Identifying the most effective strategies for improving autobiographical memory specificity and its implications for mental health problems: A meta-analysis

Abstract

The purpose of this study was to evaluate and compare the efficacy of psychological interventions, used to enhance autobiographical memory specificity, on their therapeutic targets. A systematic search identified 22 studies with 27 therapeutic effect sizes meeting the criteria for inclusion. The results showed that the aggregated effect size for all included interventions was computed as $g = 1.08$, $p < 0.001$, 95% CI [0.72, 1.44] for post-test assessments of autobiographical memory specificity, and $g = 0.78$, $p < 0.001$, 95% CI [0.44, 1.13] for the follow-up assessments. No significant moderating effects were found for number of sessions and age in post-test and follow-up assessments. However, the duration of follow-up assessments significantly moderated the effects of the interventions on autobiographical memory specificity ($b = -.17$, $p = 0.01$). Medium to large aggregated effect sizes were computed for improving depressive symptoms ($g = 0.34$, $p < 0.01$), life satisfaction ($g = 0.80$, $p < 0.05$), and executive function ($g = 1.03$, $p < 0.01$) for post-test assessments. At follow-up, no significant effects were found for the included mental health outcomes. Based on the results, Memory Specificity Training (MEST) can be suggested as the most effective short-term intervention for improving the specificity of autobiographical memory. However, the results of this meta-analysis challenge the recommendation of using autobiographical memory-based interventions as standalone therapies to improve mental health problems. Moreover, the lack of a sufficient number of high quality RCT studies is a major gap in this research field. The implications for future studies are discussed.

Keywords: autobiographical memory specificity; meta-analysis; mental health; psychological intervention

Introduction

Recent research suggests that short-term interventions targeting impairments in autobiographical memory can be more cost-effective than current cognitive and behavioral therapies for improving some mental health problems, such depressive disorders (Barry, Sze, & Raes, 2019; Hitchcock, Werner-Seidler, Blackwell & Dalgleish, 2017). Autobiographical memory, refers to a memory system including all memories of events that people have experienced in their past. In other words, it is the ability to remember personal experiences and events of one's own life generally and with details (Lapidow & Brown, 2016). Specific autobiographical memories are related to a specific place and time, and their duration is not more than a day. These memories can be either personally important or not; recent or related to a long time ago (Williams et al., 2007).

Lack of specificity of autobiographical memory is associated with various psychopathologies including depression (Dalgleish et al., 2007; Kuyken, Howell, & Dalgleish, 2006; Spinhoven et al., 2006), posttraumatic stress disorder (Crane et al., 2014; Kleim, & Ehlers, 2008) and delayed recovery from affective disorders (Dalgleish, Spinks, Yiend, & Kuyken, 2001; Peeters, Wessel, Merckelbach, & Boon-Vermeeren, 2002). In addition, non-specific autobiographical memories significantly predict poor social problem-solving ability (Arie, Apter, Orbach, Yefet, & Zalzman, 2008; Williams, Barnhofer, Crane, & Beck, 2005), hopelessness (Arie, et al., 2008), and disordered thinking about the future (Brown et al., 2013).

The link between autobiographical memory specificity and the above-mentioned mental health problems have been explained by past theory in different ways. The link between autobiographical memory and mood/emotional disorders can be explained by rumination (i.e., repetitive automatic negative thoughts) [Raes et al., 2005; Watkins &

Teasdale, 2001]. According to the theoretical explanation called the CaR-FAX [1]model (Conway & Pleydell-Pearce, 2000; Williams et al., 2007), recalling autobiographical memories follows a hierarchical pattern based on the level of specificity of memories. Accordingly, the process of recalling a memory starts with searching amongst conceptual general memories, and at the next step the search can be focused on specific episodic memories (i.e., including specific times and places). Chronic rumination is one of the factors that can disturb this process because ruminations are general in their content and can lead the person to move across general memories instead of moving down to search for specific memories (Dalgleish & Werner-Seidler, 2014). As such, frequent ruminations can reduce the chance of recalling specific memories, and conversely, high levels of autobiographical memory specificity can decrease the tendency for depressive ruminations (Raes et al., 2006; Raes, et al., 2009; Werner-Seidler, & Moulds, 2012).

Cognitive avoidance is another factor that can explain the link between autobiographical memory specificity and mental health problems based on the CaR-FAX model (Conway & Pleydell-Pearce, 2000). As posited by Williams et al. (2007), inhibiting access to specific autobiographical memories can be an avoidant style of emotion regulation, especially amongst traumatized people. Accordingly, when individuals are reminded of negative memories, their autobiographical memories (including negative, positive, or neutral memories) can become over-general. In this condition, the process of the memory search is focused only on over-general memories, and consequently traumatic memories no longer can be recalled specifically (Dalgleish & Werner-Seidler, 2014). The bases of this assumption have been confirmed through several research studies (Raes, et al., 2009; Stokes, Dritschel, & Bekerian, 2004; Wessel, Merckelbach, & Dekkers, 2002).

[1] CaR = capture and rumination; FA = functional avoidance; X = impaired executive capacity and control

When autobiographical memory is not specific, cognitive avoidance and ruminations can exist at the same time, and each of them or both together can disturb executive functions such as concentration, attention, and cognitive inhibition (Dalgleish & Werner-Seidler, 2014). In addition, lack of the specificity of autobiographical memory is associated with difficulties in problem solving, planning and hope about the future because all of these factors require specific access to past memories (Dalgleish & Werner-Seidler, 2014; Arie, et al., 2008; Williams et al., 2005).

Considering the mutual relationships between low autobiographical memory specificity and various psychopathologies, a number of past studies hypothesized that an improvement of autobiographical memory specificity may lead to improving some types of psychopathologies such as depression (Raes, et al, 2009; Serrano Selva et al., 2012). Although a considerable number of studies have been done to evaluate this hypothesis, there still remain a few important questions in this field of study. Firstly, it is not clear which therapeutic approach can be considered as the most effective and cost-effective approach to improve autobiographical memory specificity. Moreover, it has been claimed that autobiographical memory-based interventions can be used as standalone therapies to improve mental health problems due to their direct effect on the specificity of autobiographical memory (Dalgleish et al, 2014; Latorre et al, 2015; Moradi et al., 2014; Neshat-Doost et al, 2013; Serrano, Latorre, Gatz & Montanes, 2004). The results of past studies are very controversial with ongoing debate regarding its standalone utility.

Two recent meta-analyses (Barry, et al, 2019; Hitchcock, et al, 2017) have investigated the effects of a number of autobiographical memory-based interventions on a few cognitive and emotional factors. However, the results of these meta-analyses cannot answer the above-mentioned questions. In the meta-analysis of Hitchcock, et al. (2017), the effects of autobiographical memory-based interventions on some types of emotional

problems were investigated, and a significant aggregated effect on depression was found (d = 0.32; $p < .05$). However, the effect of these interventions on specificity of autobiographical memory was not evaluated. The moderating effects of potential moderators (e.g., age, number of session, type of population, active vs passive control group, group vs individual sessions) on the target outcomes were not statistically investigated. In addition, the therapeutic outcomes of different types of interventions were not statistically compared, and the included populations were limited to clinical patients. Hitchcock, et al. (2017) analyzed the pooled effect of autobiographical memory-based interventions on post-test assessments of depression; however, there are a considerable number of other aspects of mental health problems that have been targeted by these interventions. Also, it is possible to investigate the follow-up effect sizes of these interventions on depressive symptoms through a meta-analysis.

The results of a more recent meta-analysis (Barry, et al., 2019) showed that the therapeutic approach called Memory Specificity Training (MEST) has a significant aggregated effect on improving depressive symptoms (d = 0.29) and autobiographical memory specificity (d = 1.08). In addition to the points mentioned for the meta-analysis of Hitchcock et al (2017), the study of Barry et al. (2019) focused on only one therapeutic approach. Moreover, both of the meta-analyses, considered the aggregated effect size of Cohen's d. Less biased results can be achieved with only including studies with control groups and using less biased statistic of Hedges's g for computing aggregated effect sizes (Borenstein, Hedges, Higgins, & Rothstein, 2009).

Our meta-analysis addresses a number of the current research gaps by including: a larger number of studies as compared to previous meta-analyses; additional mental health factors that are theoretically related to autobiographical memory specificity investigated as

therapeutic targets; and, follow-up assessments to investigate the maintenance of treatment effects in the months after the intervention has ended.

Overall, the current meta-analysis aims to identify the most effective strategies to improve autobiographical memory specificity that are also cost-effective in different clinical and non-clinical populations. In this study, we have not conducted a cost-effectiveness analysis, but our analyses can help to recognize the therapeutic approaches that can largely improve autobiographical memory specificity within a smaller number of therapeutic sessions. This meta-analysis also specifically investigates whether effective strategies for autobiographical memory specificity are sufficiently effective on other related mental health problems (as it is claimed in the past literature). In this study, all potential moderating effects (based on available data in the included studies) have been statistically investigated. The results of this meta-analysis help to clarify the potential contribution that autobiographical memory-based therapies can have to develop cost-effective interventions for mental health problems.

Methods

Literature Search

Several databases were searched to identify English articles that were appropriate for our meta-analyses. These databases were PsychINFO, Pubmed, MEDLINE, PILOTS, Scopus, ProQuest, ScienceDirect, Embase, Wiley Online, SpringerLink, Sage Journals, Web of Science, and Google Scholar. The search was conducted in 2019 and no time limitation was considered for any of the databases. Also, we checked the research history and references in each included article to find and search for other related peer-reviewed papers. All related keywords were considered in the search including *psychological intervention, psychological treatment, psychotherapy, autobiographical memory specificity, specific memory,* and other similar worlds relating to autobiographical memory studies including names of all included therapeutic approaches. We did not register a review protocol prior to this meta-analysis.

The inclusion criteria for the meta-analysis were as follow: (a) the interventions consisted of psychological therapeutic or educating methods, (b) the participants did not have a brain or neurological disorder (c) studies had a control group [with an experimental or quasi-experimental design] (d) studies have been reported as peer-reviewed articles, (e) quantitative analyses were used to report results of interventions, (f), sufficient statistics to compute the effect size of Hedges' *g* were reported. The process of data extraction is presented in Figure 1. Initially with investigating titles and abstracts, 88 peer-reviewed articles were identified through the searches. By reviewing the manuscripts, 66 were excluded because they did not use a psychological intervention (e.g. conducting experiments not interventions), their participants were patients with brain injuries or neurological disorders, their target dependent variable was not autobiographical memory specificity, they did not present sufficient statistics, and/or they did not have a control group. The final sample included 22 studies with 27 therapeutic effect sizes (N = 1064 individuals).

Therapeutic Plans of the Included Interventions

The methods for improving autobiographical memory specificity were similar across most of the interventions as they were focused on a few simple cognitive tasks during treatment sessions. Moreover, they assigned homework tasks for recalling past memories as specifically as possible. Another similarity between these interventions was that all were short-term (10 sessions or less). However, a few differences were identified across the interventions that are explained in the following paragraphs. Eleven therapeutic approaches were included in this meta-analysis. The therapeutic plan of each approach is briefly reviewed in this section.

The intervention called event-specific memory training (Ricarte, Hernández-Viadel, Latorre, & Ros, 2012), was a group intervention that followed the basic steps of: providing psycho-education about autobiographical memory specificity; reviewing positive specific

memories from various developmental periods of clients' lives (e.g. childhood, adolescence); providing feedback and corrections from therapists and group members; and completing homework tasks to recall specific memories. These strategies were also followed by some other studies, but they were different in some aspects of their interventions. For instance, specific positive events training (Ricarte, Hernández-Viadel, Latorre, Ros, & Serran, 2014) was an individual therapy and only focused on positive memories (not neutral or negative ones). In the group intervention called Cognitive Remediation Therapy (CRT) combined with Cognitive Behavioral Therapy (CBT) [Blairy et al., 2008], the participants were not limited to recall specific memories from special developmental periods. In addition, imagination about future, personal identity and memories related to each personal trait and social roles were addressed in the intervention. In Life Review Therapy (LRT), which was administered as either group or individual sessions [Chen et al, 2017; Gonçalves, Albuquerque, & Paul, 2009; Kleijn et al, 2018; Latorre et al, 2015; Leahy, Ridout, Mushtaq, & Holland, 2017; Serrano et al, 2004; Serrano Selva et al., 2012], structured questions were used to retrieve specific positive memories from each developmental period. During MEST, which was conducted as either group or individual sessions (Leahy et al, 2017; Moradi et al., 2014; Neshat-Doost et al., 2013; Takano, Moriya, & Raes, 2017; Werner-Seidler et al, 2018) participants were helped to recall several specific positive, negative, and neutral memories from across their lifetime without any limitation regarding developmental periods. The positive psychology intervention (Ramírez, Ortega, Chamorro, & Colmenero, 2014) was a group intervention integrating life-review therapy with added components of a positive psychology approach (e.g., forgiveness and gratitude). In specific and traditional expressive writing (Maestas & Rude, 2012), participants were asked to write about some of their deepest thoughts and emotions as well as related memories for each one. Both interventions were conducted as individual sessions, and the only difference between them was that in specific writing,

participants were prompted to concentrate on details of their memories. Memory flexibility training (Leahy, Ridout, & Holland, 2018) was an individual intervention based on the procedure of MEST, but it included some practices concerning attentional bias towards negative memories. During these practices, participants should selectively recall either positive or negative memories or either general or specific memories based on the predefined instructions.

Some of the included interventions in this meta-analysis had different therapeutic plans compared to the previously described interventions. Concreteness training (Mogoaşe, et al, 2013) was not directly focused on recalling specific memories. Instead, it included some daily practice through an individual intervention to have detailed and clear imaginations based on a few written scenarios. Mindfulness-Based Cognitive Therapy (MBCT) interventions (Jermann et al, 2013; Hargus et al, 2010; Heeren, Van Broeck, & Philippot, 2009; Williams, Teasdale, Segal, & Soulsby, 2000) were group therapies based on the typical approach of MBCT, and were not only focused on autobiographical memory. Despite the differences across interventions, all included studies targeted and measured changes in autobiographical memory specificity, and therefore are relevant for inclusion in the current study.

Coding of Studies

Two independent coders coded studies, included in this meta-analysis, and inconsistencies between the two coders were solved by consensus. We coded included studies based on: (a) type of intervention, (b) type of population (i.e., clinical vs non-clinical), (c) number of sessions (d) age, (e) sample size, (f) having/not having follow-up assessments, and (g) the duration of follow-up assessment.

Figure 1 should be inserted about here

Most of the included studies used the Autobiographical Memory Task (AMT) to assess autobiographical memory specificity. The test is a well-known and valid test designed by Williams and Broadbent (1986). It consists of an equal number of positive, negative and neutral cue words that are presented to respondents. Respondents are requested to retrieve a personal memory located in a specific time, which is related to the presented word (Lapidowa & Brownb, 2016). The results of past studies have shown that the valence of cue words in AMT (positive/neutral or negative) does not have a moderating effect on the specificity of memories (Kuyken et al., 2006; Spinhoven et al., 2006; Williams et al., 2007). Amongst all the included studies only two studies used valid instruments other than AMT to measure autobiographical memory specificity. Chen et al. (2017) used Mental Time Travel (MTT) test and Hargus et al. (2010) used relapse signature specificity measure. The both test were developed based on AMT and had similar scoring system.

In terms of measurements related to mental health problems, Beck Depression Inventories (Blairy, et al, 2007; Chen et al, 2017; Hargus et al, 2010; Jermann et al, 2013; Maestas & Rude, 2012; Mogoase et al, 2013; Moradi et al, 2014; Ramírez et al, 2014; Ricarte et al, 2012; Ricarte et al, 2014; Werner-Seidler et al, 2018), Hospital Anxiety and Depression Scale (Kleijn et al, 2018; Leahy et al, 2017), Center for Epidemiologic Studies-Depression (Latorre et al, 2015; Serrano et al, 2004; Takano et al, 2017), Mood and Feeling Questionnaire (Neshat-Doost et al, 2013), Hamilton Rating Scale for Depression (Williams et al, 2000), and Geriatric Depression Scale (Gonçalves et al, 2008; Serrano et al, 2012), were used for assessing depressive symptoms. Other measurements were as follows: Beck Hopelessness Scale (Serrano et al, 2004; Serrano et al, 2012) for hopelessness; Rumination/Reflection Questionnaire (Jermann et al, 2013) and Ruminative Response Scale (Maestas & Rude, 2012; Mogoase et al, 2013; Ricarte et al, 2014; Werner-Seidler et al, 2018) for rumination; Verbal Letter Fluency Task (Blairy, et al, 2007), Verbal Fluency Tasks

(Heeren et al, 2009), FAS test (Latorre et al, 2015), Controlled Oral Word Association Test (Werner-Seidler et al, 2018), and Trail Making Test (Chen et al, 2017) for executive function; the Satisfaction with Life Scale (Chen et al, 2017), Life Satisfaction Scale (Ramírez et al, 2014), and Life Satisfaction Index (Gonçalves et al, 2008; Latorre et al, 2015; Serrano et al, 2004; Serrano et al, 2012) for life satisfaction; Means End Problem Solving Procedure (Leahy et al, 2017; Werner-Seidler et al, 2018) for social problem solving; White Bear Suppression Inventory (Maestas & Rude, 2012) and Cognitive Avoidance Questionnaire (Werner-Seidler et al, 2018) for cognitive avoidance.

For methodological quality assessment, we coded all included studies in the meta-analysis based on a valid quality assessment scale (Jadad et al., 1996). The results are shown in Table 1. These results show that most of the included studies have achieved high scores based on the scale of quality assessment for randomized controlled trials (Jadad et al., 1996). Only five studies (Chen et al, 2017; Gonçalves et al, 2008; Hargus et al, 2010; Heeren et al, 2009; Mogoase et al, 2013; Ramírez et al, 2014) from the twenty two studies achieved a score less than three from a potential score of five. However, it does not mean that these studies cannot be included in the meta-analysis. It is important to note that this scale is not an inclusion criterion for this meta-analysis, nor is it considered a necessary exclusion or inclusion criteria for meta-analytical assessments in general (Borenstein et al, 2009). We used the scale in this study in order to provide an overview of the quality of the studies included in this meta-analysis.

Table 1 should be inserted about here

Statistical Analysis

The meta-analysis of this study has been computed based on Hedge's *g* statistics. This statistic is calculated using mean differences and pooled standard deviations. Mean

Difference Effect Sizes through a random-effects model was used to compute effect sizes and potential moderators. Random Effects analysis is recommended when the results of several random samples should be generalized to a broader population (Hedges and Vevea, 1998).

We used meta-regression to evaluate the proposed continuous moderators and subgroup analysis to investigate categorical moderators. The type of intervention, the mode of intervention (group vs individual sessions), the number of sessions, participants' age, the type of control condition (active vs passive), the duration of follow-up assessments, and the type of population (clinical vs non-clinical) were investigated as potential moderators. Clinical participants were defined by the included studies through clinical diagnoses and/or using a cut-off point score on a self-reported measure.

It is important to note that we conducted moderator analyses only for autobiographical memory specificity as the main therapeutic target because there were a limited number of included studies for other dependent variables, and they were not sufficiently heterogeneous based on the considered moderators. For example, all of the included effect sizes for hopelessness were from clinical populations and older adults, which prohibited more nuanced examination of type of population and age.

Comprehensive Meta-Analysis (CMA; Biostat, 2019), Version 3, were used for the analyses. Moreover, for assessing the heterogeneity of effect sizes, we calculated *Q* statistics, and for examining publication bias we used Classic Fail safe *N* analysis to estimate how many studies with non-significant effects are required to reduce the computed aggregated effect size to a non-significant value ($p < .05$).

Results

Autobiographical memory specificity

The characteristics of all included studies are presented in Table 2. Two of the included studies (Chen et al, 2017; Moradi et al, 2014) did not compute a total score for

autobiographical memory specificity, and presented separate assessments for specific positive, negative, and neutral memories. Thus, we considered each assessment as a separate effect size because this meta-analysis is only focused on the factor of specificity not the emotional content of memories. In addition, past research has shown that the valence (positive-negative) of memories does not have a significant effect on the specificity of autobiographical memory (Kuyken et al., 2006; Spinhoven et al., 2006; Williams et al., 2007). The test of heterogeneity was not significant ($Q = 32.86$, $p > .05$ for post-test; & $Q = 16.90$, $p > .05$ for follow-up assessments), which means that we can consider all the included assessments as related to the same dependent variable which was autobiographical memory specificity. This also indicates that the aggregated effect sizes can be generalized to all of the included studies.

Table 2 should be inserted about here

Considering all the included studies in the meta-analysis, the aggregated effect size was $g = 1.08$, $p < 0.001$, 95% CI [0.72, 1.44] for post-test assessments, and $g = 0.78$, $p < 0.001$, 95% CI [0.44, 1.13] for follow-up assessments of autobiographical memory specificity as dependent variable. Both the aggregated effect sizes are considered large effects, based on Cohen's interpretation (Cohen, 1992). Figure 2 and Figure 3 provide forest plots for post-test and follow-up assessments, respectively. Based on classic fail-safe *N* analysis (Rosenthal, 1979; 1991), 1417 studies for post-test, and 208 studies for follow-up assessments, with non-significant results would be required to decrease the effect sizes to a non-significant value.

The results of the meta-regression analysis based on post-intervention assessments of autobiographical memory specificity, showed that the moderating effect of number of session ($b = 0.11$, $SE = 0.07$, $p = .12$) and age ($b = 0.005$, $SE = 0.008$, $p = 0.51$) were not significant. At follow-up there were no significant moderating effects for the number of sessions ($b = -0.07$, $SE = 0.08$, $p = .36$) and age ($b = -0.01$, $SE = 0.007$, $p = 0.08$). However, a significant

small moderating effect was computed for the duration of follow-up assessments (b = -0.17, SE = 0.06, p = 0.01). Accordingly, longer follow-up assessments are associated with smaller effect sizes for improving autobiographical memory specificity.

Figure 2 should be inserted about here

The results of subgroup analyses for post-test assessments showed a significant moderating effect for type of intervention on improving autobiographical memory specificity (Q = 124.65, p < 0.001). Accordingly, the largest aggregated effect size belonged to MEST (g = 1.63, p < 0.001). The moderating effect of the type of population (clinical vs non-clinical) on improving autobiographical memory specificity was not significant (Q = 0.66, p = 0.41). According to the result, the included interventions can be effective equally for both clinical and non-clinical populations. The mode of intervention (group vs individual sessions) had a significant moderating effect on autobiographical memory specificity (Q = 13.11, p < 0.001). Based on this finding, the aggregated effect size of group interventions (g = 1.57, p < 0.001) was significantly larger than the effect of individual interventions (g = 0.45, p < 0.001). Moreover, type of control condition (active vs passive) significantly moderated the effects of the interventions on autobiographical memory specificity in post-test assessments (Q = 6.13, p = 0.01). Accordingly, interventions with passive control groups significantly showed larger effect sizes (g = 1.78, p < 0.001) than interventions with active control groups (g = 0.81, p < 0.001).

Figure 3 should be inserted about here

In terms of follow-up assessments, the results of subgroup analyses showed a significant moderating effect for the type of intervention on improving autobiographical memory specificity (Q = 11.45, p < 0.04). Based on the results, MEST had the largest effect size (g = 1.34, p < 0.001). This result was consistent with post-test results. The moderating

effect of type of population (clinical vs non-clinical) on autobiographical memory specificity was not significant ($Q = 1.58$, $p = 0.20$) according to which there is no difference between the efficacy of the included interventions on autobiographical memory specificity in clinical and non-clinical populations based on follow-up assessments. This result was consistent with post-test assessments. The moderating effect of the mode of intervention (group vs individual sessions) on autobiographical memory specificity was not significant in follow-up assessments ($Q = 0.59$, $p = 0.44$). In addition, the type of control condition (active vs passive) had a significant moderating effect on improving autobiographical memory specificity in follow-up assessments ($Q = 10.73$, $p = 0.001$). Accordingly, interventions with passive control group showed significantly larger effect sizes ($g = 1.93$, $p < 0.001$) than the interventions with active control group ($g = 0.51$, $p < 0.001$).

In the following sections, the efficacy of the included studies on their other therapeutic targets are investigated. All of these variables have been considered related variables to autobiographical memory specificity. A summary of all the secondary outcomes is provided in Table 3. In addition, for most of these variables it was not possible to present meta-analytical results for the follow-up assessments due to a lack of sufficient number of effect sizes (i.e., at least two).

Table 3 should be inserted about here

Depressive symptoms

In terms of depressive symptoms, 23 effect sizes for post-test and 13 effect sizes for follow-up assessments were included. The aggregated effect size was $g = 0.34$, $p = 0.002$, 95% CI [0.12, 0.55] for post-test assessments, and $g = 0.05$, $p = .57$, 95% CI [-0.12, 0.22] for follow-up assessments. There was no heterogeneity for either post-test ($Q = 28.99$, $p > .05$) or follow-up assessments ($Q = 12.78$, $p > .05$). Based on Cohen's interpretation (Cohen, 1992),

the aggregated effect size for post-test assessments of depressive symptoms is considered between small and medium.

The same studies, included for depressive symptoms, had large significant effects on autobiographical memory specificity for both post-test (g = 1.02, p = < .001) and follow-up assessments (g = 0.78, p = < .001). Thus, the concurrent effects on depressive symptoms and autobiographical memory specificity is consistent for post-test, but not for follow-up assessments.

Rumination

With regard to rumination, six effect sizes for post-test and two effect sizes for follow-up assessments were included. The aggregated effect sizes were not significant for either post-test (g = -0.05, p = 0.54, 95% CI [-0.24, 0.12]) or follow-up assessments of rumination (g = -0.14, p = .60, 95% CI [-0.68, 0.39]). There was no heterogeneity for post-test (Q = 3.80, p > .05) or follow-up assessments of rumination (Q = 1.00, p > .05).

The included studies for rumination did not have a significant aggregated effect on autobiographical memory specificity for post-test (g = 0.17, p = 0.45) or follow-up assessments (g = 0.33, p = 0.51). Thus, the concurrent effects on rumination and autobiographical memory specificity were consistent for both post-test and follow-up assessments.

Hopelessness

Considering hopelessness, only two effect sizes for post-test assessments were included. The summary effect for hopelessness was not significant (g = 0.76, p = 0.09, 95% CI [-0.14, 1.66]), and there was no significant heterogeneity for the computed summary effect (Q = 1.00, p > .05). The effect is considered large (Cohen, 1992), but due to the limited number of included studies the statistical power is low, and a larger effect size is required to confirm a significant effect on hopelessness. There was a significant aggregated effect on

autobiographical memory specificity (g = 0.60, p = 0.02), indicating the concurrent effects on hopelessness and autobiographical memory specificity were not consistent.

It is important to note that although both of the aggregated effect sizes for hopelessness and autobiographical memory specificity were based on the same sample size, the variance and standard error computed for autobiographical memory specificity ($S^2 g$ = 0.07, SE g = 0.26) were considerably less than the computed statistics for hopelessness ($S^2 g$ = 0.21, SE g = 0.46). This explains why the aggregated effect for autobiographical memory was significant despite the small sample size.

Social problem-solving

Four effect sizes for post-test and three effect sizes for follow-up assessments of social problem solving were included in the meta-analyses. No significant aggregated effect size was found for either post-test (g = 0.35, p = 0.06, 95% CI [-0.01, 0.71]) or follow-up assessments (g = 0.35, p = 0.09, 95% CI [-0.06, 0.76]). The effect sizes of both post-test (Q = 3.03, p > .05) and follow-up evaluations (Q = 2.00, p > .05) were not heterogeneous.

The concurrent effects of the included studies on autobiographical memory specificity showed a medium significant summary effect for post-test assessments (g = 0.60, p = 0.004). However, the aggregated effect was not significant for follow-up assessments of this variable (g = 0.24, p = 0.18). According to these results, the concurrent effects of the included studies on autobiographical memory and social problem solving were consistent only at follow-up assessments.

Cognitive avoidance

Only three effect sizes were included for the post-test assessments of cognitive avoidance. The aggregated effect size for cognitive avoidance was not significant (g = 0.12, p = 0.27, 95% CI [-0.09, 0.33]). There was no significant heterogeneity for the summary effect (Q = 1.98, p > .05). A trivial and non-significant summary effect was computed for the effect

of the same studies on autobiographical memory specificity in post-test stage ($g = 0.01$, $p = 0.97$). Accordingly, the concurrent effects on autobiographical memory specificity and cognitive avoidance are consistent.

Life satisfaction

In terms of life satisfaction, six effect sizes for post-test results were included. The aggregated effect size for life satisfaction was large and significant ($g = 0.80$, $p = 0.03$, 95% CI [0.07, 1.53]). No significant heterogeneity was found for this summary effect ($Q = 5.26$, $p > .05$). The same studies showed a large significant aggregated effect for post-test assessments of autobiographical memory specificity ($g = 1.57$, $p < 0.001$). Accordingly, the concurrent effects on autobiographical memory specificity and anxiety are consistent.

Executive function

In terms of executive function, five effect sizes were included for post-test results. The aggregated effect size for executive function was large and significant ($g = 1.03$, $p = 0.009$, 95% CI [0.25, 1.80]), and there was no evidence of a significant heterogeneity for the computed summary effect ($Q = 3.75$, $p > .05$).

The same studies had a large but non-significant aggregated effect ($g = 1.13$, $p = 0.12$) on autobiographical memory specificity. This can be due to the limited number of included studies, small sample size, and consequently low statistical power. However, the same studies with the same sample size had a large and significant effect on executive function. This difference is due to smaller variance and standard error for the aggregated effect of executive function ($S^2 g = 0.15$, SE $g = 0.39$) compared with these statistics for the aggregated effect of autobiographical memory specificity ($S^2 g = 0.54$, SE $g = 0.73$). As such, the result highlights the inconsistency between the concurrent effects of these studies on autobiographical memory specificity and executive function.

Discussion

The improvement of autobiographical memory specificity

In this study, we conducted a meta-analysis of effects of different psychological interventions on autobiographical memory specificity amongst various clinical and non-clinical populations. The overall effect size was large for both post-intervention and follow-up assessments (on average at four months follow-up) indicating a successful effect of the psychological interventions on autobiographical memory specificity that can last at least for a few months after the intervention. The results are consistent with the findings of a recent meta-analysis (Barry, et al., 2019) showing interventions with a MEST approach have a large aggregated effect on autobiographical memory specificity. However, the major difference between the previous meta-analysis and our meta-analysis is that in this meta-analysis, the included studies were not limited to a specific approach such as MEST. Instead, 11 different therapeutic approaches were included in this meta-analysis. The aggregated effect size for autobiographical memory specificity was not heterogeneous, which implies all of the therapeutic approaches can significantly improve autobiographical memory. However, based on our comparative analyses for both post-intervention and follow-up effects, we argue that MEST is the most effective approach for improvement of autobiographical memory specificity compared with other included approaches. This is unsurprising given it is the specific, intended target of change for MEST.

With regard to this finding, MEST has several advantages over many other therapeutic protocols included in this meta-analysis. These advantages are: being short-term (average session number = five); including group activities and homework, and using flexible methods of recalling autobiographical memory (i.e., not using fully structured and repetitive methods of recalling memories). The results of this meta-analysis confirm the recommendation of the founders of MEST. That is MEST can be considered as one of the

most effective short-term therapeutic methods to improve the specificity of autobiographical memory (Barry, et al., 2019; Dalgleish et al, 2014; Neshat-Doost et al, 2013; Raes, et al., 2009). Before this meta-analysis, no meta-analytical study had investigated the efficacy of MEST compared with other therapeutic approaches on autobiographical memory specificity. It is important to note that some of the included interventions in this meta-analysis (e.g., MBCT interventions) did not theoretically assert that their therapeutic approach can be the best strategy for improving autobiographical memory specificity. However, based on our inclusion criteria we included every intervention that had chosen autobiographical memory specificity as a therapeutic target. Following this inclusion strategy, our results highlighted that interventions specifically designed for autobiographical memory specificity (e.g., MEST) can be significantly more effective than classic interventions such as MBCT which are focused on multiple factors without a specific focus on autobiographical memory.

What can moderate the therapeutic effects on autobiographical memory specificity?

The results of the moderator analyses revealed that age, number of sessions, and treatment population (clinical or non-clinical) cannot moderate the large effect computed for all of the included studies on autobiographical memory specificity. These results show that even a limited number of therapeutic sessions based on the included approaches can result in effects in autobiographical memory specificity that can be maintained at least for a few months. These results also show that the included interventions can be effective for various ages (from adolescents to older adults), and both clinical and non-clinical populations can equally benefit from these interventions.

However, there are a number of moderators that can significantly moderate the efficacy of the included interventions on autobiographical memory specificity. Accordingly, longer follow-up assessments are associated with smaller effect sizes. This suggests some

loss of treatment effect over time though the aggregated effect size computed for follow-up assessments is still large.

Based on the results of moderator analyses, group interventions had significantly larger post-intervention effect sizes for autobiographical memory specificity than individual interventions. This finding is consistent with the recommendation of past literature according to which memory-based interventions can be more effective when they are presented through group therapy (Raes et al, 2009). However, the moderating effect was not significant at follow-up. These results show that although group interventions may have some advantages over individual interventions in short-term efficacy on autobiographical memory specificity (e.g., helpful feedback and discussion on practices and training), this does not result in a significant difference for the follow-up effects (on average at four months).

We only included studies with a control group and considered less biased statistics because one of the main aims of this meta-analysis was to compute unbiased results. However, it is possible that recruiting passive control groups results in computing exaggerated and biased effect sizes. The results of moderator analyses confirmed this possibility. Accordingly, the aggregated effect sizes for both post-test and follow-up assessments were significantly smaller when we considered studies with active control groups (treatment as usual or placebo interventions) compared to interventions with passive control groups (wait-list). These findings highlight that any large effect on autobiographical memory specificity should be interpreted more conservatively when the study has not used an active control group.

Improvement of cognitive and emotional symptoms related to depression

The studies included in this meta-analysis hypothesized that an intervention-related increase in autobiographical memory specificity can indirectly result in a significant improvement in other mental health problems. The basic rationale of this assumption was the

evidence-based links between autobiographical memory specificity and various aspects of mental health. For investigating this hypothesis through a meta-analysis, it was necessary to consider concurrent effects of these interventions on autobiographical memory specificity and mental health problems. For example, according to this hypothesis, an intervention having a large effect on autobiographical memory specificity is expected to have a significant effect on depressive symptoms at the same time. Any considerable inconsistency between these two effects can lead to rejecting the hypothesis.

A recent meta-analysis (Hitchcock et al, 2017) reported a significant summary effect for the efficacy of autobiographical memory-based interventions on depression. With including a higher number of studies (21 compared to 12 in the previous meta-analysis), we computed a similar aggregated effect to the summary effect reported in the meta-analysis of Hitchcock et al. (2017). In both meta-analyses, the aggregated effects are considered between small and medium. However, in our study, the effect size decreased to a non-significant trivial effect in follow-up assessments. If the effect of these interventions on depressive symptoms was related to their effect on autobiographical memory specificity, we should find similar and consistent therapeutic effects for both variables. However, the concurrent effect of the included interventions on autobiographical memory specificity was large in both post-test and follow-up assessments. This implies that improving autobiographical memory specificity can be associated with an improvement in depressive symptoms in the short-term, but not for the long-term. Opposite to what has been suggested in past literature (Dalgleish et al, 2014; Latorre et al, 2015; Neshat-Doost et al, 2013; Serrano, Latorre, Gatz & Montanes, 2004), this analysis suggests autobiographical memory-based interventions should not be introduced as standalone alternatives to current effective psychotherapies for depression. Based on our results, improving autobiographical memory specificity can contribute to short-term therapeutic effects for depressive symptoms, but a long-term significant improvement

may be achieved through more comprehensive interventions with a higher number of therapeutic sessions. As highlighted by past research, the most effective psychological interventions for depressive symptoms are those psychotherapies addressing various cognitive, emotional and behavioral aspects related to depression (Linde et al, 2015).

The results of this meta-analysis also indicated that the studies that included rumination as a therapeutic target have not been effective in improving rumination in both post-test and follow-up assessments. Similarly, these studies did not have a strong aggregated effect on autobiographical memory specificity. Therefore, we cannot reject the claim of past research according to which a considerable improvement in autobiographical memory specificity can lead to a significant decrease in rumination. Considering our findings, the insignificant effect on rumination can be explained by the lack of a large effect on autobiographical memory specificity. It is still likely that a large effect on autobiographical memory specificity may be associated with a significant improvement in rumination. This possibility is supported by past research showing a significant negative relationship between these two variables (Raes et al., 2005; Watkins & Teasdale, 2001). However, our findings related to rumination are only based on a limited number of effect sizes (6 at post-test and 2 at follow-up), while many studies with large effects on autobiographical memory specificity could not be included because of a lack of any assessment of rumination. Thus, this finding needs to be replicated in future studies by including both autobiographical memory specificity and rumination as therapeutic targets.

In terms of hopelessness, the effects of the included studies on this variable and autobiographical memory specificity were not consistent. It is theorized that an improvement in the specificity of autobiographical memory can be associated with an improvement in hopelessness (Raes et al., 2009; Arie, et al., 2008; Serrano Selva et al., 2012). Our findings showed that the interventions that are significantly effective on autobiographical memory

specificity did not significantly improve hopelessness at the same time. Although based on past research autobiographical memory specificity can be considered as a capacity for hope (Arie, et al., 2008), our results suggest that this factor may not be adequate for a significant reduction of hopelessness. There are some other cognitive factors such as maladaptive beliefs that can directly affect hopelessness (Marchetti, 2019). As such, we argue that an effective intervention for hopelessness requires it to be comprehensive enough to work on all important cognitive predictors of hopelessness. However, it is important to note that only two studies were included for the analyses related to hopelessness. Therefore, these results need to be replicated in future controlled studies for a more robust conclusion.

The improvement of social problem-solving

Another hypothesis of the included studies was that effective interventions on autobiographical memory specificity can be significantly effective on improving social problem solving. This claim was based on the evidence-based relationship between autobiographical memory specificity and problem-solving ability (Madore & Schater, 2014; Pollock & Williams, 2001; Raes et al, 2005; Sutherland & Bryant, 2007; Williams, 1999). Our results did not support this hypothesis for post-test or follow-up assessments. However, the *p*-value = 0.06 for post-test aggregated effect, highlighted the possibility that the effect size could be significant with a higher statistical power and/or a larger effect. As a possible explanation, we assert that autobiographical memory-based interventions could affect social problem solving, but the intensity of the effect was not enough to achieve significant results. This finding suggests that interventions targeting social problem solving should consider other effective factors in addition to autobiographical memory specificity. The improvement of autobiographical memory specificity can only address the capacity of social problem solving, and a significant improvement in this skill also requires learning emotion regulation strategies and behavioral techniques (Nezu, Nezu, & D'Zurilla, 2013)

The improvement of cognitive avoidance

The efficacy of the included studies on cognitive avoidance was not confirmed in this meta-analysis. However, there were only two studies targeting cognitive avoidance and they did not have a significant concurrent effect on autobiographical memory specificity. Thus, the lack of efficacy on cognitive avoidance may be explained by the lack of sufficient efficacy on autobiographical memory specificity. This is consistent with past theory and research that indicates that when autobiographical memory system is not specific, the process of suppressing negative thoughts and memories can be facilitated (Williams, et al., 2007). However, it is still not clear whether an intervention-related improvement in autobiographical memory specificity can lead to a significant reduction in cognitive avoidance. Therefore, more research is needed to investigate this hypothesis with including interventions that are largely effective on autobiographical memory specificity.

The improvement of life satisfaction

The results of this meta-analysis showed that the interventions having a large effect on autobiographical memory specificity also can have a large effect on life satisfaction. The significant effect of the interventions on life satisfaction has been explained by the positive effects of autobiographical memory on reducing depressed mood (Chen et al, 2017; Gonçalves et al, 2009; Latorre et al., 2015; Serrano et al, 2004; Serrano Selva et al, 2012; Ramírez, 2014). However, it is important to note that we were not able to include follow-up assessments for these results. In addition, our other results showed that the effect of these interventions on depressive symptoms can be temporary (i.e., only significant for post-test and not follow-up). As such, if the interventions cannot have a long-term effect on depressed mood, it is possible that their effect for life satisfaction also may decrease to a non-significant level based on long-term follow-up assessments. This point requires clarification in future studies by replicating these results and also including follow-up assessments.

The improvement of executive function

Past theory and research suggest that the ability of recalling specific autobiographical memories is associated with an appropriate level of executive function (Williams et al., 2007). As such, the included studies in this meta-analysis hypothesized that a significant improvement in autobiographical memory specificity can result in a better performance in executive function. However, in our meta-analysis, the concurrent effects of the included studies on these two variables were not consistent. The studies targeting executive function had a significant large effect on this variable, but their aggregated effect on autobiographical memory specificity was not significant. This finding implies that factors other than autobiographical memory specificity might contribute to the improvement of executive function in those interventions. For example, most of the included effect sizes for executive function were related to interventions using mindfulness techniques that are evidence-based strategies to improve executive functioning (Mak, Whittingham, Cunnington, & Boyd, 2018). However, these techniques were not directly related to improving autobiographical memory specificity. This can explain why the included interventions were effective on executive function but not on autobiographical memory specificity. However, we cannot generalize this conclusion to all of autobiographical memory-based interventions because only three studies were included for this section of analysis. Further studies are required to replicate these results for a more robust understanding.

Conclusion

In conclusion, we argue that amongst interventions included in this meta-analysis, MEST can be suggested as an effective short-term intervention for improving autobiographical memory specificity. However, as a standalone intervention for mental health problems, MEST and other memory-based psychotherapies do not seem to be comprehensive enough. These interventions are only focused on autobiographical memory without including

other important cognitive and emotional factors contributing to the improvement of mental health problems. Therefore, despite the promising findings for autobiographical memory specificity, our results did not support the idea that standalone autobiographical memory-based interventions can have long-term effects on mental health problems. For depressive symptoms, life satisfaction, and executive functions, these interventions can have significant immediate effects, but there is no evidence supporting the long-term effects of autobiographical memory-based interventions on these variables. In addition, no significant post-intervention or follow-up effect was confirmed for rumination, hopelessness, social problem solving, and cognitive avoidance.

Based on the results of this meta-analysis we suggest that effective strategies for improving autobiographical memory specificity may work better for mental health problems if they are considered as supplementary therapeutic methods not standalone interventions. This is an important hypothesis that should be investigated by the future studies, and can help to develop more effective and cost-effective interventions for mental health problems such as depressive and stress-related disorders.

A limited number of intervention effects, especially for mental health problems, was the main limitation of this study. Based on the methodological recommendations related to the statistical methods we used (Borenstein, et al, 2009), we conducted meta-analytical evaluations for all variables having at least two effect sizes. We acknowledge that the statistical power of analyses with two or three effect sizes may not be adequate, but such findings can provide preliminary data that can guide future directions in research.

The results of the quality assessment in this meta-analysis showed that the lack of a sufficient number of high quality studies in this research field is still an important issue. Although the majority of the included studies in this meta-analysis had an acceptable quality

level, the total number of the included studies was still limited and more than one-fifth of the included studies had low quality. Therefore, this research field requires conducting a considerable number of high quality RCT studies with active control groups to consider the effects of an intervention on both autobiographical memory specificity and the related mental health variables (e.g., rumination, cognitive avoidance, life satisfaction). Such studies can replicate or clarify the preliminary findings discussed in this meta-analysis and also can provide enough data for further meta-analytical and moderator analyses.

Declarations of interest

None.

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Table 1

Methodological quality of studies included in the meta-analysis

Study	Described as randomized	Details of randomization are described	Described as double blind[1]	The method of double blinding are described	Withdrawal and dropouts are described
Blairy et al (2008)	No	No	Yes	Yes	Yes
Chen et al (2017)	Yes	No	No	No	No
Gonçalves et al (2008)	Yes	No	No	No	Yes
Hargus et al (2010)	Yes	No	No	No	Yes
Heeren et al (2009)	No	No	No	No	Yes
Jermann et al (2013)	Yes	No	Yes	Yes	Yes
Kleijn et al (2018)	Yes	Yes	No	No	Yes
Latorre et al (2015)	Yes	No	Yes	Yes	Yes
Leahy et al (2017)	Yes	Yes	Yes	Yes	Yes
Leahy et al (2018)	Yes	Yes	Yes	Yes	Yes
Maestas & Rude (2012)	Yes	No	Yes	Yes	Yes
Mogoase et al (2013)	Yes	No	No	No	Yes
Moradi et al (2014)	Yes	Yes	No	No	Yes
Neshat-Doost et al (2013)	Yes	Yes	No	No	Yes
Ramírez et al (2014)	Yes	No	No	No	Yes

Ricarte et al (2012)	Yes	Yes	Yes	Yes	Yes
Ricarte et al (2014)	Yes	Yes	Yes	Yes	No
Serrano et al (2004)	Yes	No	Yes	Yes	Yes
Serrano et al (2012)	Yes	No	Yes	Yes	Yes
Takano et al (2017)	Yes	Yes	No	No	Yes
Werner-Seidler et al (2018)	Yes	Yes	No	No	Yes
Williams et al (2000)	Yes	No	Yes	Yes	Yes

Note: The term “double” here refers to participants and analysts of data (not therapists)

Table 2

The effect sizes of included studies based on all inclusion criteria of the meta-analysis

Type of intervention	study	The type of population	Number of sessions	Age mean	Sample size	Follow-up	Duration of Follow-up
Concreteness training	Mogoase et al (2013) (Individual sessions)	Clinical	7	22.87	Ex= 20 P/Con= 21	No	-
CRT combined with CBT	Blairy et al (2008) (Group sessions)	Clinical	10	20	Ex= 15 A/Con= 12	No	-
Event-specific memory training	Ricarte et al (2012) (Group sessions)	Clinical	10	36.77	Ex= 24 A/Con= 26	No	-
LRT	Chen et al (2017) [Specific positive memory] (Group sessions)	Clinical	8	33.20	Ex= 25 A/Con= 25	No	-
	Chen et al (2017) [Specific neutral memory] (Group sessions)	Clinical	8	33.20	Ex= 25 A/Con= 25	No	-
	Chen et al (2017) [Specific negative memory] (Group sessions)	Clinical	8	33.20	Ex= 25 A/Con= 25	No	-
	Gonçalves et al (2008) (Individual sessions)	Clinical	4	80.70	Ex= 11 P/Con= 11	No	-
	Kleijn et al (2018) (Individual sessions)	Non-clinical	4	62.70	Ex= 38 P/Con= 39	No	-
	Latorre et al (2015) (Individual sessions)	Non-clinical	6	65.35	Ex= 29 A/Con= 26	No	-
	Leahy et al (2017) (Individual sessions)	Non-clinical	4	75.27	Ex= 21 A/Con= 22	Yes	3 months

	Serrano et al (2004) (Individual sessions)	Clinical	4	77.19	Ex= 20 A/Con= 23	No	-
	Serrano et al (2012) (Individual sessions)	Clinical	4	73.90	Ex= 8 A/Con= 6	Yes	6 weeks 6 months
MBCT	Jermann et al (2013) (Group sessions)	Clinical	8	46.80	Ex= 18 A/Con= 18	Yes	9 months
	Hargus et al (2010) (Group sessions)	Clinical	8	41.89	Ex= 14 A/Con= 13	No	-
	Heeren et al (2009) (Group sessions)	Non-clinical	8	54.28	Ex= 18 P/Con= 18	No	-
	Williams et al (2000) (Group sessions)	Clinical	8	44	Ex= 21 A/Con= 20	No	-
MEST	Neshat-Doost et al (2013) (Group sessions)	Clinical	5	14.88	Ex= 12 P/Con= 11	No	-
	Moradi et al (2014) [Specific positive memory] (Group sessions)	Clinical	4	45.29	Ex= 12 P/Con= 12	Yes	3 months
	Moradi et al (2014) [Specific negative memory] (Group sessions)	Clinical	4	45.29	Ex= 12 P/Con= 12	Yes	3 months
	Leahy et al (2017) (Group sessions)	Non-clinical	4	75.59	Ex= 22 A/Con= 22	Yes	3 months
	Takano et al (2017) (Individual sessions)	Non-clinical	7	20.00	Ex= 21 P/Con= 19	Yes	2 weeks
	Werner-Seidler et al (2018)	Clinical	5	41.77	Ex= 29	Yes	3 months

	(Group sessions)				A/Con= 26		
Memory flexibility training	Leahy et al (2018) (Individual sessions)	Non-clinical	8	75.55	Ex= 20 A/Con= 19	Yes	3 months
Positive psychology intervention	Ramírez et al (2014) (Group sessions)	Non-clinical	9	71.18	Ex= 26 A/Con= 20	No	-
Specific expressing writing	Maestas & Rude (2012) (Individual sessions)	Non-clinical	3	20.9	Ex= 72 A/Con= 68	Yes	6 months
Specific positive events training	Ricarte et al (2014) (Individual sessions)	Clinical	4	38.65	Ex= 16 A/Con= 16	No	-
Traditional expressive writing	Maestas & Rude (2012) (Individual sessions)	Non-clinical	3	20.9	Ex= 67 A/Con= 68	Yes	6 months

Note: *M* = mean, Ex = Experimental group; Con = Control group; A/Con = Active control group; P/control = passive control group; CRT = Cognitive Remediation Therapy; CBT = Cognitive Behavioral Therapy; LRT = Life Review Therapy; MBCT = Mindfulness Based Cognitive Therapy; MEST = Memory Specificity Training

Table 3

The aggregated effect sizes of the included studies for mental health outcomes

Target variable	Aggregated effect sizes/ posttest (*g*)	Aggregated effect sizes/ follow up (*g*)	Concurrent effects on AMS/ posttest (*g*)	Concurrent effects on AMS/follow up (*g*)	Consistency between concurrent effects	
					Post-test	Follow-up
Depressive symptoms	0.34**(n=23)	0.05 (n = 13)	1.02**	0.78**	yes	no
Rumination	-0.05 (n= 6)	-0.14 (n= 2)	0.17	0.33	yes	yes
Hopelessness	0.76 (n= 2)	-	0.60*	-	no	-
Social problem-solving	0.35 (n= 4)	0.35 (n= 3)	0.60**	0.24	no	yes
Cognitive avoidance	0.12 (n= 3)	-	0.01	-	yes	-
Life satisfaction	0.80* (n= 6)	-	1.57**	-	yes	-
Executive function	1.03** (n= 5)	-	1.13	-	no	-

Note: AMS = Autobiographical Memory Specificity; * $p < 0.05$ ** $p < 0.01$; We used the term "concurrent effects" in this article to refer the effects of an intervention at the same time (post-test or follow-up stages) on two target variables.

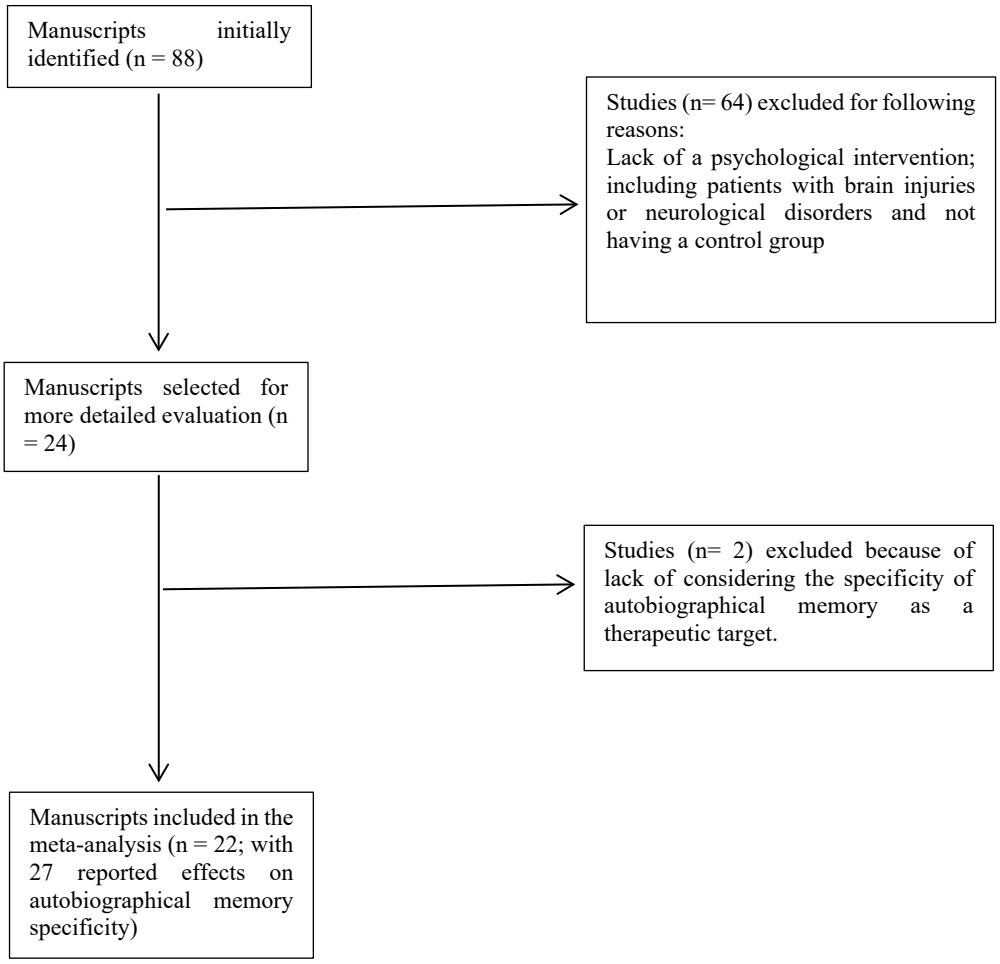

Figure 1.

Flow diagram of the study selection process

Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Blairy et al (2008)	1.043	0.401	0.161	0.256	1.829	2.597	0.009
Mogoase et al (2013)	0.625	0.314	0.099	0.009	1.240	1.990	0.047
Ricarte et al (2012)	0.801	0.290	0.084	0.233	1.370	2.764	0.006
Chen et al (2017) positive	2.033	0.345	0.119	1.358	2.709	5.898	0.000
Chen et al (2017) neutral	1.687	0.326	0.106	1.049	2.325	5.182	0.000
Chen et al (2017) negative	1.349	0.309	0.096	0.742	1.955	4.360	0.000
Gonçalves et al (2008)	2.398	0.705	0.498	1.016	3.781	3.400	0.001
Kleijn et al (2018)	0.709	0.215	0.046	0.289	1.130	3.307	0.001
Latorre et al (2015)	0.212	0.267	0.071	-0.311	0.735	0.794	0.427
Leahy et al (2017)LRT	0.775	0.311	0.097	0.165	1.384	2.492	0.013
Serrano et al (2004)	0.705	0.310	0.096	0.099	1.312	2.278	0.023
Serrano et al (2012)	0.330	0.509	0.260	-0.668	1.328	0.648	0.517
Jermann et al (2013)	-0.097	0.326	0.106	-0.736	0.542	-0.298	0.765
Hargus et al (2010)	0.934	0.395	0.156	0.160	1.707	2.367	0.018
Heeren et al (2009)	2.488	0.438	0.192	1.629	3.348	5.676	0.000
Williams et al (2000)	0.715	0.316	0.100	0.095	1.335	2.260	0.024
Neshat-Doost et al (2013)	2.509	0.547	0.299	1.438	3.580	4.591	0.000
Moradi et al (2014) positive	2.661	0.550	0.303	1.582	3.739	4.835	0.000
Moradi et al (2014) negative	2.503	0.535	0.286	1.455	3.551	4.681	0.000
Leahy et al (2017) MEST	0.796	0.308	0.095	0.193	1.400	2.586	0.010
Takano et al (2017)	1.182	0.337	0.114	0.521	1.843	3.504	0.000
Werner-Seidler et al (2018)	0.866	0.279	0.078	0.319	1.412	3.105	0.002
Leahy et al (2018)	-0.051	0.314	0.099	-0.666	0.564	-0.162	0.872
Ramírez et al (2014)	4.397	0.544	0.296	3.331	5.463	8.087	0.000
Maestas & Rude (2012).Specific	-0.309	0.169	0.029	-0.641	0.023	-1.826	0.068
Ricarte et al (2014)	0.603	0.353	0.124	-0.089	1.294	1.709	0.087
Maestas & Rude (2012)Traditional	-0.407	0.173	0.030	-0.746	-0.068	-2.352	0.019
	1.084	0.182	0.033	0.727	1.441	5.945	0.000

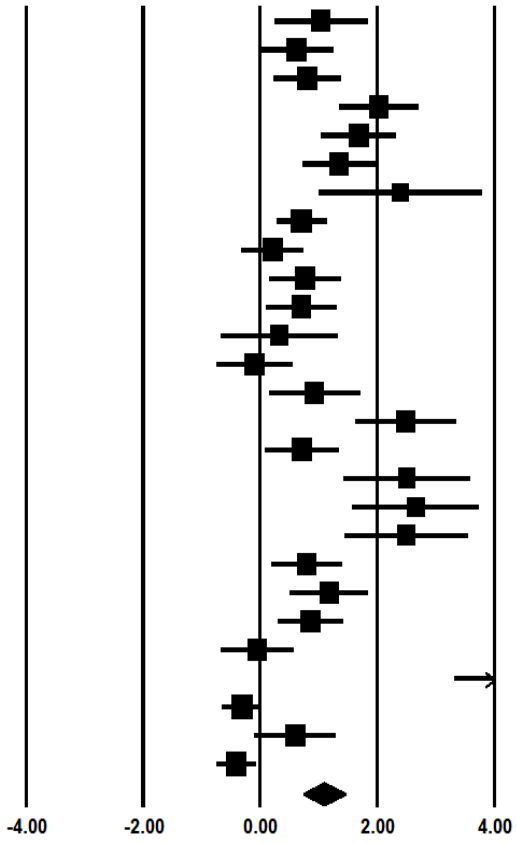

Figure 2. Forest plot for the included studies based on post-test assessments. CRT = Cognitive Remediation Therapy; CBT = Cognitive Behavioral Therapy; LRT = Life Review Therapy; MBCT = Mindfulness Based Cognitive Therapy; MEST = Memory Specificity Training

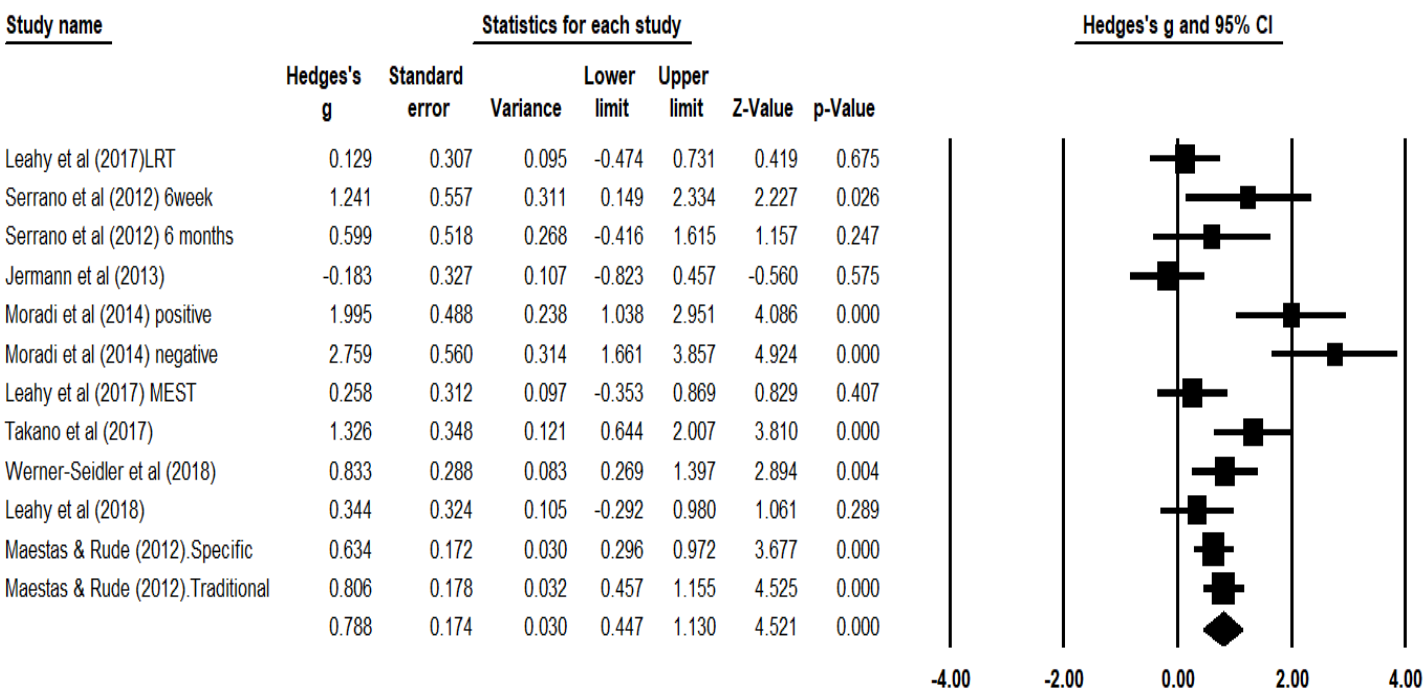

Figure 3. Forest plot for the included studies based on follow-up assessments. LRT = Life Review Therapy; MBCT = Mindfulness Based Cognitive Therapy; MEST = Memory Specificity Training