively valenced cue words, while fully remitted youth only retrieved overgeneral memories to positive cues. More recently, Champagne *et al.* (2016) showed that currently and formerly depressed adolescents exhibited overgeneral memory bias to both negative and positive cues. These findings suggest that AM deficits might be trait-like and observable outside the confines of active depression episodes (also see Kuyken & Dalgleish, 2011).

Another small group of studies have examined AM disturbances among high-risk youth, which can help to determine whether AM deficits serve as risk or vulnerability factors for eventual depression onset. Woody, Burkhouse, and Gibb (2015) found that unaffected youth of depressed mothers exhibited overgeneral memory for negative cues compared to youth of non-depressed mothers. Likewise, Rawal and Rice (2012) found that youth at familial risk of depression who exhibited greater overgeneral memory to negative cues were more likely to develop depression a year later compared to at-risk youth who were less overgeneral in their memory functioning.

Although the findings on adolescents provide preliminary evidence that AM deficits may reflect a trait marker and risk factor for depression, the studies are small in number and have relied exclusively on the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986). While the AMT has multiple strengths (e.g., simple administration, relative standardization), it also has several features that make it less than optimal with younger populations. Specifically, the AMT, which was originally developed for adults (Williams *et al.*, 2007), instructs participants to recall specific memories associated with single emotionally toned word cues (e.g., 'proud') within a fixed amount of time. Weak cues and time pressure are likely to place a particularly high cognitive demand on youth, which is likely to be further accentuated by depression, a condition that is characterized by impaired executive functioning (Snyder, 2013). The impersonal testing format of the AMT may also make it more difficult for youth to recall memories, as the recall of memories is an interpersonal activity, in which memories are told to others, who, in turn, can facilitate further recall by way of their responses (Weeks & Pasupathi, 2010).

Another limitation of prior studies is the relatively narrow assessment of AMs, often focusing on a single feature deficit (i.e., memory specificity). Thus, it is unclear how depression vulnerability affects other AM characteristics. For instance, memory coherence may be an important characteristic, given that adolescents are tasked with organizing and integrating their experiences across time to develop a coherent life narrative and sense of self (Pasupathi & McLean, 2010). Importantly, coherency of autobiographical narratives has implications for well-being (Fivush, 2011; Pasupathi & McLean, 2010). Finally, although we know that AM often serves mood-regulatory purposes (e.g., thinking of happy life episodes when sad; Isen, 1985; Josephson, Singer, & Salovey, 1996), most prior studies have not examined AM in mood-regulatory contexts, such as in response to induced sad mood.

The current study

The current study had several features designed to advance the literature. We focused on positive AMs because impairment in positive AMs may have implications for persistence of sad mood, a core feature of depression (American Psychiatric Association [APA], 2013). Indeed, positive AM recall is a key strategy individuals use to downregulate negative mood, a

process known as *mood repair* or *negative-affect repair* (Isen, 1985; Josephson *et al.*, 1996). This process may be deficient in adults and youths with a history of depression (Joormann & Siemer, 2004; Joormann, Siemer, & Gotlib, 2007; Kovacs *et al.*, 2015).

Specifically, our aim was to test how positive AM deficits relate to early-onset depression within the context of a high-risk family research design (Avenevoli & Merikangas, 2006). We contrasted probands who had a well-documented history of childhood-onset depression (remitted or in a current depressive state) with their as-of-yet never-depressed siblings, who are known to be at high risk of future depression by virtue of a positive family history. A sample of healthy youth was included as a control group. To examine AM during a mood-regulatory context, our paradigm included a negative mood induction. To achieve a developmentally appropriate test of AM recall in adolescents, we elicited positive AMs using meaningful cues, which were actively facilitated in an interpersonal interview format. Finally, we assessed a comprehensive array of AM characteristics.

We hypothesized that we would observe evidence of positive AM deficits outside of an active depressive episode. Specifically, we hypothesized that relative to control youth, currently and formerly depressed youth and their unaffected siblings would have impaired positive AMs across several memory characteristics (i.e., memories would be harder to retrieve, not specific, less detailed, and less positive). We also hypothesized that the magnitude of positive AM impairments would be greatest among currently depressed probands and least among unaffected siblings, with remitted probands between the two groups.

Method

Participants

We examined four groups of youth: 31 currently depressed probands, 185 remitted probands, 204 never-depressed siblings of probands, and 180 healthy control youth. Probands and siblings included in this study were part of a larger sample recruited in Hungary for a previous genetic study of childhood-onset depression (referred to as the *archival study* hereafter; see Burcescu *et al.*, 2006; Dempster *et al.*, 2009). Demographic and sample characteristics of each youth group are presented in Table 1; clinical characteristics of currently depressed and remitted probands are presented in Table 2.

Recruitment and diagnostic assessment procedures have been previously described (see Kiss *et al.*, 2007; Tamas *et al.*, 2007). Briefly, probands were recruited from several child mental health and guidance facilities in Hungary and were included in the archival study upon satisfying the following inclusion criteria: a current or recent major depressive episode based on DSM-IV-TR criteria (APA, 2000); absence of mental retardation or major medical disorder; 7–14 years old during the initial screening; having at least one full biological sibling aged 7–18 years; and at least one biological parent available to participate. For this study, a sample of healthy control youth – who were not part of the archival study – were recruited from public elementary and secondary schools located in three major cities in Hungary. Control youth were included in the study only if they never had any major psychiatric disorder, and were carefully selected to match the probands on sex and age.

Diagnoses were established via the semi-structured Interview Schedule for Children and Adolescents: Diagnostic version (ISCA-D), which covers mood disorders and common non-affective disorders (e.g., anxiety and behaviour disorders) based on DSM-IV criteria.

Table 1. Participant demographics and characteristics

	1. Control (N = 180)	2. Unaffected siblings (N = 204)	3. Remitted probands (N = 185)	4. Depressed probands (N = 31)	F/χ^2/t	*Post-hoc* comparisons
Age, mean (*SD*)	16.07 (2.13)	15.89 (2.15)	17.14 (1.35)	16.29 (1.49)	21.14***	1,2,4 < 3
Male, *N* (%)	115 (63.9)	95 (46.6)	118 (63.8)	21 (67.7)	17.27***	1 > 2; 2 < 3
Race, *N* (%)						
Caucasian	178 (98.9)	194 (95.1)	178 (96.2)	28 (90.3)	7.39[a]	–
Bi-/multiracial	–	1 (.5)	3 (1.6)	2 (6.5)		
Roma	–	7 (3.4)	4 (2.2)	1 (3.2)		
Other	2 (1.1)	2 (1.0)	–	–		
Parental SES[b], mean (*SD*)	3.72 (1.07)	2.79 (1.07)	2.77 (1.16)	2.84 (1.39)	31.04***	1 > 2–4
CDI 2	4.76 (4.25)	8.69 (5.96)	9.23 (6.19)	15.65 (5.72)	48.72***	1–3 < 4
Baseline negative affect	0.35 (0.43)	0.38 (0.53)	0.41 (0.68)	0.92 (0.98)	3.57*	1–3 < 4
Baseline positive affect	4.33 (1.31)	3.69 (1.36)	3.26 (1.55)	2.88 (1.62)	21.09***	1 > 2–4; 2 > 3,4
Post-mood induction						
Sad film (negative affect)	0.55 (0.52)	0.59 (0.84)	0.67 (0.86)	0.78 (0.83)	0.65	–
Sad film (positive affect)	3.31 (1.65)	3.01 (1.68)	2.58 (1.85)	2.29 (1.33)	3.63*	1 > 3
Unsolvable puzzle (negative affect)	0.92 (0.84)	0.90 (0.94)	0.52 (0.61)	1.15 (1.26)	6.64**	1, 2 > 3
Unsolvable puzzle (positive affect)	3.53 (1.47)	2.88 (1.87)	2.25 (1.65)	1.77 (2.00)	11.81***	1 > 2–4
Post-AM interview negative affect	0.14 (0.33)	0.22 (0.61)	0.22 (0.48)	0.58 (0.98)	3.17*	1–3 < 4
Post-AM interview positive affect	4.40 (1.51)	3.81 (1.68)	3.11 (1.81)	2.57 (1.95)	21.98***	1 > 2–4; 2 > 3,4

Note. AM = autobiographical memory.
The total sample size was 600. Due to random missing values, the total sample sizes ranged from 592 to 600.
[a]The chi-square test was conducted on Caucasian versus non-Caucasian racial composition.
[b]Hollingshead socioeconomic class: 1 (lowest) to 5 (highest).
*p < .05; **p < .01; ***p < .001.

Both the youth and the youth's parent were interviewed. As previously reported, inter-rater reliability for ISCA-D symptom ratings was acceptable (Kiss *et al.*, 2007). Youth were considered in remission from a mood disorder if they experienced minimal or no symptoms for at least 2 months (Kovacs, Feinberg, Crouse-Novak, Paulauskas, & Finkelstein, 1984). The youth's diagnoses were determined by trained clinicians, double-checked by senior diagnosticians, and subsequently verified by diagnostic consensus procedure (Maziade *et al.*, 1992).

Procedure overview

The research assessment consisted of completion of self-report questionnaires, an experimental protocol, and a psychiatric–psychosocial evaluation. Prior to data collection, parents provided written informed consent, and youth provided assent or consent

Table 2. Clinical characteristics of probands

	Remitted probands (*N* = 185)	Depressed probands (*N* = 31)
Comordid dysthymia, *N* (%)	31 (16.8)	8 (25.8)
Number of major depressive episodes, *M* (*SD*)	1.56 (0.76)	2.00 (0.89)
Age of onset of first depressive episode, *M* (*SD*)	8.81 (1.79)	9.02 (2.60)
Total years in depressive episode(s), *M* (*SD*)	2.70 (2.32)	4.53 (3.58)
Current psychotropic medication use, *N* (%)	4 (2.2)	3 (9.7)
Treatment history, *N* (%)		
Outpatient psychiatric therapy	152 (82.2)	26 (83.9)
Psychiatric hospitalization	71 (38.4)	15 (48.4)
Psychotropic medications	124 (67.0)	21 (67.7)
Any psychiatric treatment (inpatient/outpatient/medication)	168 (90.8)	29 (93.5)
History of suicide attempts, *N* (%)	23 (12.4)	5 (16.1)

(when appropriate). Youth first completed a series of self-report questionnaires, including the revised Children's Depression Inventory (CDI 2; Kovacs & MHS Staff, 2011), and were then introduced to the experimental procedure and physiological equipment. The youth were seated in a comfortable chair in front of a computer and webcam, completed baseline affect ratings, and were connected to physiological monitors (data not included in the present report). The experimental procedure consisted of several tasks that assessed physiological, psychological, and behavioural reactions; the entire procedure lasted approximately 1 hr, with a mid-point break. To minimize order effects, youth were randomized to one of eight different task sequences. The current report addresses the part of the experimental procedure that involved two negative mood induction tasks followed by the positive AM interview. The study session concluded with a happy film, which was included to help mood return to baseline. Upon study completion, participants were debriefed. The study was approved by the institutional review boards of our university and the clinical research sites.

Experimental procedure

Mood induction

We used two mood induction conditions to allow us to generalize positive AM recall to different mood challenges. Youth were either randomized to watch a sad film clip or presented with a series of unsolvable puzzles. The sad film stimulus was a 164-s clip from *The Champ* (commercially synchronized in Hungarian), which depicts a boy's immediate reactions to the death of a loved one. The unsolvable puzzle task (Cole *et al.*, 2007; Nolen-Hoeksema, Wolfson, Mumme, & Guskin, 1995), presented in two trials of up to 3 min each, entailed having to reproduce lettered tile-like patterns on a computer screen and was preceded by a practice period and several solvable puzzles. Both solvable and unsolvable arrangements were pre-programmed, unbeknown to the participant. We decided to collapse the data across the two mood induction conditions after analyses indicated that mood induction condition was not a statistically significant factor, nor did it improve model fit or alter our primary findings.

Positive AM interview

The positive AM interview was introduced as follows:

> In the next task, we are interested in how kids remember happy times from their life. Specifically we'd like you to think of happy things that happened to you during the last year. These are things that made you feel good, like winning in a game, going on a family vacation, having a fun time with friends, or getting a present. It can be anything as long as it's a happy thing that happened during [the last year]. OK?

The recall period was limited to the past year to constrain variability in the timing of the recalled event. When the youth had recalled a first memory, he/she was asked to write down a clue word as a reminder, and then was asked to recall a second memory and again write down a clue word. When the youth was done, the interviewer returned to the first memory clue and asked the youth to elaborate for up to one minute using standardized prompts to obtain further information. These prompts included the following: 'Can you tell me more about this?' 'Is there anything else you can tell me about ___[this memory]?' 'What made that such a happy event for you?' and 'Were there other happy things in the past year you can think of?' The interviewer provided a prompt only if the youth paused and time remained during the minute. An identical procedure was used for the second memory.

Measures

Children's Depression Inventory, Second Edition (CDI 2)

The CDI 2 (Kovacs & MHS Staff, 2011) is a 28-item instrument used to assess depressive symptoms in children and adolescents. Each item is rated on 3-point scale anchored by 0 (absence of symptoms) and 2 (definite symptom). Scores range from 0 to 56, with higher scores representing greater severity. The CDI 2 has demonstrated acceptable psychometric properties (Kovacs & MHS Staff, 2011).

Affect ratings

Youth completed affect questionnaires at baseline and after the mood induction. On both occasions, the youth reported on nine different affective states (*happy, interested*, *enthusiastic*, *sad*, *angry*, *upset*, *nervous*, *irritable*, *blue*) using 8-point scales ranging from 0 (not at all) to 7 (very much). Ratings for *sad*, *angry*, *upset*, *nervous*, *irritable*, and *blue* were averaged for a composite rating of negative affect. Ratings for *happy, interested*, and *enthusiastic* were averaged for a composite rating of positive affect. Composites for negative and positive affect had adequate internal consistency (all Cronbach's alphas >.70).

Coding of positive AM characteristics

Videotapes of the positive AM interview were transcribed and rated by independent coders blind to group status. The coders rated the written transcripts of each memory on 10 characteristics: *specificity* (rated as 1 [no] or 2 [yes] according to whether the memory contained a clear reference to a particular event or episode that lasted <1 day); *youth word count* (total number of youth's words); *coherence* (rated on an 5-point scale ranging from 0 [completely incoherent] to 4 [completely coherent] based on the degree to which

the memory was relayed in a chronological, complete, and easy-to-follow manner); *overall detail* (rated on an 11-point scale ranging from 0 [no contextual detail] to 10 [extreme contextual detail] based on the amount of specific contextual detail provided, such as time, location, persons involved, sights, sounds, thoughts, and reactions); *positive adjectives* (number of positive emotion adjectives used); *negative adjectives* (number of negative emotion adjectives used); *overall positivity* (rated on an 11-point scale ranging from 0 [not at all] to 10 [extremely] based on the strength of the memory's positive elements); *overall negativity* (rated on an 11-point scale ranging from 0 [not at all] to 10 [extremely] based on the strength of the memory's negative elements); *interviewer prompts* (total number of times the interviewer needed to facilitate youth's memory recall); and *interviewer word count* (total number of interviewer's words). Coders received several sessions of group training and were provided with a training manual. Two coders rated each memory, and inter-rater reliability was good to excellent (interclass correlation coefficients [ICCs] or kappa statistic ranged from 0.65 to 1.00).[1] Ratings of all continuous positive AM characteristics were averaged. For ratings of memory *specificity*, discrepancies were discussed until a consensus was reached.

Data management

Due to video failure or youth's inability to generate a memory, data for the first and second positive AM, respectively, were missing for six cases (one control, three unaffected siblings, one remitted proband, and one currently depressed proband) and 11 cases (one control, four unaffected siblings, three remitted probands, and three currently depressed probands). A cut-off value of greater than ± 3 standard deviations was used to detect univariate outliers. Up to 17 outliers were detected and removed per variable. Complete data were available for 407 participants; all but 12 of the remaining participants had data on some positive AM characteristics and all independent variables. Although the pattern of missing values was not discernible, our working assumption was that the data were missing at random. For analyses that did not account for random missing values, pairwise deletion was used when possible. All analyses were conducted using either SPSS v.22 (IBM Corp., Armonk, NY, USA) or SAS v. 9.3 (SAS Institute, Cary, NC, USA) unless otherwise noted.

Results

Descriptive statistics and preliminary analyses

In preliminary analyses, group differences in age, sex, race, parental socioeconomic status (SES), CDI 2 scores, and baseline negative/positive affect were examined using one-way analysis of variance (ANOVA) and chi-square tests. As shown in Table 1, the groups differed in age, sex, and SES, and thus, those variables were controlled for in the analyses. As expected, the groups also differed in depressive symptoms and baseline negative/positive affect.

[1] *ICCs for continuous positive AM characteristics for the first memory and second memory, respectively, are as follows: youth word count = 1.0/1.0; coherence = .67/.72; overall detail = .80/.74; positive adjectives = .96/98; negative adjectives = .80/.91; overall positivity = .66/69; overall negativity = .80/.77; interviewer prompts = 1.0/1.0; and interviewer word count = 1.0/1.0. The kappa statistic for specificity for the first and second memory was .65 and .73, respectively.*

Manipulation check

To verify that negative mood was induced, a 4 (Group: controls vs. unaffected siblings vs. remitted probands vs. currently depressed probands) × 2 (Time: baseline negative affect vs. post-mood induction negative affect) mixed-model ANOVA was used, with time as the within-subjects factor. Results yielded a main effect of group, $F(3, 590) = 4.72$, $p = .003$, $\eta_p^2 = .02$, such that currently depressed probands ($M = .94$, $SE = .11$) reported higher levels of negative affect than controls ($M = .55$, $SE = .05$), unaffected siblings ($M = .57$, $SE = .04$), and remitted probands ($M = .51$, $SE = .04$). The latter three groups did not significantly differ from each other. Consistent with an effective mood induction, an effect of time was observed, $F(1, 590) = 35.99$, $p < .001$, $\eta_p^2 = .06$, with higher self-reported negative affect after the mood induction ($M = .77$, $SE = .05$) than before it ($M = .52$, $SE = .03$). We also observed a significant group × time interaction, $F(3, 590) = 3.89$, $p = .009$, $\eta_p^2 = .02$, with currently depressed probands reporting a more modest increase in negative affect after the negative mood induction than the other groups of youth, who did not differ from each other. Critically, the four groups did not differ in reported negative affect after the mood induction after controlling for baseline mood, $F(3, 589) = 2.46$, $p = .06$. Further, excluding participants who were non-responders to the mood induction (score of '0' for negative affect after the mood induction) did not alter the pattern of memory findings reported below.

Between-group differences in positive AM characteristics

Positive AM characteristics of the two memories were significantly intercorrelated, as expected, and thus, we averaged over the two memories. We first present general AM recall performance. As shown in Table 3, our memory recall procedure generally elicited rich positive AMs. Collectively, positive AMs recalled by the youth were generally coherent and detailed and were characterized by moderate levels of positivity and low levels of negativity. Positive adjectives were used more often than negative adjectives. Youths typically required a handful of prompts from the interviewer, but spoke more during the positive AM interview than the interviewer did.

Group differences in positive AM characteristics, adjusted for age, sex, and SES, were tested in a multivariate analysis of covariance (MANCOVA). To retain all cases so long as some dependent variables were non-missing, MANCOVA was estimated using mixed-effects models. A preliminary unconditional multivariate analysis of variance (MANOVA) revealed a family effect on the 10 positive AM characteristics (ICC = .27), in which approximately 27% of the variability in the positive AM characteristics was due to familial dependency. As a result, robust maximum-likelihood methods were applied using Mplus v.6 (Muthen & Muthen, 1998–2010) and the *COMPLEX* command was used to account for family clusters. The MANCOVA revealed an overall difference in positive AM characteristics between the groups, $\chi^2 (30) = 127.17$, $p < .001$. Follow-up Wald chi-square tests revealed significant group effects for eight of the 10 positive AM characteristics (see Table 4 and Figure 1).

Overall, the pattern of group differences was largely consistent with our hypothesis. With respect to our first hypothesis, the most consistent differences in positive AM characteristics were between remitted probands and controls. Specifically, remitted probands recalled positive AMs that were less coherent, less detailed, less positive, and contained less positive adjectives than control youth. Furthermore, remitted probands spoke less and had more difficulty elaborating on their retrieved positive AMs, as indexed by a greater number of interviewer prompts and a higher interviewer word count. As

Table 3. Zero-order correlations among the positive autobiographical memory (AM) characteristics

Positive AM characteristic	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Youth word count	71.45	25.79	–								
2. Coherence (scale: 0–4)	2.16	.65	.74***	–							
3. Overall detail (scale: 0–10)	6.16	1.49	.84***	.85***	–						
4. Positive adjectives	2.34	1.53	.53***	.43***	.43***	–					
5. Negative adjectives	.09	.20	.25***	.19***	.23***	.17***	–				
6. Overall positivity (scale: 0–10)	6.15	.89	.49***	.63***	.64***	.47***	.07	–			
7. Overall negativity (scale: 0–10)	.48	.51	.33***	.14**	.19***	.10*	.30***	−.11*	–		
8. Interviewer prompts	4.14	1.10	−.57***	−.56***	−.59***	−.31***	−.09*	−.43***	−.15***	–	
9. Interviewer word count	44.60	13.28	−.57***	−.54***	−.58***	−.31***	−.13**	−.34***	−.21***	.83***	–

Note. *$p < .05$; **$p < .01$; ***$p < .001$.

Table 4. Positive autobiographical memory (AM) characteristics across youth groups controlling for age, sex, and SES

Positive AM characteristic	Youth groups					
	1. Controls (N = 179) M (SE)	2. Unaffected siblings (N = 199) M (SE)	3. Remitted probands (N = 182) M (SE)	4. Depressed probands (N = 28) M (SE)	Wald χ^2	*Post-hoc* group comparisons[a,b]
Specificity (1 = no, 2 = yes)	1.38 (0.03)	1.45 (0.03)	1.41 (0.03)	1.46 (0.06)	1.45	–
Youth word count	80.18 (1.87)	70.28 (1.90)	65.39 (1.77)	63.04 (4.56)	29.59**	1 > 2, 3; 2 > 3
Coherence (scale: 0–4)	2.30 (0.05)	2.19 (0.05)	2.03 (0.04)	1.90 (0.15)	17.28**	1, 2 > 3
Overall detail (scale: 0–10)	6.61 (0.11)	6.13 (0.11)	5.78 (0.10)	5.88 (0.36)	21.93**	1, 2 > 3
Positive adjectives	2.73 (0.11)	2.24 (0.11)	2.05 (0.10)	2.51 (0.33)	17.92**	1 > 3
Negative adjectives	0.10 (0.02)	0.07 (0.01)	0.11 (0.02)	0.16 (0.05)	6.54	–
Overall positivity (scale: 0–10)	6.45 (0.06)	6.20 (0.07)	5.84 (0.06)	5.80 (0.20)	50.51**	1 > 2–4; 2 > 3
Overall negativity (scale: 0–10)	0.45 (0.03)	0.43 (0.03)	0.53 (0.04)	0.75 (0.12)	10.21*	1–3 < 4
Interviewer prompts	3.66 (0.07)	4.20 (0.08)	4.52 (0.08)	4.40 (0.18)	44.11**	1 < 2–4; 2 < 3
Interviewer word count	39.51 (0.90)	45.54 (0.98)	48.15 (0.93)	47.64 (2.42)	23.88**	1 < 2–4; 2 < 3

Note. The means presented in the table are unadjusted for the covariates. *Post-hoc* group comparisons were conducted on the adjusted means.

[a]Benjamini and Hochberg's (2000) adaptive control of false discover rate procedure was used to control for type I error across the multiple *post-hoc* comparisons.

[b]Effect sizes for the *post-hoc* group comparisons ranged from d = .19 [95% CI: −0.01, 0.40] to d = .85 [95% CI: 0.64, 1.07].

*p < .05; **p < .001.

displayed in Table 4, these differences between remitted probands and controls were statistically significant. The pattern of positive AM deficits in currently depressed probands was observed for a subset of these variables. Expected differences between controls and currently depressed probands were more modest, possibly because the small sample size of currently depressed probands limited statistical power.

Similar to probands, unaffected siblings exhibited deficits on four of the positive AM characteristics. As displayed in Table 4, there were statistically significant differences between controls and unaffected siblings; unaffected siblings' positive AMs were less positive, and they spoke less and had greater difficulty elaborating on their memories (as suggested by a greater number of interviewer prompts and a higher interviewer word count).

In regard to our second hypothesis, we found some modest evidence for a gradient effect of positive AM impairment. Namely, the magnitude of positive AM impairments increased with increased depression vulnerability across the groups of unaffected siblings, remitted probands, and currently depressed probands. On six positive AM characteristics, remitted probands showed greater impairment than unaffected siblings. With the exception of one positive AM characteristic, no other statistically significant

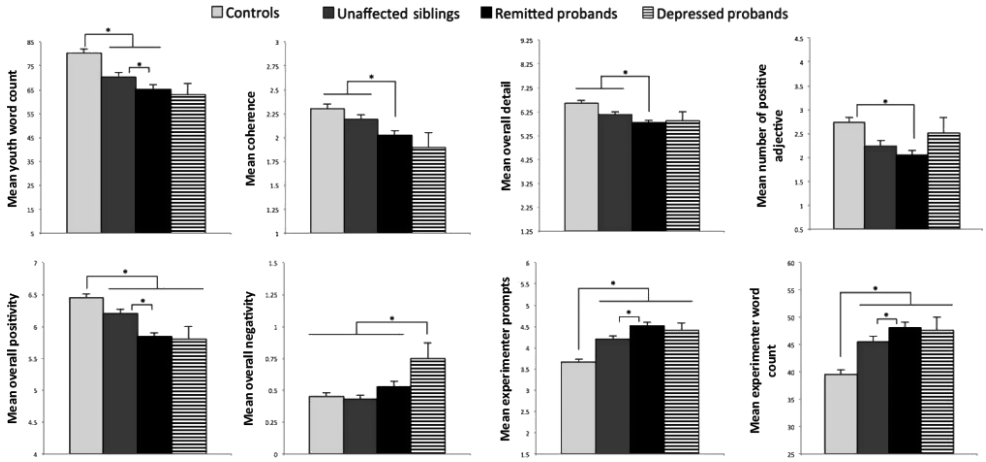

Figure 1. Mean group differences among eight significant positive autobiographical memory (AM) characteristics. Error bars represent one standard error. Asterisks denote statistically significant group differences.

differences emerged between siblings and currently depressed probands, or between the two probands groups. Finally, currently depressed probands produced positive AMs that were judged to be more negative relative not only to controls, but also to remitted probands and unaffected siblings. These findings, too, could be seen as consistent with the notion of a risk gradient.

Discussion

The aim of this study was to elucidate the nature and significance of positive AM deficits among youth vulnerable to depression. We found that adolescents with a history of depression had difficultly recalling rich positive AMs. A remarkably consistent pattern of positive AM deficits emerged among remitted probands, and to a lesser extent, among probands who were currently in episode. Overall, we found several strong results.

First, clear positive AM deficits were evident in probands and unaffected siblings. These findings suggest that positive AM disturbances not only precede the onset of depression in vulnerable youth, but also continue to persist in full remission of a depressive episode. Disrupted AM processes therefore appear to be fundamentally linked to depression. Previous studies have shown that AM deficits may be trait-like and serve as a risk marker for depression, primarily when negative AM cues were used (e.g., Champagne *et al.*, 2016; Kuyken & Dalgleish, 2011; Park *et al.*, 2002; Woody *et al.*, 2015). Our study extends this pattern to positive AMs, although it is important to note that participants were in a negative mood state prior to AM recall. Second, memory deficits were observed with a test procedure that was specifically designed to help youth recall rich positive AMs via self-generated meaningful memory cues, vigorous prompting, reduced time pressure, and an interpersonal context for memory recall. Third, our observed deficits cannot be attributed to differences in mood between clinical groups, as all groups reported similar levels of negative affect prior to the recall of positive AMs.

It is noteworthy that despite an absence of depression history, the siblings of probands also exhibited positive AM deficits. Thus, not only is disrupted positive AM a consequence

of experiencing depression, it may also constitute a component of future depression risk. The nature of the siblings' deficits (i.e., less positive memories, difficulty elaborating on positive memories) is in line with other findings reflecting low hedonic capacity in high-risk individuals (Dryman & Eaton, 1991; Gotlib *et al.*, 2010; Meehl, 1975; Olino *et al.*, 2011; Rawal, Collishaw, Thapar, & Rice, 2013).

Positive AM disturbances in proband youth and siblings may have implications for understanding the mood-regulatory functions of positive AM recall and its relation to the core features of depression. Positive AM recall is an adaptive mood repair strategy utilized by healthy persons (Josephson *et al.*, 1996; Kovacs, Rottenberg, & George, 2009). At the same time, there is evidence that this strategy may not have the intended mood enhancing effects among depression-vulnerable individuals (Joormann & Siemer, 2004; Joormann *et al.*, 2007; Kovacs *et al.*, 2015). These poor mood repair outcomes among depression-vulnerable individuals may partially stem from impaired memory characteristics. For example, our finding that probands and siblings exhibit difficulty elaborating on and conveying the positivity of their positive AMs suggests that depression-vulnerable individuals may struggle to mentally re-create a positive past event; consequently, their ability to fully re-experience the associated positive emotions is reduced. While the relationship between rich memory characteristics and affect has been previously noted (Dalgleish & Werner-Seidler, 2014; Holmes *et al.*, 2016; Joormann *et al.*, 2007; Werner-Seidler & Moulds, 2011, 2012), the direct impact of memory characteristics within the context of mood repair has yet to be empirically tested.

There are several possible causes or mechanisms that may explain why depressed and high-risk youth exhibit difficulties recalling rich positive AMs. One hypothesis is that positive AM deficits arise from impairments in one (or all) of the facets of hedonic capacity – anticipatory, consummatory, and remembered pleasure – which may more broadly represent a general impairment in the brain's reward structures (Dichter, 2010). A related hypothesis is that poor initial encoding of positive events may contribute to deficits in the recall of positive AMs. For example, depressed individuals are less likely to attend to and faster to disengage from positive stimuli compared to controls (Joormann & Gotlib, 2007; Levens & Gotlib, 2010). It is thus possible that when positive events do occur in the lives of depressed individuals, they do not focus on (and subsequently do not encode) the details of these events, which ultimately hinders later recall.

Similar to adults (Young *et al.*, 2012, 2013, 2014), the positive AM deficits observed in the depression-vulnerable youth in our study may be linked to abnormal neural correlates of AM recall. Impaired mental imagery may also contribute to abnormal activity in the brain regions that support memory recall. Young *et al.* (2012) speculated that the reduced activity depressed adults exhibit in key memory regions of brain (i.e., hippocampus and parahippocampal cortex) during AM recall may be due to impaired memory characteristics such as vividness, given that increased vividness is associated with increased activity in the hippocampus. Of course, we cannot assume that there will be identical brain–memory associations in youth populations. To the best of our knowledge, similar studies with depressed youth have yet to be conducted. As such, further investigation into the underpinnings of AM recall and memory characteristics in this population has the potential to provide important insights.

Environmental factors may also contribute to positive AM impairments. For example, research suggests that parents, particularly mothers, play an important role in fostering autobiographical remembering in infants and young children (Fivush, 2011; Pasupathi & McLean, 2010). In fact, mothers' reminiscing style (high-elaborative vs. low-elaborative) impacts AM recall skills of children, which carry into adolescence and adulthood (see

Fivush, 2011 for review). Mothers' influence in shaping their children's own AM recall style may also have important implications for mood regulation, given that elaborative recall of positive AMs may facilitate greater mood improvement in mood repair contexts (Dalgleish & Werner-Seidler, 2014; Holmes *et al.*, 2016; Joormann *et al.*, 2007; Werner-Seidler & Moulds, 2011, 2012).

Our findings need to be considered in the light of several limitations. First, the sample of currently depressed youth was small. This likely reduced power and may explain why fewer effects were observed in currently depressed youth. The lower degree of correspondence between currently depressed and remitted youth could also be attributed to low power. Similarities between currently depressed and remitted youth are often found in AM processes (e.g., Champagne *et al.*, 2016; Park *et al.*, 2002) among other psychological variables, which is consistent with a depression 'scar' hypothesis of the residual effects of early-onset depression (e.g., Rohde, Lewinsohn, & Seeley, 1994). Second, while we used a memory elicitation protocol that is less vulnerable to possible executive functioning impairments, we lacked a direct measure of executive functioning. Relatedly, our use of SES as a proxy for IQ – while it has ample precedent (e.g., Gale, O'Callaghan, Godfrey, Law, & Martyn, 2004; Lange, Froimowitz, Bigler, Lainhart, & Brain Development Cooperative Group, 2010; Shaw *et al.*, 2006) – is not ideal. Third, our study was focused on AM in the context of negative mood. Because we focused on positive AMs, we cannot assume these findings will generalize to negative memories. Similarly, future work could assess memory in a neutral mood to determine whether our results are specific to negative mood.

Our study also had several notable strengths, including large, well-diagnosed samples of youth, a family design, and the use of a carefully conceived memory elicitation procedure. Overall, our study extended previous findings by showing that positive AM deficits are a robust feature of depression history. Given the importance of positive AM processes and hedonic functioning in depression, further studies need to investigate the roots of these AM impairments and how they may be addressed via treatment and preventative strategies.

Acknowledgements

This research was supported by NIH Grants MH084938 and MH056193 and a grant from the Hungarian Scientific Research Fund (NN85285).

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Received 20 January 2017; revised version received 14 April 2017