Computerised Memory Specificity Training (c-MeST) for Major Depression:

A Randomised Controlled Trial

Hallford, D. J. ^{1,4}, Austin, D. W. ¹, Takano, K. ², Fuller-Tyszkiewicz, M. ¹, Raes, F. ³,

Please cite the published version in Behaviour Research and Therapy:

Hallford, D. J., Austin, D. W., Takano, K., Fuller-Tyszkiewicz, M., & Raes, F. (2020, February 27). Computerised Memory Specificity Training (c-MeST) for Major Depression: A Randomised Controlled Trial. *Behaviour Research and Therapy*.

¹ School of Psychology, 1 Gheringhap Street, Deakin University, Geelong, Victoria 3220, Melbourne, Australia

² Division of Clinical Psychology and Psychotherapy, Department of Psychology, Ludwig-Maximilians-University Munich, Leopoldstr. 13, Munich, Germany

³ Faculty of Psychology and Educational Sciences, KU Leuven, Tiensestraat 102, Box 3712, 3000 Leuven, Belgium

⁴ Corresponding Author, School of Psychology, Deakin University, 221 Burwood Hwy, Burwood, Victoria 3125, Melbourne, Australia, Phone: + 61 3 9251 7777, Email: david.hallford@deakin.edu.au

Abstract

Given modest response and high relapse after treatment for Major Depressive Episodes (MDE), the development and refinement of treatments to target cognitive vulnerabilities is indicated. Memory Specificity Training (MeST) remediates deficits in recalling detailed memories of past experiences through repeated practice of autobiographical memory retrieval. This randomised controlled trial aimed to assess the efficacy of an online, computerised version of MeST (c-MeST) for MDE.

Adults ($N=245$, 88.4% female; M age=46.4) with a current MDE were randomised to the c-MeST program or wait-list control group. Significantly fewer participants in the c-MeST group, relative to control, met criteria for an MDE at one-month follow-up (35.7% c-MeST vs. 60.6% control), but not at other time-points. The c-MeST group, relative to the control group, scored significantly higher on memory specificity at all time-points following baseline ($d=0.53 - 0.93$), and lower on depressive symptoms at one ($d=0.57$) and three-month follow-up ($d=0.67$). Changes in memory specificity mediated the effect of c-MeST on depressive symptoms at follow-up. c-MeST can improve memory specificity and depressive symptoms in people with an MDE, and may speed the rate of recovery. Future studies can further examine the mechanisms through which this occurs.

Keywords: memory specificity; autobiographical memory specificity, depression; major depressive episode; randomised controlled trial; overgeneral memory

Current evidence indicates that the effects of treatment for major depression are modest (e.g., Cuijpers, Karyotaki, Reijnders, & Ebert, 2019; Warden et al., 2007) and many people either do not respond to first-line treatments or relapse (Sim et al., 2016; Steinert et al., 2014). In recent times, expert groups have highlighted that treatment effects could be improved by increasing understanding of specific cognitive processes underlying psychopathology, and targeting these cognitive processes more effectively (Holmes et al., 2018). Given the prevalence and burden of major depression worldwide (World Health Organization, 2019), there is clear need for the continued development and refinement of interventions that target known cognitive mechanisms for the alleviation of symptoms.

One reliable cognitive marker in depression is difficulties in recalling spatiotemporally located events from the past (Sumner, Griffith, & Mineka, 2010). Depressed individuals, relative to non-depressed, more often fail to recall memories of event-specific experiences that occurred within the space of a day; instead, they provide memories of experiences that extended over longer periods of time, categories of repeated events, or abstractions of various experiences. This impairment, termed overgeneral memory (OGM) or reduced autobiographical memory specificity (rAMS) is recognised as a factor involved in the onset and maintenance of clinical depression (Sumner et al., 2010). Further, rAMS appears to occur in both positively and negatively-valenced memories in depression (Liu, Li, Xiao, Yang, & Jian, 2013). The ability to recall contextualized information from past experiences is critical in adaptive functioning, and in processes such as problem-solving (Goddard, Dritschel, & Burton, 1996), social support (Barry et al., 2019; Chiu, Ma, Boddez, Raes, & Barry, 2019), and imagining and anticipating future events (Schacter, Addis, & Buckner, 2007). As a means of increasing memory specificity among those with depression, Memory Specificity Training (MeST; Raes, Williams, & Hermans, 2009) has been shown to be effective (Barry, Sze, Raes, 2019). In MeST, individuals engage in sustained practice recalling specific autobiographical memories in response to a series of cue words. Over a course of weekly sessions (typically 4-5) in a group-based format, facilitators prompt participants to self-generate specific memories to cue

words. They then provide feedback on whether these responses are specific or not and guide them to elaborate on details. An initial pilot trial of MeST with inpatients indicated an increase in memory specificity following four, weekly group-based sessions (Raes et al., 2009). A subsequent, randomised controlled trial again showed significant increases in memory specificity which mediated subsequent reductions in depressive symptoms (Neshat-Doost et al., 2013). An uncontrolled trial of MeST with a sample of depressed individuals on an outpatient wait-list also found significant increases in memory specificity and decreases in depressive symptoms (Eigenhuis et al., 2017). Finally, a recent cluster-randomised trial demonstrated that MeST leads to improvements in memory specificity and was equivalent with another validated intervention (psychoeducation and supportive counselling) in reducing depressive symptoms (Werner-Seidler et al., 2018). Overall, evidence indicates that the face-to-face (or off-line) MeST training program can produce significant improvements in AM specificity and reductions in depressive symptoms (Barry et al., 2019).

Given the straightforward nature of MeST, it represents a good candidate for adaptation to an online delivery format. Online interventions for depression can be clinically- (Karyotaki et al., 2018) and cost-effective (Donker et al., 2015). They are also more accessible and less resource-intensive, thereby being more easily scalable to reach a wider population. Accordingly, a fully computerized, automated version of the MeST training program (c-MeST) has been developed, and demonstrated efficacy in increasing memory specificity in a non-clinical sample (Takano, Moriya, & Raes, 2017). In this online version, participants provide written responses to cue words over a series of sessions. Feedback is given after they submit each response via a computerised algorithm that is trained using machine learning to distinguish between written specific and non-specific autobiographical memories (Takano et al., 2017, 2018). Two subsequent studies by Martens and colleagues in older adults (Martens et al., 2019) and in adults with a history of depression (Martens, Barry, Takano, Onghena, & Raes, 2019) also showed evidence that c-MeST can significantly improve memory specificity.

The next step is to test c-MeST in a sample of individuals with clinical depression to evaluate whether it can also reduce depressive symptoms. Given that participants will not be exposed to interactions with a trainer or other group members and will focus solely on improving their recall of specific memories, this may be a stronger test of targeting this cognitive process in depression. Indeed, isolating this mechanism will mitigate against the possible confounds of common factor or interpersonal factors that occur in MeST.

Through conducting the first randomized controlled trial of online, computerized MeST in a sample of individuals with a Major Depressive Episode (MDE), the aim of this study was to assess whether improving memory specificity through this method was a means of reducing depressive symptoms. To date, MeST has not been assessed in current clinical depression in an online format. Therefore, the first step in evaluating this is to test for c-MeST against a no-treatment comparator group and establish its clinical treatment efficacy. It was hypothesized that those in the c-MeST group will report a lower incidence of MDE and significantly lower levels of depressive symptoms at post-intervention and follow-up time-points, relative to the control group. It was also hypothesized that changes in memory specificity between pre- and post-intervention would predict changes in depressive symptoms between post-intervention and follow-up. In addition to this, a number of other secondary outcomes were assessed due to their association with memory specificity: rumination, cognitive avoidance, verbal fluency, problem-solving, suicidal ideation, anxiety symptoms, and future thinking specificity.

Methods

The study was approved by the Deakin University Human Research Ethics Committee (identifier 2017_168) and registered on 8/9/2017 with the Australian New Zealand Clinical Trials Registry (ACTRN12617001156370). The protocol has been published (Hallford, Austin, Takano & Raes, 2019). Journal Article Reporting Standards for Quantitative Research in Psychology were followed (Appelbaum et al., 2018), as were CONSORT guidelines (Schulz, Altman, & Moher, 2010)

Study Design

A pre-registered online, randomized-controlled trial, using a two (condition: c-MeST vs. control group) x four (time-point: baseline, post-intervention, one- and three-months post-intervention) factorial-design. A three-month time-point was chosen as this would facilitate comparison with follow-ups from other published studies of MeST effects on depressive symptoms (see Barry et al., 2019). The addition of a one-month time-point would help investigate in more detail how change occurs over time. Participants were allocated using simple 1:1 randomization by computer. All outcome measures were administered at all three time-points, with the exception of secondary measures of problem-solving (not administered at three-months) and future thinking (not administered at one or three-months) as discussed below.

c-MeST Program

The program comprised seven sessions based on content from validated methods of improving memory specificity in face-to-face (Raes et al., 2009) and online formats (Takano et al., 2017). Participants engaged in practice providing specific autobiographical memories to a series of cue words in each session and received feedback about whether these were specific or not via an algorithm developed to classify written autobiographical memories (Takano et al., 2018). Full details of the program are in the published open-access protocol (*removed for blinding*). Participants completed the sessions at their convenience over a two-week period. They were advised not to do multiple sessions in one day, to space out the intervention, but this was not directly monitored. This two-week period was chosen as it was thought that participants might be motivated to complete the program if the availability was limited, and this two-week window had been sufficient in a previous study to improve memory specificity (Takano et al., 2017). The program was not optimized for mobile phone use, and it was recommended to participants that it was completed on laptop/personal computer.

Participants and recruitment

Recruitment occurred from August 2018 to August 2019, via advertisements in a range of online formats, such as depression-related internet forums, social media platforms, and advertising on Facebook.

The inclusion criteria, assessed through self-report, were: (i) ≥ 18 years of age, (ii) residing in Australia, (iii) English-speaking, (iv) current diagnosis of a Major Depressive Episode, (v) score of ≥ 10 on the Patient Health Questionnaire (PHQ; Spitzer et al., 1999) and (vi) internet access in the home. The exclusion criteria, also assessed through self-report, were: (i) currently receiving treatment for depression, with the exception of antidepressant medication stable in type and dosage for at least four weeks, and (ii) PHQ scores of ≥ 21 , indicative of highly severe depressive symptoms. Therefore, the sample included those with severe symptoms, but excluded highly severe. This was imposed by the approving ethics board due to the lack of provision for assertive follow-up. Participants were asked at each time-point whether they had received any treatment for their depression or another mental issue, with examples given, such as psychological therapy, medication, or support groups.

Primary outcomes

The primary outcomes were differences between the groups in MDE diagnostic status and level of self-reported depressive symptoms at post-intervention. MDE diagnostic status was assessed using the Electronic Psychological Assessment System (e-PASS; Nguyen et al., 2015). The e-PASS is an online, self-report clinical assessment system. The MDE module has 11 questions on the frequency of MDE symptoms over the last two weeks corresponding to the Diagnostic and Statistical Manual of Mental Health Disorders 5 (DSM-5; American Psychological Association, 2013). Items are answered using a scale from 0 (*not at all*) to 4 (*every day*), with one item for severity using a scale from 0 (*no interference/distress*) to 8 (*extremely significant interference/distress*). An algorithm is used to score the e-PASS, in concordance with DSM criteria, whereby if five symptoms occur either *more days than not* or *every day*, at least one of these is mood or anhedonia, and participants score $\geq$ three for interference/distress they are categorized as

experiencing an MDE. An e-PASS diagnosis corresponds well with the Mini-International Neuropsychiatric Interview (Sheehan et al., 1998; Nguyen et al., 2015).

The PHQ (Spitzer et al., 1999) was used to assess depressive symptom severity. The PHQ has nine items corresponding to DSM-5 symptom criteria for an MDE. Rating scales from 0 (*not at all*) to 3 (*nearly every day*) indicate frequency of symptoms in the last two weeks and scores are summed to provide a total (range 0 – 27; average Cronbach's alpha across time-points = .76). The PHQ has previously shown excellent validity and reliability (Kroenke et al., 2010).

Secondary outcomes

The secondary outcomes were differences between the groups in MDE diagnostic status and self-reported depressive symptoms at one and three-month follow-up. In addition to this, memory specificity was assessed using the Autobiographical Memory Test (Williams & Broadbent, 1986). Participants were asked to provide personal memories to 10 cue words, five positively and five negatively-valenced presented in alternating order. No time limit was given for responses. Four sets of cue words were used, matched on their valence, arousal, and frequency of occurrence, using Bradley and Lang's (1999) affective norms for English words, and counterbalanced across time-points. A random sample of 200 responses were coded as specific or non-specific by the first author and another researcher blinded to condition and not otherwise associated with the study (Cohen's kappa for inter-rater reliability = .84), who then coded the remaining response. Scores were summed (range 0 -10; average Cronbach's alpha across time-points = .73).

Rumination was assessed using the Ruminative Responses Scale (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). There were five items within each of the Brooding and Reflection subscales, which were summed with score range 5 – 20 (average Cronbach's alpha across time-points = .79 and .67, respectively). Cognitive avoidance was assessed with the White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994), using 15 items which are averaged, with a score range of 1-5 (average Cronbach's alpha across time-points = .84). Verbal fluency was assessed using the Controlled Oral Word Association Test (COWAT; Ruff et al., 1995). Participants

provide as many words as they can starting with one chosen letter. This is done in a written form within a one-minute time limit, and pronouns are excluded. A set of four letters (F, A, S, N.) were counterbalanced across time-points. The number of words were summed (intraclass correlation for inter-rater reliability in a subsample of 200 responses = .94). All participants were given an initial letter of E to respond to at baseline to help account for practice effects.

Problem-solving was assessed using the Means-End Problem Solving Procedure (MEPS; Platt, Spivak, & Bloom, 1971). Participants were presented with three common psychosocial problems and goals (e.g., having a bad diet and wanting to eat more healthily, having a rupture in a friendship and returning to a healthy relationship) and asked to provide in writing as many effective problem-solving steps as they could to reach the goal state. Nine problems were counterbalanced across the time-points. The responses were coded for total number of relevant problem-solving steps, as per standardized MEPS procedures (intraclass correlation for inter-rater reliability in a subsample of 200 responses = .91). Scores were summed to represent number of relevant steps (average Cronbach's alpha across time-points = .75). The MEPS was not administered at the three-month follow-up due to lack of parallel versions.

Suicidal ideation was assessed by the Suicidal Ideation Attributes Scale (Spijker et al., 2014; five items summed, score range 0 – 50, average Cronbach's alpha across time-points = .87), and symptoms of clinical anxiety as assessed by the Generalized Anxiety Disorder Scale (GAD7; Spitzer et al., 2006; seven items summed, score range 0-21, average Cronbach's alpha across time-points = .87) given previous associations between anxiety and memory specificity (Hallford et al., 2019). Future thinking specificity was assessed at baseline and post-intervention using the Episodic Future Thinking Test (EFT-T; Hallford et al., 2019). The EFT-T uses methodology consistent with the AMT. For this study, five positive cue words were responded to and coded as specific or non-specific (Cohen's kappa for inter-rater reliability in subsample of 200 responses = .87) and summed (range 0 - 5; average Cronbach's alpha across time-points = .58). No time limit was given for

responses. Although self-efficacy was planned to be assessed, an error in the online survey meant this data was not collected across time-points.

Evaluation Questions

Participants in the c-MeST group were asked five questions relating to their experience with the training program: “I found the memory training program easy to use”, “I found the memory training program helpful”, “I thought the memory training program was long enough”, “I would recommend the training program to other people”, “The feedback on whether my memories were specific was usually accurate”. A five-point Likert scale was used (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*), and ratings of 1 or 2, and 3 and 5 were collapsed so responses were reported as percentages indicating Disagree, Neither Agree nor Disagree, or Agree.

Sample Size Calculation

The sample size was calculated under the following assumptions: (1) at least moderate group difference (0.6 SMD) between the intervention and control groups for the primary outcomes, consistent with previous findings on between group differences in depressed samples with waitlist controls (Barry, Sze, & Raes, 2019); (2) power set at .80; (3) alpha set at .05 (two-tailed); and (4) expected attrition rate of 35% for the intervention group. Based on these parameters, G*Power version 3.1 (Faul et al., 2007) identified a required total sample of 105 participants across the two groups.

Data Analytic Plan

The main analyses were conducted by author M.F. who was blinded to condition. Consistent with our study protocol (Hallford et al., 2019) analyses followed the principles of intention-to-treat (ITT), with individuals retained in the group they were randomised to. Missing data-points for measures were handled using full information maximum likelihood estimation for all analyses. This meant that all available, fully completed measures at each time-point were used to estimate inferential statistics. In cases where measures were partially complete the following rules were

used: When more than 50% of a participant's responses to a measure was missing, that measure was omitted for that participant at that time-point. Where less than 50% of items from a measure were incomplete, expectation maximisation was used on the individual item level to replace responses. Per protocol analyses were not conducted as most participants missed at least a single measure across the battery of questionnaires, and there were too few cases ($n = 14$) that completed 100% of all items on all measures at all time-points to make this viable. Pre-processing was conducted in IBM SPSS 26.0. Main analyses were conducted in Mplus Version 8.3. Post-intervention group differences in proportion of individuals with an MDE diagnosis were tested at each post-intervention timepoint using logistic regression. Baseline diagnosis was not controlled for as this was a condition of entry into the study. Post-intervention group differences for continuous variables were tested using linear mixed effects models, with main effects for time (dummy coded at each post-intervention timepoint relative to the baseline assessment) and group (intervention vs control), random effects for time dummy variables clustered within individuals, and time x group interactions to assess hypotheses about greater symptom improvement among the intervention group. An unstructured variance-covariance matrix was used for random effects, and no issues of non-convergence due to high correlation among the random effects were observed. Mediation analyses on change in scores was assessed with path analysis using group assignment at baseline (Time 1) as the IV, AMT scores at post-intervention (Time 2) controlling for scores at baseline (Time 1) as the mediator, and depressive symptoms at three-month follow-up (Time 3) controlling for scores at post-intervention (Time 2) as the DV. Mediation was calculated using bias-corrected bootstrapping with 5000 samples.

Procedure

After providing informed consent, screening, and completion of the baseline survey, participants were randomized to groups. These processes were wholly conducted online and were automated. Participants in the c-MeST group were given two weeks access to the program immediately after completion of the baseline through an automated email process. During the two weeks they

received daily email prompts with links to the program to encourage them to access and complete it. After these two weeks their unique identifier code no longer allowed access. Email reminders were sent to both groups at the follow-up points with links to the online surveys, which were completed using the Qualtrics survey platform. The experimenters were not blinded during this process. Where participants scored higher than a pre-determined cut-off on the Suicidal Ideation Attributes Scale, indicative of increased risk for suicidal behavior (Spijker et al., 2014), they were contacted via email and provided with information and encouragement to access support services. The informed consent included a clear statement that the study did not involve comprehensive treatment or management of risk. Ongoing involvement in the study was at the participants discretion. Participants in the control group were given access to the training program following the cessation of the study. Recruitment ceased when the estimated number of participants had completed three-month follow-ups.

Results

Participant flow and characteristics

In total, 2,813 individuals attempted screening for the study. Only 648 (23%) were screened as eligible, and 245 (37.8%) of these eligible individuals completed baseline measures and were randomized to a group (see Figure 1 for CONSORT flowchart). Table 1 shows the demographic characteristics. The sample was on average in their mid-40s and predominantly female. There were no significant differences on any demographic characteristics, including treatment for depression or other mental health issues. To assess factors that might have affected dropout, a series of *t*-tests and chi-square tests were conducted to assess for any differences at baseline between participants that completed the three-month follow-up versus participants that did not. Participants who did not complete the three-month measures were more likely to report receiving other treatment/support for mental health issues between baseline and one-month follow-up (52.8% vs. 29.3%, $\chi^2(1) = 8.3$, $p = .004$). Participants who did not complete the three-month follow-up had lower rates of employment (67.5% vs. 54.1%, $\chi^2(1) = 3.9$, $p = .046$). There were no other significant differences

(all p 's $>.058$). Participants in the c-MeST group completed an average of 3.3 ($SD=2.6$) intervention sessions, consistent with typically low adherence in unguided-internet intervention for depression (Webb, Rosso, & Rauch, 2017).

Primary outcomes group differences

There was no significant difference on rates of MDE diagnosis on the ePASS immediately post-intervention (45.8% c-MeST vs 57.6% control, Wald statistic=1.7, OR=0.62 95% CI [0.30, 1.26], $p=.188$; see Figure 2). As shown in Table 2, there was also no difference in depressive symptoms on the PHQ between control and intervention group at post-intervention.

Secondary outcomes group differences

A difference was found at one-month follow-up for MDE diagnosis, with lower rates in the c-MeST group (35.7% c-MeST vs. 60.6% control, Wald statistic = 4.4, OR = 0.36 95% CI [0.14, 0.92], $p = .034$). However, there was no significant difference between the groups at three-month follow-up (26.5% c-MeST vs 34.2% control, Wald statistic = 0.5, OR=0.69 95% CI [0.25, 1.91], $p = .478$). For depressive symptoms on the PHQ, there were significant group differences at the one-month follow-up and three-month follow-up with a moderate effect size (see Figure 3).

Autobiographical memory was the only variable to show significantly greater improvement in the intervention group by post-intervention, with these changes remaining significant and increasing in magnitude at follow-up points from moderate to large (see Figure 4).

The intervention group had significantly higher verbal fluency and borderline significantly lower reflective rumination and general anxiety symptoms compared to the control group by the one-month follow-up with moderate effects sizes, but differences were not maintained at the three-month follow-up. Episodic future thinking, problem solving, suicidal ideation, brooding rumination, and cognitive avoidance did not significantly differ across groups at any of the timepoints, despite some small effect sizes that might be considered non-trivial (i.e., Cohen's $d>.2$).

Mediation effects

When testing separate pathways, the effect of group on change in memory specificity from

Time 1 to Time 2 was significant ($b=1.41$, 95% CI [0.38, 2.50]), though the effect of memory specificity on change in PHQ from Time 2 to Time 3 was non-significant ($b=-0.39$, 95% CI [-0.78, 0.06]). In the full mediation model, the direct effect of group on change in PHQ was non-significant ($b=-2.03$, 95% CI [-3.87, 0.05]), but the proposed indirect effect of group on depressive symptoms via memory specificity was supported ($b=-0.55$, 95% CI [-1.56, -0.02]).

Program Evaluation

Half of the sample agreed the program was easy to use (Disagree=30%, Neither Agree nor Disagree=15%, Agree=55%). A third of the sample found it helpful, a third weren't sure and a third disagreed (Disagree=33%, Neither Agree nor Disagree=36.7%, Agree=30.3%). Half agreed it was long enough, and a third were undecided (Disagree=16.7%, Neither Agree nor Disagree=28.3%, Agree=55%). A third of the sample agreed they would recommend it to others, while a third weren't sure and a third disagreed (Disagree=33.3%, Neither Agree nor Disagree=33.4%, Agree=33.3%). Less than half agreed that feedback on responses in the program was usually accurate, and third disagreed (Disagree=36.7%, Neither Agree nor Disagree=21.7%, Agree=41.7%). No specific harms or unintended effects were identified. Exploratory correlation analyses, not originally reported in the pre-registration, were conducted to examine whether responses on the evaluation questions were related to residualized changes scores from baseline to three-month follow-up on the ePASS ($n = 29$), PHQ ($n = 27$), and AMT ($n = 24$). Notably, statistical power for these analyses was low. For the ePASS, the correlations were non-significant and generally small in magnitude indicating more positive evaluations were related to remission from meeting diagnostic criteria (r range = -.17 to -.25, p 's $\geq .250$). A similar pattern was found on the PHQ, with stronger agreement that one would recommend the program approaching significance ($r = -.33$, $p = .084$, remaining r range = -.11 to -.27, p 's $\geq .158$). Lastly, for the AMT, the more that participants agreed that the feedback in training was accurate the higher their specificity was at three-months ($r = .43$, $p = .034$). Agreement that the program was helpful ($r = .39$, $p = .057$) and that one would recommend it to others ($r = .36$, $p = .076$) also approached significance (remaining r range = -.11 to -.27, p 's $\geq .368$).

Discussion

This study was the first to evaluate a computerized, automated version of Memory Specificity Training to improve specificity in autobiographical memory in clinical depression and alleviate depressive symptoms. Consistent with prior studies of c-MeST (Martens et al., 2019a, 2019b; Takano, Moriya, & Raes, 2017), improvements were found in the retrieval of specific, spatiotemporally-located personal memories in the c-MeST group, relative to control. This indicates that memory specificity can be improved in both depressed and non-depressed samples using online, automated methods.

MDE diagnostic status differed significantly between the groups at the one-month follow-up, but not at the three-month follow-up. For self-report symptom severity, an advantage for c-MeST emerged at one-month and was maintained at three-months. Together, these findings suggest that c-MeST played a role in reducing depressive symptoms and shortening the time to remission from meeting criteria for MDE. These findings at one-month and three-months are consistent with post-intervention effect sizes for depressive symptoms in meta-analysis of MeST intervention outcomes (Barry et al., 2019). However, relative to comparably designed studies using a wait-list group and participants selected for having clinical depression, the effects were somewhat lower than studies using a face-to-face modality (e.g. Neshat-Doost et al., 2013; Serrano, Latorre, Gatz, & Montanes, 2004) or telephone-based modality on (Celano et al., 2016). Notably, the contact with clinicians/researchers through these modalities facilitates compliance and engagement in the material. Further, and as noted in the introduction, these modalities provide other possible avenues for therapeutic effects. These might include empathic support and group processes where applicable, such as normalizing of issues and modelling/vicarious learning of adaptive coping or emotional regulation from group members. It is noted that few previous studies comparing MeST to waitlist in clinical groups in general have included a follow-up, and these findings have been mixed on depressive symptoms (Barry et al., 2019). Notably, two studies that selected for participants with depression showed differences at follow-up (Celano et al., 2016; Neshat-Doost et al., 2013),

whereas one that selected for posttraumatic stress disorder did not (Moradi et al., 2014). These current findings support the notion that when clinically depressed participants engage in MeST, effects on depression might be maintained beyond immediately post-intervention.

Some differences were found for verbal fluency, and some borderline significant differences for rumination and general anxiety symptoms, at one month follow-up, but not at other time-points or on other secondary measures. These findings reflect the inconsistency with which these variables are found to be related to memory specificity. For example, rumination has been posited as associated with, and perhaps causal in, rAMS in depression (Williams et al., 2007). However, recent meta-analytic evidence contradicts this, showing rumination is not correlated with memory specificity, even in depressed samples (Chiu et al., 2018). Further, Barry et al.'s (2019) review indicates inconsistent findings for MeST's effects on verbal fluency and rumination, and no effects for problem-solving at follow-ups. We also assessed future thinking specificity at pre and post-training, with a non-significant, small-to-moderate between-group difference. This may be due to poor internal reliability in this study or low participant motivation, given it was at the end of the survey. This notwithstanding, if psychometric issues are addressed then future specificity may be of interest to assess in future studies, as it is closely related to memory specificity and may show change at subsequent follow-up.

Changes in memory specificity during the training were found to mediate subsequent changes in depressive symptoms. Previous research on mediation effects have been mixed, with a small, early trial showing evidence for this change process (Neshat-Doost et al., 2013), but a more recent trial showing no mediation effect compared to an active control that was not targeting memory specificity (Werner-Siedler et al., 2018). This study provides further support for the mechanism of change in MeST. Indeed, differences in depression were not found immediately after the intervention period, which suggests that antidepressant effects occur after, and not during, c-MeST training, and are predicted by changes in memory specificity that do occur during the training. Nevertheless, this may not fully explain the effects of MeST on depressive symptoms.

Further exploration is needed to ascertain which other variables in MeST might act as mechanisms of change in reducing depressive symptoms. Given that participants are retrieving memories with a range of personal content this may facilitate reappraisal of beliefs about oneself or one's life. Therefore, candidate variables might include self-related variables such as self-construals/self-schema, meaning in life, or a more cohesive narrative identity (Hallford & Mellor, 2017). Another possibility is that MeST may promote experiential processing, that is, processing of past experiences in a direct and non-judgmental way. Experiential processing has been shown to increase positive emotional response during recall (Gadekis, Bos, Schweizer, Murphy, & Dunn, 2017), which may help address anhedonia in depression.

Limitations

This study provides evidence for the efficacy of c-MeST, but the lack of an active comparator group means that specific effects may be confounded with non-specific effects of an online intervention (e.g., expectation effects). A next step will be to test c-MeST against other evidence-based online interventions that do not necessarily aim to affect memory specificity. In general, participant feedback on the c-MeST program was not particularly positive. c-MeST lacks the social, supportive environment and positive feedback and encouragement from other participants and facilitator that face-to-face, or off-line MeST offers. Responses on the evaluation questions strongly indicate that c-MeST requires modification to make the user experience more interesting and engaging. Overall, participants did not agree that the feedback on specificity in the program was accurate. This is interesting given that the algorithm has achieved a classification accuracy of over 80% (Takano et al., 2018). Further testing of this algorithm may be needed to understand whether this accuracy is compromised in individuals with depression. Alternatively, some participants may not be learning how to provide specific memories in the context of limited, dichotomous feedback (correct/incorrect). Given that perceptions of the accuracy of feedback was related to higher increases in specificity, improving the accuracy and learning seems paramount in future iterations of this program. Perhaps relatedly, mean AMT scores were still low in the c-MeST

group at the three-month follow-up. It is worth noting, however, that this mean score was not dissimilar to the average number of specific responses provided by community samples in paper and pencil formats of the AMT (Griffiths et al., 2009). This may also be an artefact of reduced participant motivation/effort in online delivery, in the absence of an experimenter. In this study we chose internet-administered AMT to reduce burden on participants and researchers, and increase accessibility. However, future research may opt for face-to-face administration, for example on video conferencing, to better control for task adherence when assessing outcomes. Regardless, there is significant room for improvement in feedback in c-MeST to improve learning of how to retrieve specific memories and mastery of this task, and to improve user experience. The c-MeST application was not optimized for mobile phone use. Although participants were advised to use it on personal computer/laptop, some negative feedback regarding usability may relate to this. Future iterations of c-MeST could rectify this. The high rate of dropout from baseline to follow-ups, although common in online interventions, is a limitation. Participants that dropped out by 3 months were more likely to have received help elsewhere. While this provides one potential reason for dropout, our data does not allow us to understand more about why dropout occurred. The predominantly female sample also limits generalizability to males, although no obvious reason why gender might moderate c-MeST effects comes to mind. Future studies with adequate power to test gender differences might explore this.

Future studies examining c-MeST might incorporate changes to the program and design as above, in order to more robustly test the effects of this online intervention. A longer-term follow-up would be informative, and provide scope to test mediation at different time lengths. C-MeST might be tested in other clinical groups that have shown response to MeST, such as posttraumatic stress disorder (Moradi et al., 2014). Future research might also incorporate c-MeST into other interventions. A study examining c-MeST as an adjunct to other treatments for depression is currently underway (*removed for blinding*). Integrating c-MeST into treatments that already target

autobiographical memory, such as reminiscence therapies, might provide further enhancement of change processes (e.g., Kleijn et al., 2018; also see Piquart & Forstmeier, 2012).

In conclusion, the study provides evidence that c-MeST can improve memory specificity and depressive symptoms in those with a MDE, and may speed the rate of recovery. Future studies can examine further the mechanism/s through which this occurs.

Declarations of interest: FR is one of the developers of the original in-group face-to-face MeST and of the online, computerized MeST (c-MeST). FR additionally receives payments for training workshops and presentations related to MeST. There are no other competing interests to declare

Funding statement

The lead author received support for this research from Deakin University, as part of a Deakin Health Postdoctoral Research Fellowship.

References

- American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (5th ed.). Arlington, VA: American Psychiatric Publishing 2013.
- Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., & Rao, S. M. (2018). Journal article reporting standards for quantitative research in psychology: The APA Publications and Communications Board task force report. *American Psychologist*, 73(1), 3-25. doi:10.1037/amp0000389
- Barry, T. J., Sze, W. Y., & Raes, F. (2019). A meta-analysis and systematic review of Memory Specificity Training (MeST) in the treatment of emotional disorders. *Behaviour Research and Therapy*, 116, 36-51. <https://doi.org/10.1016/j.brat.2019.02.001>
- Barry, T. J., Vinograd, M., Boddez, Y., Raes, F., Zinbarg, R., Mineka, S., & Craske, M. G. (2019). Reduced autobiographical memory specificity affects general distress through poor social support. *Memory*, 27(7), 916-923. <https://doi.org/10.1080/09658211.2019.1607876>
- Bradley MM, Lang PJ. Affective norms for English words (ANEW): Instruction manual and affective ratings. Technical Report C-1, The Center for Research in Psychophysiology, University of Florida 1999.
- Celano, C. M., Beale, E. E., Mastromauro, C. A., Stewart, J. G., Millstein, R. A., Auerbach, R. P., ... Huffman, J. C. (2016). Psychological interventions to reduce suicidality in high-risk patients with major depression: a randomized controlled trial. *Psychological Medicine*, 47, 810–812. <https://doi.org/10.1017/S0033291716002798>
- Chiu, C. P., Griffith, J. W., Lenaert, B., Raes, F., Hermans, D., & Barry, T. J. (2018). Meta-analysis of the association between rumination and reduced autobiographical memory specificity. *Memory*, 26(10), 1323-1334. doi:10.1080/09658211.2018.1474928
- Chiu, C. H., Ma, H. W., Boddez, Y., Raes, F., & Barry, T. J. (2019). Social support from friends predicts changes in memory specificity following a stressful life event. *Memory*, 27(9), 1263-1272. <https://doi.org/10.1080/09658211.2019.1648687>

- Cuijpers, P., Karyotaki, E., Reijnders, M., & Ebert, D. D. (2019). Was Eysenck right after all? A reassessment of the effects of psychotherapy for adult depression. *Epidemiology and Psychiatric Sciences*, 28(1), 21-30. <https://doi.org/10.1017/S2045796018000057>
- Donker, T., Blankers, M., Hedman, E., Ljotsson, B., Petrie, K., & Christensen, H. (2015). Economic evaluations of Internet interventions for mental health: a systematic review. *Psychological Medicine*, 45(16), 3357-3376. <https://doi.org/10.1017/S0033291715001427>
- Eigenhuis, E., Seldenrijk, A., van Schaik, A., Raes, F., & van Oppen, P. (2017). Feasibility and effectiveness of memory specificity training in depressed outpatients: A pilot study. *Clinical Psychology & Psychotherapy*, 24(1), 269-277. <https://doi.org/10.1002/cpp.1995>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175-191. <https://doi.org/10.3758/BF03193146>
- Gadeikis, D., Bos, N., Schweizer, S., Murphy, F., & Dunn, B. (2017). Engaging in an experiential processing mode increases positive emotional response during recall of pleasant autobiographical memories. *Behaviour Research and Therapy*, 92, 68–76. <http://dx.doi.org/10.1016/j.brat.2017.02.005>
- Griffith, J. W., Sumner, J. A., Debeer, E., Raes, F., Hermans, D., Mineka, S., . . . Craske, M. G. (2009). An item response theory/confirmatory factor analysis of the Autobiographical Memory Test. *Memory*, 17(6), 609-623. doi: 10.1080/09658210902939348
- Goddard, L., Dritschel, B., & Burton, A. (1996). Role of autobiographical memory in social problem solving and depression. *Journal of Abnormal Psychology*, 105, 609-616. doi: 10.1037/0021-843X.105.4.609
- Hallford, D. J., Austin, D. W., Takano, K., & Raes, F. (2018). Psychopathology and episodic future thinking: A systematic review and meta-analysis of specificity and episodic detail. *Behaviour Research Therapy*, 102, 42-51. <https://doi.org/10.1016/j.brat.2018.01.003>
- Hallford, D. J., Austin, D. W., Raes, F., & Takano, K. (2019). Computerised memory specificity

training (c-MeST) for the treatment of major depression: a study protocol for a randomised controlled trial. *BMJ open*, 9(2), e024508. doi:10.1136/bmjopen-2018-024508

Hallford, D. J., Mellor, D., Bafit, L., Devenish, B., Bogeski, T., Austin, D. W., & Kaplan, R. (2019).

The effect of increasing state anxiety on autobiographical memory specificity and future thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, 65, 101488.

<https://doi.org/10.1016/j.jbtep.2019.101488>

Hallford, D. J., & Mellor, D. (2017). Development and validation of the Awareness of Narrative Identity Questionnaire (ANIQ). *Assessment*, 24(3), 399-413.

Hallford, D. J., Takano, K., Raes, F., & Austin, D. W. (2019). Psychometric Evaluation of an Episodic Future Thinking Variant of the Autobiographical Memory Test–Episodic Future Thinking-Test (EFT-T). *European Journal of Psychological Assessment*.

<https://doi.org/10.1027/1015-5759/a000536>

Holmes, E. A., Ghaderi, A., Harmer, C. J., Ramchandani, P. G., Cuijpers, P., Morrison, A. P., ... & Moulds, M. L. (2018). The Lancet Psychiatry Commission on psychological treatments research in tomorrow's science. *The Lancet Psychiatry*, 5(3), 237-286.

[https://doi.org/10.1016/S2215-0366\(17\)30513-8](https://doi.org/10.1016/S2215-0366(17)30513-8)

Karyotaki, E., Riper, H., Twisk, J., Hoogendoorn, A., Kleiboer, A., Mira, A., ... & Andersson, G. (2017). Efficacy of self-guided internet-based cognitive behavioral therapy in the treatment of depressive symptoms: a meta-analysis of individual participant data. *JAMA Psychiatry*, 74(4), 351-359. doi:10.1001/jamapsychiatry.2017.0044

Kleijn, G., Lissenberg-Witte, B. I., Bohlmeijer, E. T., Steunenberg, B., Knipscheer-Kuijpers, K., Willemsen, V., ... & van der Vorst, M. (2018). The efficacy of Life Review Therapy combined with Memory Specificity Training (LRT-MST) targeting cancer patients in palliative care: A randomized controlled trial. *PloS one*, 13(5).

[10.1371/journal.pone.0197277](https://doi.org/10.1371/journal.pone.0197277)

Liu, X., Li, L., Xiao, J., Yang, J., & Jiang, X. (2013). Abnormalities of autobiographical memory of

- patients with depressive disorders: A meta-analysis. *Psychology and Psychotherapy: Theory, Research and Practice*, 86(4), 353-373. <https://doi.org/10.1111/j.2044-8341.2012.02077.x>
- Martens, K., Barry, T. J., Takano, K., Onghena, P., & Raes, F. (2019a). Efficacy of online Memory Specificity Training in adults with a history of depression, using a multiple baseline across participants design. *Internet Interventions*, 18, 100259. <https://doi.org/10.1016/j.invent.2019.100259>
- Martens, K., Takano, K., Barry, T. J., Goedleven, J., Van den Meutter, L., & Raes, F. (2019b). Remediating reduced autobiographical memory in healthy older adults with computerized memory specificity training (c-MeST): An observational before-after study. *Journal of Medical Internet Research*, 21(5), e13333. doi:10.2196/13333
- Moradi, A. R., Moshirpanahi, S., Parhon, H., Mirzaei, J., Dalgleish, T., & Jobson, L. (2014). A pilot randomized controlled trial investigating the efficacy of MEMory Specificity Training in improving symptoms of posttraumatic stress disorder. *Behaviour Research and Therapy*, 56(1), 68–74. <https://doi.org/10.1016/j.brat.2014.03.002>
- Neshat-Doost, H. T., Dalgleish, T., Yule, W., Kalantari, M., Ahmadi, S. J., Dyregrov, A., & Jobson, L. (2013). Enhancing autobiographical memory specificity through cognitive training: An intervention for depression translated from basic science. *Clinical Psychological Science*, 1(1), 84-92.12. <https://doi.org/10.1177/2167702612454613>
- Nguyen, D. P., Klein, B., Meyer, D., Austin, D. W., and Abbott, J. A. M. (2015). The diagnostic validity and reliability of an internet-based clinical assessment program for mental disorders. *J Med Internet Res*, 17(9). doi:10.2196/jmir.4195
- Takano, K., Moriya, J., & Raes, F. (2017). Lost in distractors: reduced autobiographical memory specificity and dispersed activation spreading over distractors in working memory. *Behaviour Research and Therapy*, 94, 19-35. <https://doi.org/10.1016/j.brat.2017.04.005>
- Takano, K., Hallford, D. J., Vanderveren, E., Austin, D. W., & Raes, F. (2018). The computerized scoring algorithm for the autobiographical memory test: updates and extensions for

analyzing memories of English-speaking adults. *Memory*, 27(3), 306-313.

<https://doi.org/10.1080/09658211.2018.1507042>

Takano, K., Ueno, M., Moriya, J., Mori, M., Nishiguchi, Y., & Raes, F. (2017). Unraveling the linguistic nature of specific autobiographical memories using a computerized classification algorithm. *Behavior Research Methods*, 49(3), 835-852. <https://doi.org/10.3758/s13428-016-0753-x>

Serrano, J. P., Latorre, J. M., Gatz, M., & Montanes, J. (2004). Life review therapy using autobiographical retrieval practice for older adults with depressive symptomatology. *Psychology and Aging*, 19(2), 270–277. <https://doi.org/10.1037/0882-7974.19.2.272>

Spitzer, R. L., Kroenke, K., Williams, J. B., & Patient Health Questionnaire Primary Care Study Group. (1999). Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *JAMA*, 282(18), 1737-1744 23. doi:10.1001/jama.282.18.1737

Kroenke, K., Spitzer, R. L., Williams, J. B., & Löwe, B. (2010). The patient health questionnaire somatic, anxiety, and depressive symptom scales: a systematic review. *General Hospital Psychiatry*, 32(4), 345-359. <https://doi.org/10.1016/j.genhosppsych.2010.03.006>

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: A psychometric analysis. *Cognitive therapy and Research*, 27(3), 247-259. <https://doi.org/10.1023/A:1023910315561>

Pinquart, M., & Forstmeier, S. (2012). Effects of reminiscence interventions on psychosocial outcomes: A meta-analysis. *Aging & Mental Health*, 16(5), 541-558. <https://doi.org/10.1080/13607863.2011.651434>

Platt JJ, Spivak G, Bloom MR. Means-ends problem-solving procedure (MEPS): Manual and tentative norms. Research and Evaluation Report No. 29, Hahnemann; Medical College and Hospital, Department of Mental Health Sciences, 1971.

Ruff, R. M., Light, R. H., Parker, S. B., & Levin, H. S. (1996). Benton controlled oral word association test: Reliability and updated norms. *Archives of Clinical Neuropsychology*,

11(4), 329-338. <https://doi.org/10.1093/arclin/11.4.329>

- Raes, F., Williams, J. M. G., Hermans, D. (2009). Reducing cognitive vulnerability to depression: A preliminary investigation of MEemory Specificity Training (MEST) in inpatients with depressive symptomatology. *Journal of Behavioural and Experimental Psychiatry*, 40(1). 24-38. <https://doi.org/10.1016/j.jbtep.2008.03.001>
- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2007). Remembering the past to imagine the future: the prospective brain. *Nature Reviews Neuroscience*, 8(9), 657-661. <https://doi.org/10.1038/nrn2213>.
- Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMC Medicine*, 8(1), 18. <https://doi.org/10.1186/1741-7015-8-18>.
- Van Spijker, B. A., Batterham, P. J., Caelear, A. L., Farrer, L., Christensen, H., Reynolds, J., & Kerkhof, A. J. (2014). The Suicidal Ideation Attributes Scale (SIDAS): Community-based validation study of a new scale for the measurement of suicidal ideation. *Suicide and Life-Threatening Behavior*, 44(4), 408-419. <https://doi.org/10.1111/sltb.12084>
- Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine*, 166(10), 1092-1097. doi:10.1001/archinte.166.10.1092
- Sumner, J. A., Griffith, J. W., Mineka, S (2010). Overgeneral autobiographical memory as a predictor of the course of depression: A meta-analysis. *Behaviour Research Therapy*. 48(7). 614-25. <https://doi.org/10.1016/j.brat.2010.03.013>
- Steinert, C., Hofmann, M., Kruse, J., & Leichsenring, F. (2014). Relapse rates after psychotherapy for depression—stable long-term effects? A meta-analysis. *Journal of Affective Disorders*, 168, 107-118. <https://doi.org/10.1016/j.jad.2014.06.043>
- Sim, K., Lau, W. K., Sim, J., Sum, M. Y., & Baldessarini, R. J. (2016). Prevention of relapse and recurrence in adults with major depressive disorder: systematic review and meta-analyses of

- controlled trials. *International Journal of Neuropsychopharmacology*, 19(2), pyv076, <https://doi.org/10.1093/ijnp/pyv076>
- Warden, D., Rush, A. J., Trivedi, M. H., Fava, M., & Wisniewski, S. R. (2007). The STAR* D Project results: a comprehensive review of findings. *Current Psychiatry Reports*, 9(6), 449-459. <https://doi.org/10.1007/s11920-007-0061-3>
- Webb, C. A., Rosso, I. M., & Rauch, S. L. (2017). Internet-based cognitive behavioral therapy for depression: current progress & future directions. *Harvard Review of Psychiatry*, 25(3), 114-122. [10.1097/HRP.0000000000000139](https://doi.org/10.1097/HRP.0000000000000139)
- Wegner DM, Zanakos S. Chronic thought suppression. *J Personal* 1994;62(4):615-640.
- Williams, J. M. G., Barnhofer, T., Crane, C., Herman, D., Raes, F., Watkins, E., & Dalgleish, T. (2007). Autobiographical memory specificity and emotional disorder. *Psychological bulletin*, 133(1), 122-148. <https://doi.org/10.1037/0033-2909.133.1.122>
- Williams, J. M., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of abnormal psychology*, 95(2), 144-149. <https://doi.org/10.1037/0021-843X.95.2.144>
- Werner-Seidler, A., Hitchcock, C., Bevan, A., McKinnon, A., Gillard, J., Dahm, T., ... & Rodrigues, E. (2018). A cluster randomized controlled platform trial comparing group Memory specificity training (MEST) to group psychoeducation and supportive counselling (PSC) in the treatment of recurrent depression. *Behaviour Research and Therapy*, 105, 1-9. <https://doi.org/10.1016/j.brat.2018.03.004>
- World Health Organization (2019). Depression fact sheet. Retrieved on 23rd Feb 2020 from <http://www.who.int/news-room/fact-sheets/detail/depression>

Figure 1. Participant Flowchart

Figure 2. *Outcomes for the ePASS using all observed data*

Figure 3. Outcomes for Depressive Symptoms on the PHQ (with 95% CI of SD), using all observed data in the full information maximum likelihood estimation

Figure 4. *Outcomes for Memory Specificity (with 95% CI of SD), using all observed data in the full information maximum likelihood estimation*

Table 1.

Characteristics of Participants

Characteristic	Full Sample	Control	c-MeST	Statistics
Age	46.4 (<i>SD</i> = 13.3)	46.1 (<i>SD</i> = 12.5)	46.4 (<i>SD</i> = 13.5)	$t = 0.16, p = .867$
Number of Females	213 (88.4%)	117 (89.7%)	124 (87.1%)	$\chi^2 = 0.4, p = .522$
Level of Education				$\chi^2 = 6.4, p = .168$
Primary School	1 (0.7%)	0	1 (1.4%)	
High School	50 (17.1%)	19 (16.0%)	31 (24.8%)	
Diploma	95 (37%)	49 (41.2%)	46 (36.8%)	
Undergraduate	62 (30.1%)	36 (30.3%)	26 (20.8%)	
Degree				
Postgraduate	36 (15.1%)	15 (12.6%)	21 (16.8%)	
Degree				
Currently Studying	35 (14.3%)	13 (10.9%)	22 (17.6%)	$\chi^2 = 1.3, p = .238$
Employed	154 (61.2%)	78 (66.1%)	76 (60.8%)	$\chi^2 = 0.7, p = .391$
Ethnicity				$\chi^2 = 2.3, p = .800$
Caucasian/White	227 (93.4%)	112 (94.9%)	115 (92.0%)	
European				
Asian	4 (1.6%)	2 (1.7%)	2 (1.6%)	
African	2 (0.8%)	1 (0.8%)	1 (0.8%)	
Arab/Middle	1 (0.4%)	0	1 (0.8%)	
Eastern				
Latino	1 (0.4%)	0	1 (0.8%)	
Other	8 (3.1%)	3 (2.5%)	5 (4.0%)	
Treatment/Support for Mental Health During the Trial	60 (40.8%)	30 (30.6%)	30 (29.4%)	$\chi^2 = 0.04, p = .837$

Table 2.

Comparison of Outcomes between Intervention and Control Groups across Time

Outcomes	Control Group		c-MeST Group		Adjusted difference (c-MeST - control)		
	<i>N</i>	Mean (<i>SD</i>)	<i>N</i>	Mean (<i>SD</i>)	Mean (95% CI)	Cohen's <i>d</i>	<i>p</i> - value
PHQ9							
Baseline	119	17.62 (2.84)	125	17.60 (3.18)			
Post-int	64	14.90 (4.78)	57	13.45 (6.05)	-0.79 (-2.61, 1.03)	0.15	.393
1-mpost	33	14.35 (4.47)	42	11.57 (4.64)	-2.55 (-4.56, -0.53)	0.57	.013
3-m post	36	13.52 (5.15)	32	10.46 (3.95)	-2.77 (-4.71, -0.82)	0.67	.006
AMT							
Baseline	117	3.38 (2.29)	123	3.42 (2.33)			
Post-int	51	3.11 (2.29)	40	4.62 (2.73)	1.38 (0.32, 2.43)	0.53	.010
1-mpost	29	2.89 (2.59)	32	4.40 (3.18)	1.61 (0.40, 2.81)	0.67	.008
3-m post	31	2.51 (2.11)	28	4.89 (2.54)	2.01 (0.91, 3.10)	0.93	<.001
COWAT							
Baseline	115	11.93 (4.00)	121	12.57 (4.01)			
Post-int	51	13.00 (4.75)	42	13.42 (4.53)	-0.43 (-2.08, 1.22)	0.10	.603
1-mpost	29	10.48 (3.49)	32	11.62 (3.25)	1.70 (0.02, 3.37)	0.52	.047
3-m post	31	14.35 (6.42)	27	12.85 (4.72)	-1.21 (-3.44, 1.02)	0.27	.218
EFT-T							
Baseline	113	1.85 (1.43)	121	1.68 (1.42)			
Post-int	44	1.02 (1.32)	36	1.33 (1.28)	0.48 (-0.12, 1.08)	0.35	.115
GAD7							
Baseline	115	13.48 (4.39)	121	13.47 (4.37)			
Post-int	46	12.41 (4.73)	36	10.61 (6.08)	-0.67 (-2.86, 1.52)	0.13	.545
1-mpost	20	10.60 (3.43)	28	9.07 (4.11)	-1.73 (-3.60, 0.14)	0.51	.070
3-m post	31	10.74 (5.22)	18	10.33 (5.06)	-0.03 (-2.26, 2.40)	0.00	.975
MEPS							
Baseline	116	18.53 (6.75)	120	17.86 (7.65)			
Post-int	46	19.36 (8.22)	38	20.86 (9.39)	1.00 (-2.03, 4.03)	0.14	.512
1-mpost	25	21.08 (10.78)	31	23.58 (10.03)	1.40 (-3.30, 6.10)	0.16	.544
RRS-B							
Baseline	71	14.09 (3.24)	121	14.30 (3.22)			
Post-int	51	14.01 (3.55)	42	13.45 (3.50)	0.05 (-1.12, 1.22)	0.02	.923
1-mpost	29	13.79 (3.64)	32	13.43 (3.19)	-0.23 (-1.59, 1.13)	0.08	.733
3-m post	31	12.83 (4.04)	26	12.30 (3.72)	-0.22 (-1.92, 1.48)	0.06	.795

Note. The adjusted difference reflects the group x time interaction.

Table 2. continued...

Outcomes	Control Group		c-MeST Group		Adjusted difference (c-MeST - Control)		
	No.	Mean (SD)	No	Mean (SD)	Mean (95% CI)	Effect size	P value
RRS-R							
Baseline	117	12.81 (3.00)	122	12.89 (3.10)			
Post-int	52	13.32 (3.03)	42	12.50 (3.52)	-0.65 (-1.80, 0.50)	0.22	.264
1-mpost	29	14.10 (3.16)	32	12.21 (2.88)	-1.30 (-2.62, -0.02)	0.49	.054
3-m post	29	12.96 (3.02)	27	11.81 (2.73)	-0.71 (-2.05, 0.63)	0.27	.299
SIDAS							
Baseline	117	11.52 (10.84)	118	11.27 (10.40)			
Post-int	52	10.84 (9.56)	42	10.47 (12.19)	-1.07 (-4.06, 1.92)	0.14	.482
1-mpost	29	10.65 (10.15)	32	11.03 (12.56)	-2.13 (-5.65, 1.39)	0.30	.236
3-m post	31	7.67 (10.14)	27	9.74 (9.33)	-2.76 (-7.89, 2.37)	0.27	.293
WBSI							
Baseline	112	3.97 (0.49)	122	4.09 (0.53)			
Post-int	52	3.84 (0.42)	40	3.79 (0.65)	-0.12 (-0.36, 0.12)	0.20	.317
1-mpost	28	4.02 (0.41)	31	3.87 (0.58)	-0.17 (-0.40, 0.06)	0.37	.148
3-m post	28	3.55 (0.41)	27	3.57 (0.40)	-0.09 (-0.34, 0.16)	0.19	.458

Note: PHQ = Patient Health Questionnaire-9, AMT = Autobiographical Memory Test, COWAT = Controlled Oral Word Association Test, EFT-T = Episodic Future Thinking-Test, GAD = Generalized Anxiety Disorder Scale, MEPS = Means-End Problem Solving, RRS-B = Ruminative Response Scale – Brooding Subscale. RRS-R = Ruminative Response Scale – Reflective Subscale, SIDAS = Suicidal Attributes Scale, WBSI = White Bear Suppression Inventory. The adjusted difference reflects the group x time interaction.