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Improving outcome for mental disorders by enhancing memory for treatment

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ABSTRACT

Patients exhibit poor memory for treatment. A novel Memory Support Intervention, derived from basic science in cognitive psychology and education, is tested with the goal of improving patient memory for treatment and treatment outcome. Adults with major depressive disorder (MDD) were randomized to 14 sessions of cognitive therapy (CT)+Memory Support ($n = 25$) or CT-as-usual ($n = 23$). Outcomes were assessed at baseline, post-treatment and 6 months later. Memory support was greater in CT+Memory Support compared to the CT-as-usual. Compared to CT-as-usual, small to medium effect sizes were observed for recall of treatment points at post-treatment. There was no difference between the treatment arms on depression severity (primary outcome). However, the odds of meeting criteria for 'response' and 'remission' were higher in CT+Memory Support compared with CT-as-usual. CT+Memory Support also showed an advantage on functional impairment. While some decline was observed, the advantage of CT+Memory Support was evident through 6-month follow-up. Patients with less than 16 years of education experience greater benefits from memory support than those with 16 or more years of education.

Memory support can be manipulated, may improve patient memory for treatment and may be associated with an improved outcome.

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Patient memory for the contents of treatment is poor. Accurate recall for physician advice is approximately one third (Jansen et al., 2008). Following a cognitive behavior therapy (CBT) session (Lee & Harvey, 2015), patients successfully recalled only 19.6%–36.9% of the recommendations made. Recall is particularly poor for health behavior change advice (Flocke & Stange, 2004) and poor memory for treatment is associated with poorer adherence (Lee & Harvey, 2015).

These findings are perhaps not surprising. First, even when memory functioning is optimal, it is an imperfect system, with fallibility possible at encoding, storage or later recollection (Schacter, 2001). Second, a psychosocial treatment session is typically 50 min long, covers complex information, and can elicit negative emotion. Negative emotion is associated with attentional biasing and narrowing, which impacts encoding (Easterbrook, 1959). Third, even in the absence of memory deficits, the odds are stacked *against* people learning, generalizing and transferring knowledge to new situations; this is known as the transfer of learning problem (Barnett & Ceci, 2002; Thorndike, 1932). Fourth, memory deficits and biases are common across mental disorders (Airaksinen, Larsson, & Forsell, 2005; Behnken et al., 2010; Jelinek et al., 2006; Robinson et al., 2006; Varga, Magnusson, Flekkoy, David, & Opjordsmoen, 2007). Memory impairment is associated with worse outcome including poorer social functioning and increased risk of relapse (Bearden et al., 2006; Cohen, Forbes, Mann, & Blanchard, 2006; Majer et al., 2004; Martinez-Aran et al., 2004; Polak, Witteveen, Reitsma, & Olff, 2012). Additionally, memory impairment predicts worse outcome following cognitive behavior therapy (CBT) (Aharonovich, Nunes, & Hasin, 2003; Lee & Harvey, 2015; Wild & Gur, 2008). Perhaps poor memory for treatment may, at least in part, account for these findings.

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There is a literature documenting that the impact of memory impairment on memory encoding and retrieval can be minimized. Specifically, memory encoding and retention can be markedly improved via the application of memory support techniques among older adults (Bamidis et al., 2014) and even among those with memory impairments as severe as Alzheimer's disease, vascular dementia (Almkvist, Fratiglioni, Agüero-Torres, Viitanen, & Bäckman, 2010) and frontal lobe dysfunction (Bunce, 2003). Beneficial changes of memory support have also been observed at the structural and functional levels in the brain (Engvig et al., 2010; Kirchhoff, Anderson, Barch, & Jacoby, 2012).

This evidence raises the possibility that an adjunctive intervention that improves memory for treatment might also improve treatment outcome. Hence, a Memory Support Intervention was developed comprised of eight powerful memory promoting strategies that can be proactively, strategically and intensively integrated into treatment-as-usual to support patient encoding and retrieval of the contents of treatment. These strategies were distilled from the education and cognitive science literature and selected based on carefully honed criteria (Harvey et al., 2014). Examples are provided in Table 1. The memory support is delivered alongside each 'treatment point'. A treatment point is defined as a main idea, principle, or experience that the treatment provider wants the patient to remember or implement as part of the treatment (Lee & Harvey, 2015).

The Memory Support Intervention is designed to be applicable across disorders (transdiagnostic) and across treatments (transtreatment). However, as a platform for conducting a preliminary evaluation of the approach, we evaluated the Memory Support Intervention with patients who met diagnostic criteria for major depressive disorder (MDD) who were treated with one intervention—cognitive therapy (CT). MDD was selected as the focus because it is one of the most prevalent psychiatric disorders and a leading cause of disability worldwide (Mathers & Loncar, 2006). Hence, there is an urgent need for innovations focused on improving treatment for MDD. Also, there is evidence that MDD is characterized by memory impairment (Taconnat et al., 2010), memory impairment is associated with poorer outcome (Bearden et al., 2006) and memory impairment can be minimized in MDD (Taconnat et al., 2010). The rationale for focusing on CT for MDD is that it has been extensively studied. The encouraging pattern of results is clear and well replicated. There is evidence that CT for MDD can be as effective as antidepressant medication for the initial treatment of moderate to severe MDD (DeRubeis et al., 2005; Dimidjian et al., 2006). Moreover, following the withdrawal of treatment, patients treated with CT are significantly less likely to relapse relative to patients treated with antidepressant medication and no more likely to relapse than patients continued on medications (Dobson et al., 2008; Hollon et al., 2005). Recent meta-analyses confirm CT as an important and frontline treatment for

Table 1
The eight memory support strategies (Harvey et al., 2014).

Definition	Use in treatment
Attention recruitment	
Theories of memory include attention as a core process (Baddeley, 2012; Baddeley & Hitch, 1974). Experiments show that engaging attention improves memory (Gazzaley & Nobre, 2012; Harrison, Mullet, Whiffen, Ousterhout, & Einstein, 2014; Markant & Amso, 2014; Melara, Tong, & Rao, 2012).	The treatment provider uses expressive language that explicitly communicates to the patient that a treatment point is important to remember (e.g., "if there is one thing I would like you to remember in ten years time, it is this skill" or "this is a key point to remember"), or multimedia/diverse presentation modes (e.g., handouts, poems, songs, note taking, role-playing, imagery, using a white board) as a means to recruit the patient's attention.
Categorization	
There is ample empirical evidence that categorizing information improves recall (Hunt & McDaniel, 1993; Ley, Bradshaw, Eaves, & Walker, 1973). Given the limited capacity of the human information processing system, binding information into meaningful chunks increases memory capacity (Baddeley, 2012; Baddeley & Hitch, 1974).	Involves explicit effort by the treatment provider to work with the patient to group treatment points discussed into common themes/principles (e.g., "Let's create a list of ways we can work on waking up at the same time each morning.").
Evaluation	
It is clear that generating and evaluating explanations promotes learning across a wide variety of settings (Graesser, Langston, & Baggett, 1997; Lombrozo, 2006; Siegler, 2002), and is more effective than spending twice as much time studying (Chi, de Leeuw, Chiu, & LaVancher, 1994). Evaluation promotes deeper processing (Craik & Lockhart, 1972) as well as conceptual understanding (Murphy & Medin, 1985).	The treatment provider works with the patient to (a) discuss the pros/cons of a treatment point (e.g., "What would be some advantages/disadvantages of waking up at the same time each morning?"); or (b) use comparisons to compare a new treatment point to an existing or hypothetical alternative (e.g., "How would this new strategy of exercising more compare to lying in bed all day when you are feeling depressed?").
Application	
Empirical demonstrations show that people fail to apply learned material to a similar situation that only differs in surface features (Gick & Holyoak, 1983; Lockhart, Lamon, & Gick, 1988). Practicing the application of new knowledge in a variety of contexts assists transfer of learning (Hmelo-Silver, 2004).	The treatment provider works with the patient to apply a treatment point to past, present, or future (real or hypothesized) scenarios (e.g., "Can you think of an example in which you might try this new method of coping to deal with your stress at work?").
Repetition	
There is robust evidence that repetition automatizes new knowledge (Guttentag, 1984; Rohrer & Taylor, 2007).	The treatment provider restates, rephrases, or revisits information discussed in treatment (e.g., "in other words," "as we talked about earlier," or "in sum").
Practice remembering	
Theories and empirical studies highlight that facilitating regenerating, restating and/or rephrasing information improves learning (Ballard, 1913; Karpicke & Roediger, 2007). Each conscious retrieval allows for another chance to encode (Bjork, 1975).	The treatment provider facilitates the patient to regenerate, restate, rephrase, and/or revisit a treatment point (e.g., "Can you tell me what some of the main ideas you've taken away from today's session?).
Cue-based reminders	
Transfer of learning is reduced when the learning and transfer contexts differ. Establishing cues that provide reminders increase the potential for transfer of learning (Kolodner, 1997).	The treatment provider helps the patient develop new or existing cues (e.g., colored wrist bands, reminder text messages/phone calls/e-mails, smart phone apps, acronyms, rhymes, and other mnemonics) to facilitate memory for treatment points.
Praising recall	
Classic experiments demonstrate that positive consequences for a behavior increases the probability of that behavior (Pavlov, 1927; Skinner, 1938; Thorndike, 1927).	The treatment provider rewards the patient for successfully recalling a treatment point (e.g., "It's really great that you remembered that point!") or remembering to implement a desired treatment point (e.g., "I'm so glad you remembered to step back and look at the evidence.").

MDD (e.g., Cuijpers et al., 2013). Despite these impressive outcomes, there is room for improvement. DeRubeis et al. (2005) reported response rates of 58% and remission rates of 40% after 16 weeks of CT, meaning that 42% and 60% of MDD patients do not respond or remit, respectively. Also, CT may be less effective for more severe depression, relative to less severe depression (Dimidjian et al., 2006; Elkin et al., 1989, 1995).

In the present pilot study, adults who met diagnostic criteria for MDD, regardless of chronicity or recurrence, were randomly allocated to receive 14 sessions of CT plus the Memory Support Intervention (CT+Memory Support) or 14 sessions of CT-as-usual. In the tradition of pilot randomized controlled trials (RCT), this study was not powered to obtain significant effects (Lee, Whitehead, Jacques, & Julious, 2014). As such, our emphasis on reporting and interpreting these results is less on statistical significance and more on effect sizes (Cumming, 2012; Lee et al., 2014). The rationale is that pilot RCTs are 'more about learning than confirming' and are not formally powered (Lee et al., 2014). It is also important to note that we have used this pilot study to empirically derive the optimal dose of memory support. Hence, we anticipate that the results of future research in this domain will be stronger because the optimal dose will be delivered in every treatment session.

Our first aim was to establish if the Memory Support Intervention effectively manipulates memory support and patient recall. Total amount of memory support, the number of types of memory support and patient treatment recall were hypothesized to be greater in CT+Memory Support vs. CT-as-usual. The second aim was to determine if the Memory Support Intervention improves treatment outcome. We hypothesized that CT+Memory Support, relative to CT-as-usual, would be more efficacious for improving mood symptoms and functional impairment immediately post-treatment and at a six-month follow-up. The mood outcomes included change in the severity of depression symptoms, the odds of meeting criteria for American College of Neuropsychopharmacology (ACNP) criteria (Rush et al., 2006) defined 'response' and 'remission' and the proportion of participants who met diagnostic criteria for MDD. The third aim was to establish if treatment response is associated with patient treatment recall. Treatment responders were hypothesized to have better memory for treatment relative to treatment non-responders. The final aim was to determine if poor treatment response characteristics—older age, lower IQ, depression chronicity, less education and poor baseline declarative memory performance (Bremner, Vythilingam, Vermetten, Vaccarino, & Charney, 2004; Deuschle et al., 2004; Fournier et al., 2009; Persons, Burns, & Perloff, 1988)—moderate the effectiveness of the memory support intervention on outcome. Also, given that mood medication is a common and effective treatment for MDD (National Collaborating Centre for Mental Health, 2010) and that there are documented effects of mood medications on learning and memory (Andrews, Bharwani, Lee, Fox, & Thomson, 2015; Harmer, Goodwin, & Cowen, 2009; Vythilingam et al., 2004), we also tested medication use as a moderator.

1. Method

1.1. Design

The study was registered (NCT01790919). The design was a prospective two-arm, assessor blinded pilot RCT. Adults with MDD were randomly assigned, in a 1:1 parallel group design, to receive either CT+Memory Support or CT-as-usual. Randomization was stratified by age (<46, ≥46) and sex. The assessment team was blind to treatment allocation by using sequentially numbered, opaque, sealed envelopes—the sequence for which was generated via a web-based randomization system—opened by a project coordinator.

Both treatments were comprised of 14 weekly sessions that were approximately 50 min each. Assessments were conducted at baseline, end of treatment, and 6-month follow-up. The University of California, Berkeley, Committee for the Protection of Human Subjects (CPHS) approved the study. All participants provided written informed consent and were financially compensated for their time and expenses. A Data Safety and Monitoring Board (DSMB) reviewed the study every 6 months during the active treatment phase.

1.2. Participants

Participants included 48 adults who met diagnostic criteria for MDD, regardless of chronicity or recurrence, recruited between November, 2012 and March, 2014 through clinician referrals or advertisements. Individuals considered potentially eligible during a telephone screen were invited for an in-person diagnostic session.

Individuals were eligible if they met the following inclusion criteria: (a) diagnosis of MDD, regardless of chronicity or recurrence, according to DSM-IV-TR criteria (American Psychiatric Association, 1994); (b) minimum scores of 26 or above on the Inventory of Depressive Symptomatology, Self-Report (IDS-SR) (Rush, Gullion, Basco, Jarrett, & Trivedi, 1996), (c) minimum scores of 24 or above on the Inventory of Depressive Symptomatology, Clinician Report (IDS-C) (Rush et al., 1996), (d) 18 years of age or older; (e) if taking medications for mood, medications must have been stable for the past four weeks, and (f) able and willing to give informed consent.

People were excluded if they met any of the following criteria: (a) history of bipolar affective disorder; (b) history of psychosis or psychotic features; (c) current non-psychotic Axis I disorder that constitutes the principal diagnosis (defined below) that required treatment other than that offered within the study; (d) history of substance dependence in the past six months; (e) IQ below 80; (f) evidence of any medical disorder or condition that could cause depression, or preclude participation in CT or that is associated with memory problems; or (g) current suicide risk sufficient to preclude treatment on an outpatient basis. 'Principal' diagnosis was defined as the disorder currently most distressing and disabling, using a widely accepted severity rating scale capturing distress and interference (Di Nardo, Moras, Barlow, & Rapee, 1993).

1.3. Treatments

All treatments were administered by licensed therapists, or therapists working toward licensure. Weekly CT supervision was conducted by licensed clinical psychologists (SDH, AGH). Weekly memory support supervision was conducted by AGH.

CT-as-usual. CT was first described by Aaron T. Beck and colleagues (Beck, 1979). Based on cognitive theories of depression. Treatment maneuvers identify, reality test, and correct unhelpful beliefs and information processing and make use of the core CT skills of guided discovery, Socratic questioning and individualized experiments. CT was conducted according to the published manuals (e.g., Beck, 1979).

CT+Memory Support. The Memory Support Intervention was delivered alongside CT-as-usual. The Memory Support Intervention is comprised of eight memory promoting strategies (listed and defined in Table 1), distilled from the education and cognitive science literature based on carefully honed criteria (Harvey et al., 2014). These memory promoting strategies were designed to be proactively, strategically and intensively integrated into treatment-as-usual to support the encoding of the contents of treatment.

Memory support is delivered alongside each 'treatment point'. A treatment point is defined as a main idea, principle, or experience that the treatment provider wants the patient to remember or implement as part of the treatment (Lee & Harvey, 2015). This intervention does not lengthen session time or the number of sessions. See Supplementary Material for a transcript of a therapist-patient conversation, with and without memory support.

1.4. Measures

Blind assessors were graduate students in clinical psychology and research assistants, independent of the therapy team and blind to treatment condition. All assessment sessions were tape recorded and a random subset (20%) were selected for close scrutiny by raters blind to treatment condition and diagnoses. Interrater reliabilities for the diagnostic measures were very good [MDD diagnosis $\kappa = 0.634$; non-MDD diagnoses (81.38% agreement)]. Except where specified, all measures were delivered at baseline, at the end of treatment, and at 6-month follow-up.

Memory Support Rating Scale (MSRS) is a reliable and valid measure of the use of memory support by treatment providers (Lee et al., in press). MSRS coders were independent of the therapist and assessment teams. Each member needed to individually establish 80% or higher inter-coder agreement with the expert coder (JL) across five consecutive 30-min segments of treatment recordings.

Patient Recall Task (Lee & Harvey, 2015). In this free recall task, completed at the end of Sessions 7 and 14 and at the 6-month follow-up, patients are handed a sheet of paper and asked to take 10 min to recall session content for all of the sessions they have had so far as well as their most recent session. The instructions were: *'list as many distinct treatment points as you can recall since the start of your treatment'* (referred to as 'Cumulative Points Recalled) and *'list as many distinct treatment points as you can recall that were discussed in your MOST RECENT session'* (referred to as 'Past Session Recall'). The 'expert coder' (JL) evaluated the written responses each patient made on the free recall task in terms of the scoring rubric used in a previous study (Lee & Harvey, 2015). The rubric states that for each CT treatment point (e.g., "thoughts contribute to feelings") 1 point is awarded and that if a patient makes the same point more than once, 1 point is awarded to the group of repeated responses. The raw number of treatment points accurately recalled by the patient is then summed. The 'expert coder' has established excellent inter-rater reliability between two independent coders ($n = 32$, $r = 0.92$, $p < 0.001$) and excellent predictive validity of clinical outcome ($n = 30$, $r's = 0.34–0.69$, $p's < 0.001–0.154$) in a previous study (Lee & Harvey, 2015). In the present sample, the scores demonstrated adequate predictive validity with levels of memory support received ($r's = 0.29–0.36$, $p = 0.022–0.073$).

Mood Outcomes. The primary mood outcome was depression severity as indexed by the IDS-SR. There were several additional mood outcomes. Based on American College of Neuropsychopharmacology (ACNP) criteria (Rush et al., 2006), *'Response'* was defined as 50% reduction in IDS-SR from baseline to post-treatment,*'Remission'* was defined as less than or equal to 14 on the IDS-SR at posttreatment, *'Relapse'* was defined as greater than or equal to 26 on the IDS-SR at 6-month follow-up for participants who had remitted and *'Recurrence'* was defined as a return to moderate or severe depression following recovery which was defined as remission that has been sustained for $\geq$ 4 months. Recovery and recurrence were established with the SCID and the Longitudinal Interval Follow-up Evaluation (LIFE) (Keller et al., 1987).

The SCID was administered to assess for DSM-IV-TR Axis I disorders and to determine the presence or absence of current DSM-IV-TR defined episodes of depression. We also administered the LIFE as another means of ascertaining number of mood episodes and time to relapse and recurrence. Given the small sample size for these two variables, we calculated 'time to first relapse or recurrence' as the shorter of either time to relapse or time to recurrence.

Functional Impairment Outcomes. The Global Assessment of Functioning (GAF) is an assessor rating from 1 to 100, with lower scores indicating more severe impairment (American Psychiatric Association, 1994).

Poor Response Subgroups. Given that poorer treatment response has been associated with older age, lower IQ, depression chronicity, less education and poor baseline declarative memory performance, these were tested as moderators. Age and years of education were ascertained via a demographics form. For education, we compared college education or higher (16 years or more) with those who had less than college education. The National Adult Reading Test (NART) (Nelson & Willison, 1991) was the measure of premorbid intelligence. Chronicity of depression was defined as current episode greater than or equal to 2-years (Fournier et al., 2009). Declarative memory was quantified with the Episodic Face-Name Learning Task and as the proportion of correctly recalled face-name pairs on the cued recall test (Mander, Santhanam, Saletin, & Walker, 2011; Miller et al., 2008; Sperling et al., 2003).

Cognitive Therapy Rating Scale (CTRS) (Young & Beck, 1980) measures therapist competence and was conducted by one of three expert coders (SDH, KHa, AGH). The inter-rater reliability among random pairs of coders on 18.67% of the coded sessions was ICC (1,1) = 0.77.

Credibility/Expectancy Questionnaire (CEQ) (Devilly & Borkovec, 2000) administered at the end of the first therapy session, is a measure of treatment expectancies for success.

Medications. A medication tracking log was completed at the beginning of every visit.

1.5. Trial registration

We believe it is important to draw attention to, and provide the rationale for, the update to the ClinicalTrials.gov protocol in September 2015 (NCT01790919). It is important to emphasize that the pilot study reported here was funded by a treatment development grant (NIMH R34MH094535). As such, substantial development of the new treatment and the development and selection of appropriate measures unfolds over the course of the pilot study. The goal is to prepare for a fully powered study, if the results are encouraging.

The updates to ClinicalTrials.gov can be summarized as follows. First, we added clarifications, such as the specific version of the IDS used. Second, we honed our knowledge and understanding of this line of research over the unfolding of this multi-year study. Specifically, we learned that the ACNP criteria were the appropriate criteria to use for the depression outcomes and that they require the use of the IDS, SCID and LIFE. Also, we realized that our administration of the SCID included the GAF so we added it as an index of impairment. Also, with the recommendations favoring HLM approaches (Raudenbush & Bryk, 2002) the 6-month follow-up could be included in the primary analyses. Third, the MSRS was developed over the course of the study and the other 'process measures' (measure of patient memory for treatment and baseline memory) were initially difficult to enter on clinicaltrials.gov as the time points for the measurement are not the standard pre, post and follow-up. During the most recent update we managed to include these. Finally, one error was corrected. Specifically, the first submission of the grant application included a 3rd arm (improving sleep). This arm was removed for the second grant submission and was never a part of the funded and implemented study.

1.6. Data analysis

Baseline differences between groups in demographic and clinical characteristics were assessed. An intent-to-treat approach was employed. Continuous outcomes evaluated at baseline, posttreatment and 6-month follow-up were analyzed using hierarchical linear models with restricted maximum likelihood estimation. The fixed part of the model included an indicator variable for treatment condition (CT+Memory Support vs. CT-as-usual), two indicators for time periods (posttreatment and 6-month follow-up, with baseline as the reference), and two treatment-by-period interaction terms. The random part included a random intercept and slope of time (in days) since entry into the study, assumed to have a bivariate normal distribution with zero means and unstructured covariance matrix. The treatment effect of interest was the difference in mean change during the treatment phase (from pre to post) between CT+Memory Support versus CT-as-usual. To investigate whether treatment gains were maintained through follow-up, a contrast was used to estimate the change in the treatment-group difference from posttreatment to follow-up. The treatment effect on the change during the treatment phase and on the change from baseline through follow-up were also expressed as Cohen's *d*, obtained by dividing the estimated difference in mean change by the model-implied within-group standard deviation of the changes (for the latter, time was evaluated at the mean for the posttreatment assessment). Cohen's *d* will be interpreted as 0.20 = small effect size, 0.50 = medium effect size, and 0.80 = large effect size (Cohen, 1988). Following recent recommendations for pilot studies, we will not only interpret results that are significant at the 0.05 level, but also those that achieve a medium or greater effect size without corresponding statistical significance (Cumming, 2012; Lee et al., 2014).

Categorical outcomes included mood variables (e.g., response, remission). Chi-square tests were used to test differences between CT+Memory Support and CT-as-usual for categorical outcomes at posttreatment and 6-month follow-up. The phi coefficient (Φ) was used to express the difference between two dichotomous variables. The Φ coefficient interpretation is 0.10 = small effect size, 0.30 = medium effect size, and 0.50 = large effect size (Cohen, 1988). A significance level of 0.05 was used throughout.

2. Results

The groups were similar in their baseline demographics and clinical characteristics (Table 2). Fig. 1 illustrates participant flow. Among the randomized participants, there was an overall dropout rate of 16.70%, a rate that is consistent with prior recent studies of CT for MDD (e.g., DeRubeis et al., 2005; Dimidjian et al., 2006). Attrition was not significantly different between treatment groups, $\chi^2(1, N = 41) = 0.21$, $p = 0.65$. Relative to completers, participants who did not begin treatment or dropped out were more likely to be female, $\chi^2(1, N = 41) = 7.74$, $p = 0.01$. The mean ± SD number of therapy sessions attended by participants who initiated treatment was similar for the CT+Memory Support (13.13 ± 3.33) and CT-as-usual (14.14 ± 0.36) groups, $t(43) = -1.39$, $p = 0.17$.

MSRS. The total amount of memory support used and number of types of memory support, as measured by the MSRS, were significantly higher in the CT+Memory Support group compared to the CT-as-usual group and the effect sizes were large (see Table 3).

Patient Recall Task. There were no significant differences between CT+Memory Support and CT-as-usual. However, at posttreatment Cohen's *d* effect sizes were in the small to medium range (0.38 and 0.38) for both 'Cumulative Recall' and 'Past Session Recall' in the direction of the CT+Memory Support group recalling more treatment points compared to the CT-as-usual group (see Table 3).

Mood Outcomes. The mean values for the IDS-SR are presented in Table 3. The coefficient estimates from HLMs are presented as Table 1 in the Supplementary Materials. Both groups experienced an improvement in IDS-SR scores during the acute treatment phase (change from pre to post in CT-as-usual, $B = -17.68$, $SE = 2.68$, $z = -6.59$, $p < 0.01$, and CT+Memory Support, $B = -20.05$, $SE = 2.68$, $z = -7.47$, $p < 0.01$) and these gains were sustained through 6-month follow-up (change from post to 6-month follow-up in CT-as-usual, $B = -1.11$, $SE = 2.68$, $z = -0.41$, $p = 0.68$, and CT+Memory Support, $B = 1.42$, $SE = 2.68$, $z = 0.53$, $p = 0.60$). No significant Treatment Condition × Period interactions were observed, indicating no between-groups differences in change from pretreatment to posttreatment or 6-month follow-up. However, as evident in Table 3, at posttreatment the between group Cohen's *d* effect size was in the medium range (0.50) in the direction of the CT+Memory Support group scoring lower relative to the CT-as-usual group, although a small to medium effect size difference was observed on this measure at baseline and 6-month follow-up.

As evident in Table 3, 54.55% of the participants in the CT+Memory Support group, compared to 30.00% of the CT-as-usual group, met ACNP criteria for 'response'. This translates into an odds ratio of 2.80 (95% CI [0.78–9.99]). In other words, the odds of meeting criteria for 'response' were 2.80 times as high for participants in CT+Memory Support as for participants in CT-as-usual. 36.36% of participants in the CT+Memory Support group, compared to 15.00% of the CT-as-usual group, met ACNP criteria for 'remission.' This translates into an odds ratio of 3.24 (95% CI [0.72–14.57]). In other words, the odds of meeting criteria for 'remission' were 3.24 times as high for participants in CT+Memory Support as for participants in CT-as-usual. These differences were not statistically significant. The phi coefficients (Φ) were in the small to medium effect size range.

As evident in Table 3, across both treatment arms, the number of patients who experienced an ACNP defined *'Relapse'* (CT+Memory Support = 2/7; CT-as-usual = 0/3) across the 6-month follow-up was small. This pattern is not surprising given the small sample size and because CT is an efficacious treatment. There was no significant difference in the number of patients who experienced an ACNP defined *'Recurrence'* (CT+Memory Support = 5/14; CT-as-usual = 7/15). There was not a statistically significant difference between the two groups for 'Time to relapse or recurrence'.

There was no statistically significant difference between the two groups in the proportion of people who did not meet criteria for MDD via the SCID and the LIFE at posttreatment and 6-month follow-up (see Table 3). However, the direction of the mean values favored the CT+Memory Support group with a phi coefficient (Φ) falling into the small effect size range.

Functional Impairment Outcomes. The mean values for the GAF are presented in Table 3. The coefficient estimates from HLMs are presented in Table 1 of the Supplementary Materials. Compared to CT-as-usual, the CT+Memory Support condition was associated with a greater improvement in GAF scores from pretreatment to posttreatment, but not from pre to 6-month follow-up. The improvement in GAF scores from pretreatment to posttreatment for CT+Memory Support than for CT-as-usual was sustained from post to 6-month follow-up, $B = -2.38$, $SE = 3.00$, $z = -0.80$, $p = 0.43$. Furthermore, participants in both treatment arms benefited from the interventions (change from pre to post in CT-as-usual, $B = 6.40$, $SE = 2.18$, $z = 2.94$, $p < 0.01$, and CT+Memory Support, $B = 13.47$, $SE = 2.10$, $z = 6.42$, $p < 0.01$) and these gains were sustained through follow-up (change from post to 6-month follow-up in CT-as-usual, $B = 2.59$, $SE = 2.14$, $z = 1.21$, $p = 0.23$, and CT+Memory Support, $B = 0.21$, $SE = 2.10$, $z = 0.10$, $p = 0.92$).

Treatment Responders and Remitters and Patient Treatment Recall Task. There were no significant differences for Cumulative

Table 2
Baseline demographic and clinical characteristics.

Characteristic	CT-as-usual ($n = 23$)		CT+memory support ($n = 25$)		t or χ^2	p
	M or N	% or SD	M or N	% or SD		
Female	17	73.90	12	48.00	3.42	0.06
Ethnicity (3 declined to answer)					4.82	0.09
Hispanic or Latino	3	13.00	5	20.00		
Not Hispanic or Latino	17	73.90	20	80.00		
Race					4.18	0.52
American Indian/Alaska Native	0	0.00	1	4.00		
Asian	3	13.00	1	4.00		
African American	1	4.30	1	4.00		
Caucasian	16	69.60	20	80.00		
Bi-racial/multi-racial	1	4.30	0	0.00		
Decline to answer/other	2	8.70	2	8.00		
Marital status (1 declined to answer)					3.55	0.62
Single	11	47.80	12	48.00		
Married/partnered	8	34.80	10	40.00		
Divorced/separated/widow	3	13.0	3	12.00		
Employed					3.42	0.49
Full-time	6	26.09	7	28.00		
Part-time	4	17.39	9	36.00		
Unemployed	8	34.78	7	28.00		
Retired	2	8.70	1	4.00		
Declined to state	3	13.04	1	4.00		
Income					7.86	0.16
<$20,000	7	30.40	10	40.00		
$20,000–$35,000	2	8.70	4	16.00		
$35,000–$50,000	7	30.40	4	16.00		
$50,000–$60,000	1	4.30	5	20.00		
>$60,000	2	8.70	1	4.00		
Refused/did not know	4	16.70	1	4.00		
Comorbidity, medical	11	45.80	12	50.00	0.05	0.82
Comorbidity, psychiatric	10	43.50	16	64.00	0.66	0.51
Mood medication	8	32.00	8	34.78	0.00	1.00
Age (years)	44.65	12.17	43.92	9.98	0.23	0.82
Education (years)	16.26	2.03	15.40	1.68	1.61	0.12
Education (<16 years/16 years+)	14/8	–	14/9	–	0.04	0.85
Current depressive episode (≥2years/<2years)	3/17	–	4/20	–	0.02	0.88
Full scale IQ (NART)	120.68	5.62	119.78	6.33	0.53	0.60
Correctly recalled face-name pairs	0.67	0.17	0.68	0.17	−0.34	0.74

Note. SD = Standard Deviation; NART = National Adult Reading Test.

Points Recalled. For Past Session Recall, t-tests of group differences indicate that patients who were classified as 'responders' recalled more points from the prior session compared to 'non-responders' at posttreatment, $t(38) = 2.43$, $p = 0.02$, and 6-month follow-up, $t(38) = 2.11$, $p = 0.04$. This pattern of findings also held for 're-mitters' and 'non-remitters' at 6-month follow-up, $t(38) = 2.03$, $p = 0.05$, and for those who did not experience a recurrence compared to those who did experience a recurrence at posttreatment at the trend level at 6-month follow-up, $t(26) = 1.93$, $p = 0.06$. The opposite finding was observed for past session recall at Session 7 in that participants who experienced a recurrence recalled more treatment points relative to those who did not experience a recurrence, $t(26) = -2.64$, $p = 0.01$. The mean values and t-test results are presented in Table 2 of the Supplementary Materials.

To further define the relationship between treatment response and recall, HLM models were applied. The coefficient estimates from HLMs are presented in Table 3 of the Supplementary Materials. The reference for comparison was session 7 instead of pretreatment. For points recalled from last session, 'responders' recalled more treatment points from the last session than 'non-responders' from Session 7 through posttreatment, $B = 2.55$, $SE = 1.22$, $z = 2.08$, $p = 0.04$, and from Session 7 through 6-month follow-up at the trend level, $B = 2.33$, $SE = 1.21$, $z = 1.93$, $p = 0.06$. Also, 'remitters' recalled more treatment points at the last session than 'non-remitters' from Session 7 through 6-month follow-up, $B = 3.30$, $SE = 1.33$, $z = 2.48$, $p = 0.02$. Those who did not experience recurrence recalled more treatment points in the past session than those who did experience recurrence from Session 7 through posttreatment, $B = 4.95$, $SE = 1.53$, $z = 3.23$, $p < 0.01$. The mean values and t-test results are presented in Table 2 of the Supplementary Materials.

Poor Treatment Response Subgroups. Older age, lower IQ, more chronic depression, less education and poorer baseline declarative memory performance were tested as moderators of the effectiveness of the memory support intervention on IDS-SR scores (see Table 2 for mean values). Of the moderators tested, only education was associated with treatment group differences in change in depression severity and overall functioning from baseline through 6-month follow-up. There was a significant three-way interaction between education, group, and the 6-month follow-up indicator for IDS-SR, $B = 27.43$, $SE = 9.01$, $z = 3.04$ $p < 0.01$, and for GAF, $B = -17.33$, $SE = 7.15$, $z = -2.42$, $p = 0.02$. See Fig. 2 for a graphical representation of the effect. In the section that follows we describe follow-up analyses to explain these significant interactions.

Among participants with less than 16 years of education, there was no significant treatment group difference in IDS-SR at baseline ($p = 0.55$). However, there was a significant treatment group difference in IDS-SR at 6-month follow up in favor of CT+Memory Support ($p = 0.05$). The slope of IDS-SR score change from baseline to 6-month follow-up was significant for both groups ($p < 0.01$), and there was a significant difference in the slope of IDS-SR score

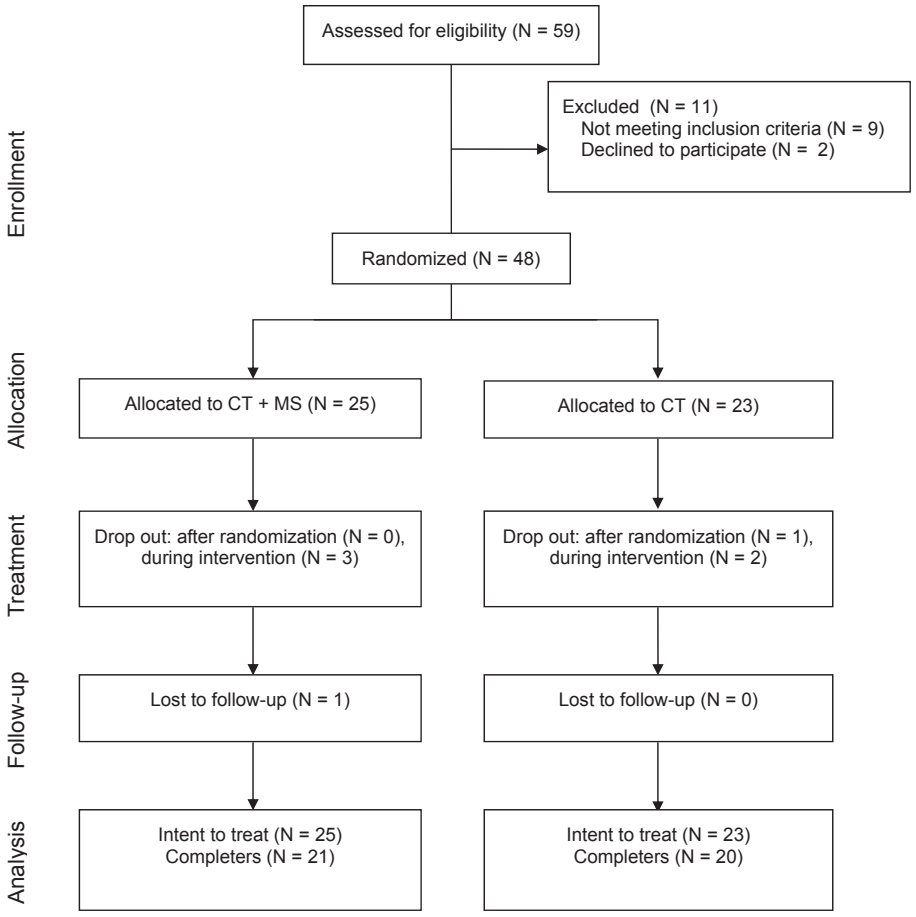


Fig. 1. CONSORT diagram illustrating the flow of participants with major depressive disorder throughout the study.

change from baseline to 6-month follow-up for participants in the CT+Memory Support condition compared to CT-as-usual participants ($z = -3.66$, $p < 0.01$), such that the slope for CT+Memory Support was steeper compared to CT-as-usual.

Among participants with 16 or more years of education, there was no significant treatment group difference in IDS-SR at baseline ($p = 0.56$). However, there was a significant treatment group difference in IDS-SR at 6-month follow up in favor of CT-as-usual ($p = 0.04$). The slope of IDS-SR score change from baseline to 6-month follow-up was significant for CT-as-usual ($p < 0.01$), but not for CT+Memory Support ($p = 0.80$). There was a significant difference in the slope of IDS-SR score change from baseline to 6-month follow-up for participants in the CT-as-usual condition compared to CT+Memory Support participants ($z = -5.91$, $p < 0.01$), such that the slope for CT-as-usual was steeper compared to CT+Memory Support.

Among participants with less than 16 years of education, there was no significant treatment group difference in GAF at baseline ($p = 0.58$). However, there was a significant treatment group difference in GAF at 6-month follow up in favor of CT+Memory Support ($p < 0.01$). The slope of GAF score change from baseline to 6-month follow-up was significant for both groups (p's < 0.05), and there was a significant difference in the slope of GAF score change from baseline to 6-month follow-up for participants in the CT+Memory Support condition compared to CT-as-usual participants ($z = 4.38$, $p < 0.01$), such that the slope for CT+Memory Support was steeper compared to CT-as-usual.

Among participants with 16 or more years of education, there was no significant treatment group difference in GAF at baseline ($p = 0.30$). However, there was a significant treatment group difference in GAF at 6-month follow up in favor of CT-as-usual ($p < 0.01$). The slope of GAF score change from baseline to 6-month follow-up was significant for CT-as-usual ($p < 0.01$), but not for CT+Memory Support ($p = 0.85$). There was a significant difference in the slope of GAF score change from baseline to 6-month follow-up for participants in the CT-as-usual condition compared to CT+Memory Support participants ($z = 3.51$, $p < 0.01$), such that the slope for CT-as-usual was steeper compared to CT+Memory Support.

CTRS and CEQ. There was no difference in CTRS scores between the CT+Memory Support group ($n = 30$, $M = 46.67$, $SD = 5.09$) and the CT-as-usual group ($n = 45$, $M = 46.88$, $SD = 4.59$), $t(73) = 0.19$, ($p = 0.85$, $d = 0.04$). Also, there were no significant group differences on the CEQ (all $p > 0.05$).

Medications. Sixteen of the 48 participants (33.33%) were taking prescription medications to stabilize mood at study entry. When considering each medication for each participant separately, the doses of 75% of mood medications remained stable across the treatment phase. The percentage of CT+Memory Support compared to CT-as-usual participants taking mood medications was statistically similar at baseline (32.00% vs. 34.78%, $\chi^2(1, N = 44) = 0.00$, $p = 1.00$), posttreatment (24.00% vs. 26.08%; $\chi^2(1, N = 42) = 0.04$, $p = 0.85$), and at the end of the follow-up phase (20.00% vs. 17.39%; $\chi^2(1, N = 42) = 0.29$, $p = 0.59$). There was no significant difference in the percentage of participants discontinuing at least one mood medication at some point during the

Table 3
Outcomes for patients treated with CT+Memory support and CT-as-usual.

Characteristic	CT+memory support ($n = 25$)			CT-as-usual ($n = 23$)			t or χ^2	p	Effect size[c]
	# Obs.	M or N	% or SD	# Obs.	M or N	% or SD			
Memory support rating scale									
MSRS amount	23	18.32	8.83	21	8.23	3.87	4.83	<0.01	1.46
MSRS no. of types	23	4.85	1.16	21	3.34	0.74	5.08	<0.01	1.53
Patient recall task: cumulative recall									
# Points recalled session 7	21	8.52	4.87	19	7.84	2.52	0.55	0.59	0.17
# Points recalled post	22	9.86	6.13	18	7.94	3.37	1.19	0.24	0.38
# Points recalled 6 FU	21	8.62	5.11	19	7.58	4.59	0.67	0.50	0.21
Patient recall task: past session recall									
# Points recalled session 7	21	4.38	2.58	19	4.95	3.01	−0.64	0.53	−0.20
# Points recalled post	22	5.09	4.21	18	3.61	3.53	1.19	0.24	0.38
# Points recalled 6 FU	21	3.43	3.20	19	3.11	3.31	0.31	0.76	0.10
Mood outcomes									
IDS-SR pre	25	39.52	8.55	23	43.00	9.77	−1.32	0.19	−0.38
IDS-SR post	22	19.41	11.69	20	25.45	10.83	−1.73	0.09	−0.54
IDS-SR 6 FU	21	21.71	13.07	20	24.60	13.70	−0.69	0.49	−0.22
Response[a]	22	12	54.55%	20	6	30.00%	2.61	0.11	0.25
Remission[a]	22	8	36.36%	20	3	15.00%	2.55	0.11	0.24
Relapse[b]	7	2	28.57%	3	0	0.00%	1.63	0.20	0.33
Recurrence[b]	14	5	35.71%	15	7	46.67%	−0.36	0.55	−0.11
Time to relapse or recurrence (months)	5	5.20	3.19	7	4.71	1.11	0.38	0.71	0.22
No MDD SCID/LIFE post	22	5	22.73%	19	3	15.79%	0.84	0.36	0.20
No MDD SCID/LIFE 6 FU	20	14	70.00%	16	11	68.75%	0.01	0.94	0.01
Impairment outcomes									
GAF pre	25	59.56	3.75	22	59.45	5.47	0.08	0.94	0.02
GAF post	22	71.50	8.55	19	66.63	8.39	1.83	0.07	0.57
GAF 6 FU	21	72.00	11.17	20	68.80	11.98	0.89	0.38	0.28

Note. For [a] [b] the denominator to calculate percentages does not reflect the full sample because [a] 3 CT+Memory Support and 3 CT-as-usual participants dropped out during treatment and [b] not all participants met criteria for relapse or recurrence. [c] Cohen's *d* and the phi coefficient were used for effect size estimates of continuous and categorical variables, respectively. # Obs. = Number of observations (variability is due to drop outs or missing data or the random tape selection protocol).

treatment phase (12.50% vs. 37.50%; $\chi^2(1, N = 16) = 1.38$, $p = 0.24$) or during the follow-up phase (12.50% vs. 16.67%; $\chi^2(1, N = 14) = 0.05$, $p = 0.83$).

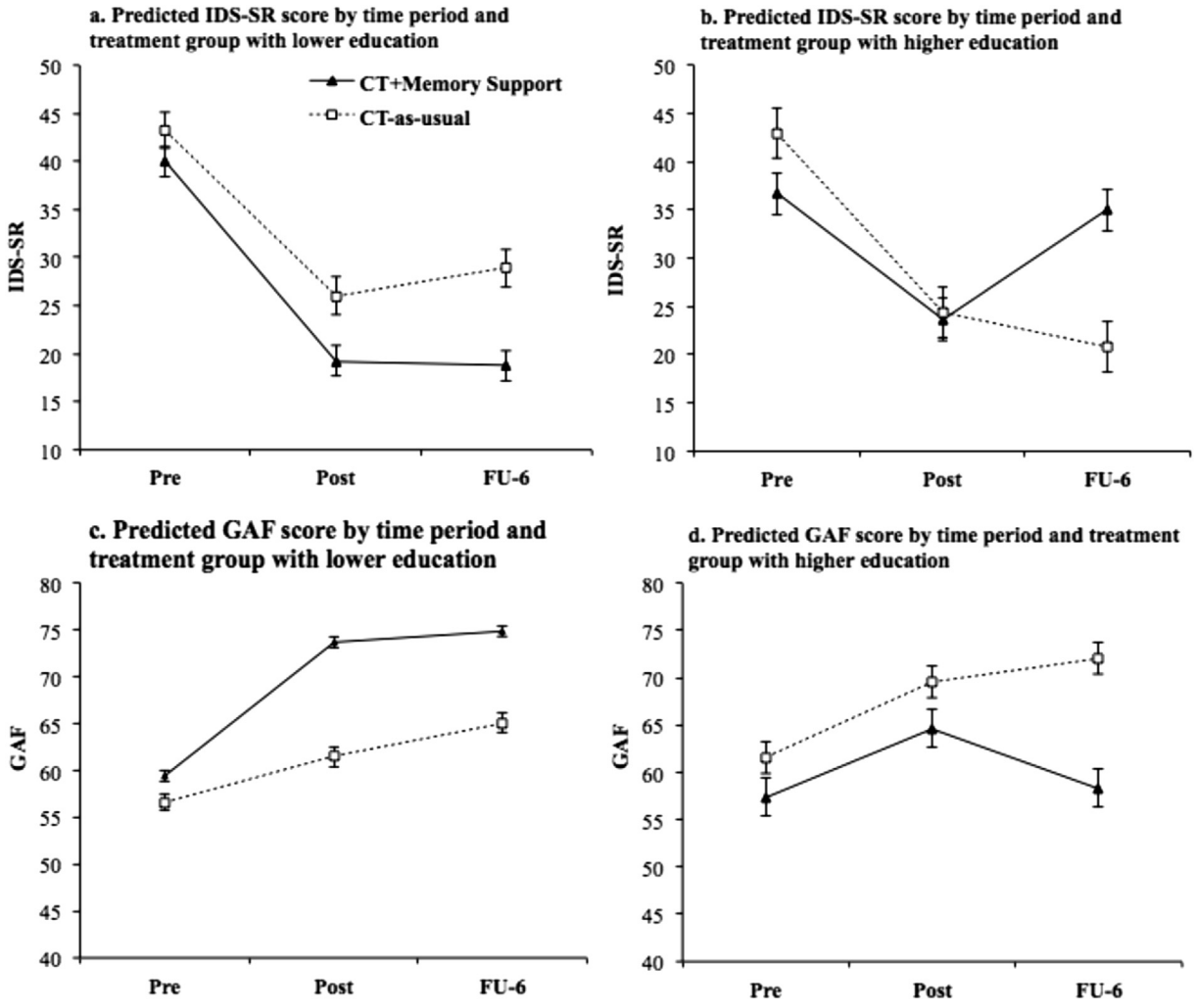
Given the effectiveness of mood medication treatment, medication use was tested as a moderator of the effectiveness of the memory support intervention on IDS-SR and GAF scores. The presence of mood medication was associated with group differences in IDS-SR from baseline to post-treatment but not 6-month follow-up (See Fig. 3). No effect was observed for GAF. For IDS-SR, there was a significant three-way interaction between mood medication, group, and the post-treatment indicator, $B = 18.43$, $SE = 8.44$, $z = 2.18$, $p = 0.03$. This interaction suggests that among participants taking mood medications, there was no significant group difference in IDS-SR at baseline ($p = 0.20$) or at post-treatment ($p = 0.85$). While the slope of IDS-SR score change from baseline to post-treatment was significant for both groups ($p = 0.01$), there was no difference in the slope of IDS-SR score change from baseline to post-treatment for participants in the CT+Memory Support condition compared to CT-as-usual participants, $z = 1.83$, $p = 0.07$ (see Fig. 3). Among participants taking no medications, while there was no significant group difference in IDS-SR at baseline, this difference was significant at post-treatment ($p = 0.04$). The slope of IDS-SR score change from baseline to post-treatment was significant for both groups ($p \leq 0.01$) and there was a significant difference in the slope of IDS-SR score change from baseline to post-treatment for participants in the CT+Memory Support condition compared to CT-as-usual participants, such that the slope for CT+Memory Support was steeper compared to CT-as-usual, $z = -2.36$, $p = 0.02$ (see Fig. 3).

3. Discussion

Before highlighting the main results, it might be helpful to reemphasize that following the tradition of pilot RCTs this study was not powered to obtain significant effects (Lee et al., 2014). The findings confirm that the Memory Support Intervention can reliably manipulate memory support. Indeed, the total amount of memory support used and number of types of memory support were significantly higher in the CT+Memory Support group compared to the CT-as-usual group and the effect sizes were large. The average dose of memory support in a trial-quality standard 50-min CT session was 8–9 units, relative to an average dose of 18–19 units when the Memory Support Intervention is added.

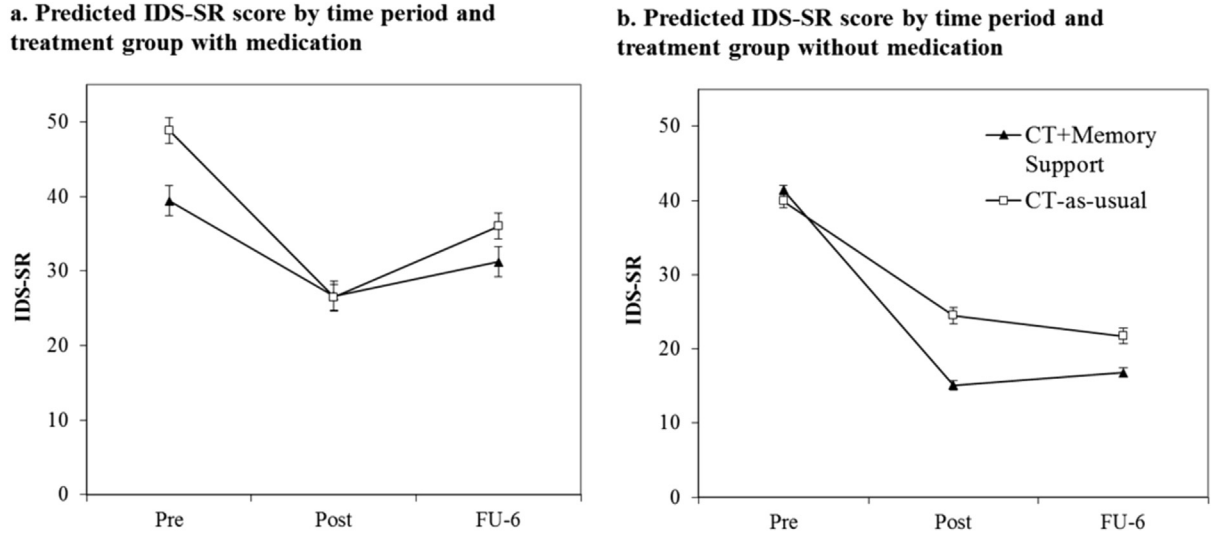
An inspection of the mean values provides some encouragement that patients who receive memory support recall more treatment points at posttreatment compared with those who do not receive memory support. The Cohen's *d* effect size group difference was in the small to medium range, although the difference did not reach statistical significance. Taken together, these findings are consistent with prior demonstrations that memory support can improve recall (Almkvist et al., 2010; Bamidis et al., 2014; Bunce, 2003). At 6-month follow-up, although the mean values are in the predicted direction, there was a notable drop-off in patient memory for treatment compared with the posttreatment assessment. Perhaps booster memory support is needed to ensure that gains are maintained.

Several findings suggest that CT+Memory Support was associated with a better depression outcome relative to CT-as-usual. First, a medium effect size in IDS-SR at posttreatment was observed comparing CT+Memory Support ($M = 19.41$; $SD = 11.69$) to CT-as-usual ($M = 25.45$; $SD = 10.83$), although this difference was not significant and the finding must be considered in the context of the non-significant small effect size in the group difference at baseline such that the CT-as-usual group scored higher ($M = 43.00$; $SD = 9.77$) than CT+Memory Support ($M = 39.52$; $SD = 8.55$). Second, the odds of meeting criteria for 'response' and 'remission' were 2.80 and 3.24 times as high, respectively, for CT+Memory Support as for CT-as-usual. In terms of functional impairment, the



Note. IDS-SR = Inventory of Depressive Symptomatology, Self Report; GAF = Global Assessment of Functioning.

Fig. 2. Graph of fitted values derived from three-way interaction (treatment condition × education × time period) HLM.



Note. IDS-SR = Inventory of Depressive Symptomatology, Self Report

Fig. 3. Graph of fitted values derived from three-way interaction (treatment condition × medication × time period) HLM.

CT+Memory Support group experienced a statistically significant greater reduction in impairment than the CT-as-usual group at posttreatment. At 6-month follow-up, the pattern of findings was in the same direction, indicating an advantage to CT+Memory Support, but was not significant, with a medium effect size. Third, in terms of IDS-SR cut-offs for severity (Rush et al., 2003; Trivedi et al., 2004), the CT+Memory Support group started out in the "Severe" range and ended up firmly within the "Mild" range at the post-treatment assessment, whereas the CT-as-usual group also started out in the "Severe" range but ended up at the border between the "Moderate" and "Mild" range at the post-treatment assessment. In other words, only those receiving CT+Memory Support fell well within the threshold for MDD (i.e., "Mild" or below) by the end of treatment. Although awaiting replication with a larger fully powered study and given that CT-as-usual is an already efficacious treatment (DeRubeis et al., 2005), these results suggest that further testing of memory support as an adjunctive treatment will be advantageous in terms of symptom relief and functioning.

Between groups comparison showed that patients who met ACNP criteria as 'responders' recalled significantly more points from the prior session compared to 'non-responders' at posttreatment and 6-month follow-up. This pattern of findings also held for 'remitters' and 'non-remitters' at 6-month follow-up but not posttreatment and for those who did not experience a recurrence of depression at posttreatment relative to those who did experience a recurrence, although the latter was at the trend level. The HLM corroborated these findings. Together, these findings are consistent with the proposal that improving patient memory for treatment has potential to improve outcomes (Harvey et al., 2014). The finding that, at Session 7, those who recalled more treatment points were more likely to experience a recurrence is difficult to explain given that it runs contrary to the other findings. In a future fully powered study it will be important to remain vigilant for possible adverse consequences of memory support. It is notable that there were no effects for Cumulative Points Recalled. Perhaps the task of recalling all points across all 14 50 min sessions is too difficult regardless of the memory support provided.

Of the poor response subgroup moderators tested, only years of education moderated the treatment effect on changes in depression severity from baseline through 6-month follow-up, with greater treatment effects observed for those who had less than 16 years of education. Surprisingly, those who had more than 16 years of education experienced greater benefits from CT-as-usual than CT+Memory Support at 6-month follow-up. Perhaps individuals who finished college (typically taking 16 years) habitually do their own memory support and thus do not benefit as much.

Given that mood medication is a common and effective treatment for MDD and the associated effects on learning and memory (Andrews et al., 2015; Harmer et al., 2009; Vythilingam et al., 2004), we also tested medication use as a moderator. While there were no significant effects of memory support for participants taking medications, for those not taking medications there was an advantage to the participants who received memory support relative to treatment-as-usual from pre- to post-treatment. This finding raises the possibility that a future research direction would be determining if CT+Memory Support will be a strong alternative to mood medications (see Fig. 3).

The HLM analyses indicated that both groups experienced reduced depression severity from before to after treatment and these gains were maintained through to 6-month followup. These findings add to the substantial evidence base for CT. Notably, while the rate of response in CT-as-usual was similar to Thase et al. (2007), it was lower than DeRubeis et al. (2005) and Dimidjian et al. (2006). There are several differences between the studies that are likely to explain this difference. DeRubeis et al. (2005) and Dimidjian et al. (2006) both delivered 16 weeks of treatment and 20–26 sessions of CT, the therapists were experienced cognitive therapists and the MacArthur recommendations were used to define response and remission. In contrast, in the pilot RCT reported here, 14 sessions of CT were delivered across an average of 14 weeks, the therapists had no prior training in CT-as-usual and the ACNP criteria for response and remission were used (Rush et al., 2006). Also, there was n = 60 in the CT arm of DeRubeis et al. (2005). In the present report, there were 20 completers in CT-as-usual. The smaller sample means larger standard errors and wider confidence intervals. Hence, our finding may also be attributable to the small sample.

There are several limitations. First, this pilot RCT was not powered to obtain significant effects. In particular, the sample size for the subgroups as we dissected the education and medication interaction effects were small. Second, based on the present design, we cannot rule out the possibility that patient recall of the content of treatment is more due to being less depressed or if more treatment recall leads to less depression. Relatedly, perhaps the free recall approach is too limited in scope and that other indices of learning might be a more accurate means of measuring memory support (Gumport, Williams, & Harvey, 2015). Third, we also do not know precisely why the memory support intervention improves outcome. For example, perhaps improved memory for treatment improves adherence to homework or increases the spontaneous 'real world' applications of treatment points. Fourth, nearly twice as many males (13) were randomized to CT+Memory Support Group and as to CT-as-usual (6) and this difference did approach statistical significance, $\chi 2(1, N = 48) = 3.42$, $p = 0.06$. Hence, we repeated our main analyses adding sex as a covariate. None of the reported effects changed (i.e., from significance to non-significance or vice versa), $\chi 2(1, N = 48) = 3.42$, $p = 0.06$. Hence, we further examined whether the main analyses were influenced by the sex composition of the groups by adding sex as a covariate. None of the reported effects changed (i.e., from significance to non-significance or vice versa). Finally, there was a non-significant small effect size group difference in IDS at baseline, which particularly impacted the group taking medications (see Fig. 3). On the one hand, this baseline difference may favor CT+Memory Support because the CT-as-usual was more severe and may therefore be more difficult to treat. On the other hand, this baseline difference may favor the CT-as-usual group because there was more scope to improve. Replication with a larger sample is needed before drawing firm conclusions relating to sex effects and effects on IDS.

In sum, this study suggests that memory support can be manipulated and that doing so may improve patient memory for treatment and lead to an improvement in depression outcome and functional impairment, especially for patients who have not received a college education. Although cognitive therapy for depression is the focus for this study, future research is needed to test the transdiagnostic and transtreatment applicability of the memory support intervention.

Declaration of interests

No authors have a conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.brat.2016.03.007.

References

Aharonovich, E., Nunes, E., & Hasin, D. (2003). Cognitive impairment, retention and abstinence among cocaine abusers in cognitive-behavioral treatment. *Drug and Alcohol Dependence, 71*, 207–211.

Airaksinen, E., Larsson, M., & Forsell, Y. (2005). Neuropsychological functions in anxiety disorders in population-based samples: evidence of episodic memory dysfunction. *Journal of Psychiatric Research, 39*, 207–214.

Almkvist, O., Fratiglioni, L., Agüero-Torres, H., Viitanen, M., & Bäckman, L. (2010). Cognitive support at episodic encoding and retrieval: similar patterns of utilization in community-based samples of Alzheimer's disease and vascular dementia patients. *Journal of Clinical and Experimental Neuropsychology, 21*, 816–830.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, D.C.: American Psychiatric Association.

Andrews, P. W., Bharwani, A., Lee, K. R., Fox, M., & Thomson, J. A. (2015). Is serotonin an upper or a downer? The evolution of the serotonergic system and its role in depression and the antidepressant response. *Neuroscience & Biobehavioral Reviews, 51*, 164–188.

Baddeley, A. (2012). Working memory: theories, models, and controversies. *Annual Review of Psychology, 63*, 1–29.

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation*. New York: Academic Press.

Ballard, P. B. (1913). Oblivescence and reminiscence. *British Journal of Psychology Monograph Supplements, 1*, 1–82.

Bamidis, P., Vivas, A., Styliadis, C., Frantzidis, C., Klados, M., Schlee, W., et al. (2014). A review of physical and cognitive interventions in aging. *Neuroscience and Biobehavioral Reviews, 44*, 206–220.

Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin, 128*, 612.

Bearden, C. E., Glahn, D. C., Monkul, E. S., Barrett, J., Najt, P., Villarreal, V., et al. (2006). Patterns of memory impairment in bipolar disorder and unipolar major depression. *Psychiatry Research, 142*(2), 139–150.

Beck, A. T. (1979). *Cognitive therapy of depression*. New York: Guilford Press.

Behnken, A., Schöning, S., Gerss, J., Konrad, C., de Jong-Meyer, R., Zwanzger, P., et al. (2010). Persistent non-verbal memory impairment in remitted major depression - caused by encoding deficits? *Journal of Affective Disorders, 122*, 144–148.

Bjork, R. A. (1975). Retrieval as a memory modifier: an interpretation of negative recency and related phenomena. In *Paper presented at the Information processing and cognition: The Loyola symposium*.

Bremner, J. D., Vythilingam, M., Vermetten, E., Vaccarino, V., & Charney, D. S. (2004). Deficits in hippocampal and anterior cingulate functioning during verbal declarative memory encoding in midlife major depression. *American Journal of Psychiatry, 161*(4), 637–645.

Bunce, D. (2003). Cognitive support at encoding attenuates age differences in recollective experience among adults of lower frontal lobe function. *Neuropsychology, 17*, 353–361.

Chi, M. T. H., de Leeuw, N., Chiu, M. H., & LaVancher, C. (1994). Eliciting self-explanations improves understanding. *Cognitive Science, 18*, 439–477.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hilsdale, NJ: Erlbaum.

Cohen, A. S., Forbes, C. B., Mann, M. C., & Blanchard, J. J. (2006). Specific cognitive deficits and differential domains of social functioning impairment in schizophrenia. *Schizophrenia Research, 81*(2), 227–238.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 671–684.

Cuijpers, P., Hollon, S. D., van Straten, A., Bockting, C., Berking, M., & Andersson, G. (2013). Does cognitive behaviour therapy have an enduring effect that is superior to keeping patients on continuation pharmacotherapy? A meta-analysis. *British Medical Journal Open, 3*(4).

Cumming, G. (2012). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. Routledge.

DeRubeis, R. J., Hollon, S. D., Amsterdam, J. D., Shelton, R. C., Young, P. R., Salomon, R. M., et al. (2005). Cognitive therapy vs medications in the treatment of moderate to severe depression. *Archives of General Psychiatry, 62*, 409–416.

Deuschle, M., Kniest, A., Niemann, H., Erb-Bies, N., Colla, M., Hamann, B., et al. (2004). Impaired declarative memory in depressed patients is slow to recover: clinical experience. *Pharmacopsychiatry, 37*(04), 147–151.

Devilly, G. J., & Borkovec, T. D. (2000). Psychometric properties of the credibility/expectancy questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 31*, 73–86.

Di Nardo, P. A., Moras, K., Barlow, D. H., & Rapee, R. M. (1993). Reliability of DSM-III–R anxiety disorder categories: using the anxiety disorders interview schedule–revised (ADIS–R). *Archives of General Psychiatry, 50*, 251–256.

Dimidjian, S., Hollon, S. D., Dobson, K. S., Schmaling, K. B., Kohlenberg, R. J., Addis, M. E., et al. (2006). Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the acute treatment of adults with major depression. *Journal of Consulting and Clinical Psychology, 74*(4), 658.

Dobson, K. S., Hollon, S. D., Dimidjian, S., Schmaling, K. B., Kohlenberg, R. J., Gallop, R. J., et al. (2008). Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the prevention of relapse and recurrence in major depression. *Journal of Consulting and Clinical Psychology, 76*(3), 468.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66*, 183–201.

Elkin, I., Gibbons, R. D., Shea, M. T., Sotsky, S. M., Watkins, J. T., Pilkonis, P. A., et al. (1995). Initial severity and differential treatment outcome in the National Institute of Mental Health Treatment of Depression Collaborative Research Program. *Journal of Consulting and Clinical Psychology, 63*(5), 841.

Elkin, I., Shea, M. T., Watkins, J. T., Imber, S. D., Sotsky, S. M., Collins, J. F., et al. (1989). NIMH treatment of depression collaborative research program: general effectiveness of treatments. *Archives of General Psychiatry, 46*, 971–982.

Engvig, A., Fjell, A. M., Westlye, L. T., Moberget, T., Sundseth, Ø., Larsen, V. A., et al. (2010). Effects of memory training on cortical thickness in the elderly. *Neuroimage, 52*(4), 1667–1676.

Flocke, S. A., & Stange, K. C. (2004). Direct observation and patient recall of health behavior advice. *Preventive Medicine, 38*, 343–349.

Fournier, J. C., DeRubeis, R. J., Shelton, R. C., Hollon, S. D., Amsterdam, J. D., & Gallop, R. (2009). Prediction of response to medication and cognitive therapy in the treatment of moderate to severe depression. *Journal of Consulting and Clinical Psychology, 77*(4), 775.

Gazzaley, A., & Nobre, A. C. (2012). Top-down modulation: bridging selective attention and working memory. *Trends in Cognitive Sciences, 16*(2), 129–135.

Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive Psychology, 15*, 1–38.

Graesser, A. C., Langston, M. C., & Baggett, W. B. (1997). Exploring information about concepts by asking questions. In G. V. Nakamura, R. M. Taraban, & D. Medin (Eds.), *Categorization by humans and machines: Vol. 29. The psychology of learning and motivation* (pp. 411–436). Orlando, FL: Academic Press.

Gumport, N. B., Williams, J. J., & Harvey, A. G. (2015). Learning cognitive behavior therapy. *Journal of Behavior Therapy and Experimental Psychiatry, 48*, 164–169.

Guttentag, R. E. (1984). The mental effort requirement of cumulative rehearsal: a developmental study. *Journal of Experimental Child Psychology, 37*, 92–106.

Harmer, C. J., Goodwin, G. M., & Cowen, P. J. (2009). Why do antidepressants take so long to work? A cognitive neuropsychological model of antidepressant drug action. *The British Journal of Psychiatry, 195*(2), 102–108.

Harrison, T. L., Mullet, H. G., Whiffen, K. N., Ousterhout, H., & Einstein, G. O. (2014). Prospective memory: effects of divided attention on spontaneous retrieval. *Memory and Cognition, 42*(2), 212–224.

Harvey, A. G., Lee, J., Williams, J., Hollon, S. D., Walker, M. P., Thompson, M. A., et al. (2014). Improving outcome of psychosocial treatments by enhancing memory and learning. *Perspectives on Psychological Science, 9*, 161–179.

Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Review, 16*, 235–266.

Hollon, S. D., DeRubeis, R. J., Shelton, R. C., Amsterdam, J. D., Salomon, R. M., O'Reardon, J. P., et al. (2005). Prevention of relapse following cognitive therapy vs medications in moderate to severe depression. *Archives of General Psychiatry, 62*, 417–422.

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language, 32*, 421–445.

Jansen, J., Butow, P. N., van Weert, J. C., van Dulmen, S., Devine, R. J., Heeren, T. J., et al. (2008). Does age really matter? Recall of information presented to newly referred patients with cancer. *Journal of Clinical Oncology, 26*, 5450–5457.

Jelinek, L., Jacobsen, D., Kellner, M., Larbig, F., Biesold, K.-H., Barre, K., et al. (2006). Verbal and nonverbal memory functioning in posttraumatic stress disorder (PTSD). *Journal of Clinical and Experimental Neuropsychology, 28*, 940–948.

Karpicke, J. D., & Roediger, H. L. (2007). Repeated retrieval during learning is the key to long-term retention. *Journal of Memory and Language, 57*(2), 151–162.

Keller, M. B., Lavori, P. W., Friedman, B., Nielsen, E., Endicott, J., McDonald, S., et al. (1987). The longitudinal interval follow-up evaluation: a comprehensive method for assessing outcome in prospective longitudinal studies. *Archives of General Psychiatry, 44*, 540–548.

Kirchhoff, B., Anderson, B., Barch, D., & Jacoby, L. (2012). Cognitive and neural effects of semantic encoding strategy training in older adults. *Cerebral Cortex, 22*(4), 788–799.

Kolodner, J. L. (1997). Educational implications of analogy: a view from case-based reasoning. *American Psychologist, 52*, 57–66.

Lee, J., & Harvey, A. G. (2015). Memory for therapy in bipolar disorder and comorbid insomnia. *Journal of Consulting and Clinical Psychology, 83*, 92–102.

Lee, E. C., Whitehead, A. L., Jacques, R. M., & Julious, S. A. (2014). The statistical interpretation of pilot trials: should significance thresholds be reconsidered? *BMC medical research methodology, 14*(1), 41.

Lee, J. Y., Worrell, F. C., & Harvey, A. G. (2016). The Development and validation of the memory support rating scale (MSRS). *Psychological Assessment* (in press).

Ley, P., Bradshaw, P., Eaves, D., & Walker, C. (1973). A method for increasing patients' recall of information presented by doctors. *Psychological Medicine, 3*, 217–220.

Lockhart, R. S., Lamon, M., & Gick, M. L. (1988). Conceptual transfer in simple insight problems. *Memory and Cognition, 16*, 36–44.

Lombrozo, T. (2006). The structure and function of explanations. *Trends in Cognitive*

Sciences, 10, 464–470.
Majer, M., Ising, M., Künzel, H., Binder, E. B., Holsboer, F., Modell, S., et al. (2004). Impaired divided attention predicts delayed response and risk to relapse in subjects with depressive disorders. *Psychological Medicine, 34*, 1453–1463.
Mander, B. A., Santhanam, S., Saletin, J. M., & Walker, M. P. (2011). Wake deterioration and sleep restoration of human learning. *Current Biology, 21*, R183–R184.
Markant, J., & Amso, D. (2014). Leveling the playing field: attention mitigates the effects of intelligence on memory. *Cognition, 131*(2), 195–204.
Martinez-Aran, A., Vieta, E., Reinares, M., Colom, F., Torrent, C., Sanchez-Moreno, J., et al. (2004). Cognitive function across manic or hypomanic, depressed, and euthymic states in bipolar disorder. *American Journal of Psychiatry, 161*, 262–270.
Mathers, C. D., & Loncar, D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Medicine, 3*(11), e442.
Melara, R. D., Tong, Y., & Rao, A. (2012). Control of working memory: effects of attention training on target recognition and distractor salience in an auditory selection task. *Brain Research, 1430*, 68–77.
Miller, S. L., Celone, K., DePeau, K., Diamond, E., Dickerson, B. C., Rentz, D., et al. (2008). Age-related memory impairment associated with loss of parietal deactivation but preserved hippocampal activation. *Proceedings of the National Academy of Sciences, 105*(6), 2181–2186.
Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*, 289.
National Collaborating Centre for Mental Health. (2010). *Depression: the treatment and management of depression in adults* (updated edition).
Nelson, H. E., & Willison, J. (1991). *National adult reading test (NART)*. Nfer-Nelson.
Pavlov, I. P. (1927). *Conditioned reflexes. An investigation of the physiological activities of the cerebral cortex*.
Persons, J. B., Burns, D. D., & Perloff, J. M. (1988). Predictors of dropout and outcome in cognitive therapy for depression in a private practice setting. *Cognitive Therapy and Research, 12*(6), 557–575.
Polak, A. R., Witteveen, A. B., Reitsma, J. B., & Olff, M. (2012). The role of executive function in posttraumatic stress disorder: a systematic review. *Journal of Affective Disorders, 141*(1), 11–21.
Raudenbush, S., & Bryk, A. (2002). *Hierarchical linear models*. Thousand Oaks: Sage.
Robinson, L. J., Thompson, J. M., Gallagher, P., Goswami, U., Young, A. H., Ferrier, I. N., et al. (2006). A meta-analysis of cognitive deficits in euthymic patients with bipolar disorder. *Journal of Affective Disorders, 93*, 105–115.
Rohrer, D., & Taylor, K. (2007). The shuffling of mathematics practice problems improves learning. *Instructional Science, 35*, 481–498.
Rush, A. J., Gullion, C. M., Basco, M. R., Jarrett, R. B., & Trivedi, M. H. (1996). The inventory of depressive symptomatology (IDS): psychometric properties. *Psychological Medicine, 26*, 477–486.
Rush, A. J., Kraemer, H. C., Sackeim, H. A., Fava, M., Trivedi, M. H., Frank, E., et al. (2006). Report by the ACNP Task Force on response and remission in major depressive disorder. *Neuropsychopharmacology, 31*(9), 1841–1853.
Rush, A. J., Trivedi, M. H., Ibrahim, H. M., Carmody, T. J., Arnow, B., Klein, D. N., et al. (2003). The 16-item quick inventory of depressive symptomatology (QIDS), clinician rating (QIDS-C), and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. *Biological Psychiatry, 54*, 573–583.
Schacter, D. (2001). *The seven sins of memory: How the mind forgets and remembers*. New York City: Houghton Mifflin.
Siegler, R. S. (2002). Microgenetic studies of self-explanations. In N. Granott, & J. Parziale (Eds.), *Microdevelopment: Transition processes in development and learning* (pp. 31–58). New York: Cambridge University.
Skinner, B. F. (1938). *The behavior of organisms: an experimental analysis*.
Sperling, R., Bates, J., Chua, E., Cocchiarella, A., Rentz, D., Rosen, B., et al. (2003). fMRI studies of associative encoding in young and elderly controls and mild Alzheimer's disease. *Journal of Neurology, Neurosurgery and Psychiatry, 74*(1), 44–50.
Taconnat, L., Baudouin, A., Fay, S., Raz, N., Bouazzaoui, B., El-Hage, W., et al. (2010). Episodic memory and organizational strategy in free recall in unipolar depression: the role of cognitive support and executive functions. *Journal of Clinical and Experimental Neuropsychology, 32*, 719–727.
Thase, M. E., Friedman, E. S., Biggs, M. M., Wisniewski, S. R., Trivedi, M. H., Luther, J. F., et al. (2007). Cognitive therapy versus medication in augmentation and switch strategies as second-step treatments: a STAR*D report. *American Journal of Psychiatry, 164*, 739–752.
Thorndike, E. L. (1927). The law of effect. *The American Journal of Psychology, 39*(1/4), 212–222.
Thorndike, E. L. (1932). *The fundamentals of learning*. New York: Teacher's College Bureau of Publications.
Trivedi, M. H., Rush, A., Ibrahim, H., Carmody, T., Biggs, M., Suppes, T., et al. (2004). The inventory of depressive symptomatology, clinician rating (IDS-C) and self-report (IDS-SR), and the quick inventory of depressive symptomatology, clinician rating (QIDS-C) and self-report (QIDS-SR) in public sector patients with mood disorders: a psychometric evaluation. *Psychological medicine, 34*(01), 73–82.
Varga, M., Magnusson, A., Flekkoy, K., David, A. S., & Opjordsmoen, S. (2007). Clinical and neuropsychological correlates of insight in schizophrenia and bipolar I disorder: does diagnosis matter? *Comprehensive Psychiatry, 48*, 583–591.
Vythilingam, M., Vermetten, E., Anderson, G. M., Luckenbaugh, D., Anderson, E. R., Snow, J., et al. (2004). Hippocampal volume, memory, and cortisol status in major depressive disorder: effects of treatment. *Biological psychiatry, 56*(2), 101–112.
Wild, J., & Gur, R. (2008). Verbal memory and treatment response in post-traumatic stress disorder. *British Journal of Psychiatry, 193*, 254–255.
Young, J., & Beck, A. (1980). *Cognitive therapy scale: Rating manual*. Philadelphia: University of Pennsylvania.