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Client Memory and Learning of Treatment Contents: An Experimental Study of Intervention Strategies and Relationship to Outcome in a Brief Treatment for Procrastination

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Abstract

Background and Objectives: Client memory and learning is limited for psychological treatment contents. This study investigated different approaches to support client memory and learning of treatment contents and the relationship between memory and learning of treatment contents and outcome.

Methods: Adult participants (n = 428) were recruited through Amazon's Mechanical Turk and randomized to complete one of three versions of a one-session procrastination intervention. Two versions of the intervention included different amounts of memory support strategy types from the Memory Support Intervention. A control version did not include any types of memory support. Memory and learning of treatment contents were assessed immediately after the intervention and one week later. Procrastination and two mechanisms of procrastination (impulsiveness and self-efficacy) were assessed at baseline and one week after the intervention.

Results: Contrary to the hypotheses, a version of the intervention with multiple types of memory support strategies was not associated with better memory and learning of treatment contents than a version of the intervention with only one type of memory support strategy or the control intervention. Greater memory and learning of treatment contents predicted improvement in mechanisms of procrastination, but not procrastination itself.

Limitations: The mean level of procrastination in this study was lower than in other treatment studies of procrastination.

Conclusions: Results partially support the rationale for the Memory Support Intervention that improving client memory and learning of treatment contents can improve outcome. Findings

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Author Statement

Garret Zieve: conceptualization, methodology, formal analysis, writing - original draft. Cara Woodworth: project administration, data curation, writing - review & editing. Allison Harvey: conceptualization, methodology, writing - review & editing, funding acquisition

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Conflict of Interest

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suggest that the Memory Support Intervention may be simplified to include fewer strategies without compromising efficacy.

Keywords

client recall; memory support; procrastination; cognitive behavior therapy

1. Introduction

Client memory and learning is often limited for psychological treatment contents. In cognitive behavioral therapy (CBT) for insomnia, clients forget up to 80% of treatment recommendations (Chambers, 1991; Lee & Harvey, 2015). In CBT for depression, when clients think about CBT skills and concepts in between sessions, less than half of these thoughts reflect accurate learning of content presented during sessions (Gumport, Williams, & Harvey, 2015). One decade after receiving behavioral couples counseling, up to 55% of clients cannot recall any skills presented (Hahlweg & Richter, 2010).

Findings documenting limited client memory and learning of treatment contents prompted the development of the Memory Support Intervention (Harvey et al., 2016, 2014). The Memory Support Intervention is an adjunctive intervention composed of eight empirically-derived *memory support strategies* that therapists incorporate frequently alongside treatment-as-usual (Table 1; Harvey et al., 2014). The Memory Support Intervention aims to increase client memory and learning of treatment contents, but not general memory functioning per se, with the overall goal of improving treatment outcome. A pilot randomized controlled trial of the Memory Support Intervention in the context of CBT for depression suggested that adding the intervention was associated with small to medium effect sizes in the expected direction on mood outcomes (Harvey et al., 2016). Although none of these effects were statistically significant in this small, pilot study focused more on 'learning than confirming,' (Lee, Whitehead, Jacques, & Julious, 2014), a larger, confirmatory study of the Memory Support Intervention is currently underway (Harvey et al., 2017).

While this initial signal of the overall efficacy of the Memory Support Intervention was promising, several questions remain unanswered. It is unknown to what extent each individual memory support strategy uniquely contributes to client memory and learning of treatment contents. Memory support strategies may operate through a generic effect, such that the strategies are interchangeable in terms of their effect on memory and learning. If this were true, for example, then using 20 instances of one strategy would be equivalent to using 20 instances total of a variety of different strategies. On the other hand, the memory support strategies derive from multiple, complementary theories of memory and are hypothesized to target distinct processes. For example, the strategies of application and evaluation may enhance memory and learning by encouraging clients to engage in deeper *levels of processing* (Craik & Lockhart, 1972), while the strategy of practice remembering may take effect by expanding *retrieval routes* to stored information (Bjork, 1988). Thus, using a variety of strategies may result in a more comprehensive intervention with more robust effects on memory and learning relative to using only one strategy.

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Additionally, the rationale for the Memory Support Intervention relies on the relationship between client memory and learning of treatment contents and outcome, though empirical investigations of this relationship have shown mixed results. One study in the context of psychological treatment for insomnia found moderate to strong correlations (*r*s = 0.50 – 0.69) between recall and outcome such that greater recall was associated with better outcome (Lee & Harvey, 2015). Greater recall is also associated with better therapist and client ratings of treatment adherence in cognitive therapy for depression (Dong, Lee, & Harvey, 2017a), and treatment adherence has been linked to better outcomes (Taylor, Abramowitz, & McKay, 2012). Moreover, clients receiving cognitive therapy for depression who recall the process of cognitive restructuring are more likely to show good outcomes (Dong, Zhao, Ong, & Harvey, 2017). On the other hand, one initial study did not find an association between recall of treatment contents and outcome in psychological treatment for insomnia (Chambers, 1991). Additionally, recall of skills learned in behavioral couples counselling one decade after completing treatment was not associated with relationship outcomes (Hahlweg & Richter, 2010).

In an initial study moving beyond recall to examine broader indices of learning during CBT for depression, clients' ability to generalize treatment contents to hypothetical situations was associated with fewer symptoms, but accurate thoughts and applications of treatment contents in between sessions was not (Gumport et al., 2015). Conversely, in a subsequent study using the same measures, accurate thoughts and applications of treatment contents predicted fewer symptoms, but generalization to hypothetical situations did not (Gumport, Dong, Lee, & Harvey, 2018).

Several factors may contribute to these mixed findings. First, studies to date have analyzed relatively small samples (*n* = 20 to 70), potentially lacking statistical power. Second, studies have utilized a variety of measures of memory and learning for treatment contents, some of which may be better suited for investigating the relationship between memory and learning of treatment contents and outcome. Finally, the relationship between memory and learning of treatment contents and outcome may depend on the timing relative to treatment. Studies investigating memory and learning of treatment contents and outcome on a shorter timeframe (i.e., week-to-week during treatment) have generally found significant relationships between these variables (Dong, Lee, et al., 2017a; Dong, Zhao, et al., 2017; Gumport et al., 2015; Lee & Harvey, 2015). Studies that investigated the association between memory and learning of treatment contents and outcome on a longer timeframe (e.g., months to years after treatment ended) tended to not find significant relationships between these variables (Chambers, 1991; Gumport et al., 2018; Hahlweg & Richter, 2010). The current investigation aimed to examine the relationship between memory and learning of treatment contents and outcome in a large sample (*n* = 428), using a variety of measures of memory and learning of treatment contents, with a short (one-week) delay between the assessments of memory and learning and outcome.

The present study also investigated client memory and learning of treatment contents in a novel treatment area: CBT for procrastination (Rozental & Carlbring, 2014). Procrastination is defined as the voluntary delay of an intended course of action despite expecting to be worse off for the delay (Steel, 2007). Procrastination is prevalent and associated with poorer

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academic and work performance, in addition to decreased general well-being (Steel, 2007). An emerging clinical literature suggests that procrastination can be reduced by teaching cognitive and behavioral skills such as time-management, goal setting, and cognitive restructuring (Rozental, Forsell, Svensson, Andersson, & Carlbring, 2015).

In addition to assessing procrastination, we included measures of two mechanisms that are strongly linked to procrastination and likely to change during CBT for procrastination: impulsiveness and self-efficacy (Steel, 2007). Impulsiveness is positively correlated with procrastination and has been used as a primary outcome in previous treatment studies of procrastination (Rozental et al., 2015). People high in impulsivity are more likely to procrastinate because they often pursue immediate gratification and neglect longer term responsibilities (Steel, 2007). Self-efficacy is negatively correlated with procrastination, as low self-efficacy can promote avoidance of procrastinated tasks (Steel, 2007). While procrastination treatment studies have not yet included self-efficacy as an outcome, many techniques in CBT for procrastination target self-efficacy (Rozental & Carlbring, 2014).

In summary, the current study includes two aims. The first aim is to examine the effect of combining memory support strategies on memory and learning of treatment contents compared to both using a single strategy and using no strategies (control group) in the context of a brief intervention for procrastination. We hypothesized that combining memory support strategies will result in better memory and learning of treatment contents than both using a single strategy and using no strategies. The second aim is to investigate the relationship between memory and learning of treatment contents and outcome. We hypothesized that better memory and learning will predict improvements in procrastination and related mechanisms (self-efficacy and impulsiveness) over the course of the study.

2. Method

2.1. Participants

Participants for this study were 428 adults recruited through Amazon's Mechanical Turk, an online recruitment platform with demonstrated reliability for producing high-quality research, as long as procedures are in place to monitor and reduce selective attrition (Buhrmester, Kwang, & Gosling, 2011; Zhou & Fishbach, 2016). The number of participants was selected to detect a small effect size ($d = 0.3$) in memory and learning outcomes between the two memory support conditions (All Strategies and Single Strategy conditions, described below) at $\alpha = 0.05$ with 80% power (Faul, Erdfelder, Lang, & Buchner, 2007). As previous studies comparing memory support to no memory support conditions have yielded an average effect size across timepoints and measures in the medium range for memory and learning outcomes ($d = 0.46$; Gumport et al., 2018; Harvey et al., 2016), an effect size of 0.3 was selected for power analysis to reflect the likely smaller differences between two active memory support conditions. The inclusion criteria were (1) being age 18 or older and (2) being a resident of the United States. Participant demographic characteristics are summarized in Table 2. Despite randomization, participants across the three study conditions differed somewhat with respect to age.

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2.2. Study conditions

Participants were randomized to one of three versions of a one-session, online intervention for procrastination that included different amounts and types of memory support strategies.

2.2.1. All Strategies condition.—The intervention in the All Strategies condition incorporated 12 instances total of five different memory support strategies from the Memory Support Intervention: attention recruitment, categorization, evaluation, application, and practice remembering. For example, for application participants were provided with a free text response box and asked to describe how they would apply an idea from the intervention in their own lives. The memory support strategies in the All Strategies condition were chosen because of their suitability for straightforward implementation in an online setting.

2.2.2. Single Strategy condition.—The intervention in the Single Strategy condition incorporated only one memory support strategy but retained the same overall frequency of memory support use as the All Strategies condition. Practice remembering was selected as the memory support strategy for the Single Strategy condition to pose a sound challenge for the All Strategies condition, as practice remembering has demonstrated potent effects on memory and learning (Karpicke & Roediger, 2006).

2.2.3. No Strategies condition.—The intervention in the No Strategies condition served as the control condition and did not utilize any memory support strategies from the All Strategies condition, though participants were asked to read through the intervention twice to control for time spent engaging with treatment contents. As rereading is associated with improved memory on immediate tests but poor long-term retention (Karpicke & Roediger, 2006), it was expected that the effects of rereading would become negligible at the follow-up assessment points included in this study.

2.3. Intervention for procrastination

The intervention consisted of 14 empirically-supported *treatment points*, which are defined as the distinct ideas, concepts, skills, and/or insights that form the contents of treatment (Lee & Harvey, 2015). Treatment points in this study included points about the causes of procrastination (e.g., lack self-efficacy) and intervention strategies (e.g., completing “mini goals” within a task to increase self-efficacy) (Rozental & Carlbring, 2014). A list of treatment points included in the intervention can be found in the Appendix.

2.4. Procedure

Potential participants reviewed the consent form through Amazon’s Mechanical Turk’s web platform. The consent form stated that participants would be randomly assigned to one of three versions of an online procrastination intervention which differed in the amount and types of learning supports. Interested participants were directed to a Qualtrics survey containing the study protocol (Qualtrics, Provo, UT). Several strategies were used to reduce attrition (e.g., *prewarning*) (Zhou & Fishbach, 2016). Study outcomes were measured pre-intervention, post-intervention, and during a one-week follow-up.

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For the intervention, treatment points were presented on separate screens with examples. Memory support instances were evenly distributed throughout the intervention so that each treatment content screen was followed by one memory support screen. To encourage participants to read the full intervention text, the option to advance to the next screen only appeared after a brief timer elapsed. Participants in the No Strategies, Single Strategy, and All Strategies conditions completed the pre-intervention measures, intervention, and post intervention measures in an average of 56.94 (SD = 18.89), 62.16 (SD = 24.17), and 63.98 (SD = 23.27) minutes, respectively. An omnibus ANVOA indicated that these average completion times differed significantly from each other, $F(2, 369) = 3.38$, $p = 0.04$. Follow-up comparisons revealed that the All Strategies condition took significantly longer to complete than the No Strategies condition.

All procedures were approved by the University of California, Berkeley, Committee for the Protection of Human Subjects. All participants provided informed consent. Participant flow is summarized in Figure 1.

2.5. Measures of procrastination and related mechanisms

2.5.1. Irrational Procrastination Scale.—The Irrational Procrastination Scale is a nine-item self-report measure of procrastination (Steel, 2010). The Irrational Procrastination Scale has demonstrated excellent internal consistency ($\alpha = 0.91$), and sensitivity to change during treatment for procrastination (Rozental et al., 2015).

2.5.2. Susceptibility to Temptation Scale.—The Susceptibility to Temptation Scale is an 11-item self-report measure of impulsiveness, defined as the tendency to become distracted or giving into diversions (Steel, 2010). The Susceptibility to Temptation Scale has demonstrated excellent internal consistency ($\alpha = 0.89$), and convergent validity with the Irrational Procrastination Scale ($r = 0.69$) and a measure of subjective well-being ($r = -0.31$) (Steel, 2010).

2.5.3. New General Self-Efficacy Scale.—The New General Self-Efficacy Scale is an eight-item self-report measure of general self-efficacy (Chen, Gully, & Eden, 2001). The New General Self-Efficacy Scale has demonstrated high test-retest reliability (rs = 0.62–0.66), good internal consistency (αs = 0.85–0.90), and predictive validity of self-efficacy for specific tasks (Chen et al., 2001).

2.6. Measures of memory and learning of treatment contents

2.6.1. Treatment Recall Task.—The Treatment Recall Task is a free recall measure of memory for treatment contents, during which participants are asked to write out as many distinct treatment points as they can remember from the intervention (Lee & Harvey, 2015). In this study participants were given five minutes to recall as many treatment points as they could remember. The overall number of treatment points recalled was determined using a scoring rubric developed in a previous study (Lee & Harvey, 2015). According to the rubric, recall responses must be descriptive enough to clearly identify one distinct treatment point presented in the intervention. For example, the response “goals” would not be counted but “set mini goals” would be counted. Because 14 treatment points were presented during the

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intervention, Treatment Recall Task scores could range from 0 – 14. In this study, the inter-rater reliability between independent coders for the total number of treatment points recalled was in the good range according to a one-way, single-rater, consistency intraclass correlation coefficient (n = 80, ICC = 0.89, p < 0.001) (Koo & Li, 2016; McGraw & Wong, 1996). Participants completed the Treatment Recall Task immediately after the intervention and one-week later.

2.6.2. Generalization Task.—Generalization of treatment contents was assessed by presenting participants with brief vignettes (about 50 words each) of people procrastinating specific tasks (e.g., finding a new general practitioner). Participants were presented with a free text response box to answer the question "What recommendations would you give [name] to reduce his/her procrastination?" There were four vignettes total, and participants were presented with two vignettes at each assessment point. The sequence of the vignettes was randomized for each participant. The original scoring system for this task calls for coders to determine whether participants generalized any treatment points (coded no = 0, yes = 1) to each vignette, producing possible scores from 0 – 2 (Gumport et al., 2018, 2015). In this study, a most participants generalized at least one treatment point to each vignette, resulting in limited variability. To remedy this problem, coders instead determined the overall number of treatment points generalized to each vignette, and participants' final scores were calculated by averaging their performance across the two vignettes. Treatment points were counted using the same rubric used for the Treatment Recall Task. Inter-rater reliability for the alternative scoring system used in this study was in the good range according to a one-way, single-rater, consistency intraclass correlation coefficient (n = 80, ICC = 0.85, p < 0.001). Participants completed the generalization task immediately after the intervention and one-week later.

2.6.3. Application Task.—Application of treatment contents to daily life was assessed one-week after participants completed the intervention. For each treatment point participants recalled in the Treatment Recall Tasks, they were asked "did you apply this treatment point in the last week?" If yes, participants were prompted to describe in a free text box how they applied the treatment point. The timeframe of "the last week" was selected instead of "the past 24 hours" used in previous studies (Gumport et al., 2018, 2015) in order to provide a more comprehensive assessment of participants' application of treatment points since completing the intervention. Participant responses were evaluated by coders to determine the overall number of correct applications of treatment points. If participants provided information in their response that revealed an incorrect understanding of the treatment point, they were not coded for a correct application. In this study, the inter-rater reliability between independent coders for the total number of treatment points applied was in the moderate range according to a one-way, single-rater, consistency intraclass correlation coefficient (n = 80, ICC = 0.72, p < 0.001).

2.7. Data analysis

2.7.1. Missing data.—As indicated in Figure 1, approximately 15% of participants did not complete the post intervention measures, and approximately 30% did not complete the one-week follow-up measures. These missing data were handled using multiple imputation,

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which involves generating multiple datasets that fill in missing values with a variety of plausible values given other observed responses (Enders, 2017). Statistical tests are then conducted in each imputed dataset and pooled into a final result. Multiple imputation was selected instead of complete case analysis to increase the sample size of the analyses and increase power (Enders, 2017). For this analysis, all study variables were used to impute missing values, 20 independent datasets were generated using parallel data augmentation chains of 200 iterations each, and the stability of imputed values were confirmed by inspecting convergence plots (Enders, 2017).

2.7.2. Substantive analyses.—For the first aim, means were compared across the conditions on memory and learning outcomes at post-intervention and one-week follow-up. Multiple regression was used for the second aim which involved investigating the relationship between memory and learning of treatment contents and outcome. Each model included the outcome variable measured at baseline as a predictor (e.g., procrastination measured at baseline as a covariate in the model predicting procrastination at the one-week follow-up). The inclusion of these auto-regressive effects allowed for an examination of the amount of change variance in the outcome explained by the memory and learning measures after controlling for the stability information from the baseline measurement occasion (Little, 2013).

All analyses were conducted in R (R Core Team, 2016). Multiple imputation was completed using the mice package (van Buuren & Groothuis-Oudshoorn, 2011).

3. Results

3.1. Study completion

Of those who completed baseline measures, 92.91% of participants in the No Strategies condition, 89.67% of participants in the Single Strategy condition, and 80.28% of participants in the All Strategies condition completed the intervention and post-intervention measures. Completers and non-completers did not differ on any baseline characteristics. An omnibus X^2 test indicated that rates of study completion across conditions were significantly different from one another ($X^2 = 11.24$, df = 2, $p = 0.004$). Inspection of standardized residuals for each cell in the X^2 analysis suggested that participants in the All Strategies condition completed the intervention and post-intervention measures at a lower rate than expected ($z = 3.25$, $p = 0.005$). Of those who completed the post intervention measures, 84.73% of participants in the No Strategies condition, 81.54% of participants in the Single Strategy condition, and 79.82% of participants in the All Strategies condition completed the follow-up measures. These rates of study completion were not significantly different from one another. Altogether, these results provide evidence of selective attrition in the All Strategies condition from baseline to post-intervention, suggesting caution in interpreting any findings favoring the All Strategies condition (Zhou & Fishbach, 2016).

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3.2. Aim 1: Examine the effect of combining memory support strategies on memory and learning of treatment contents

Means and standard deviations for the memory and learning measures, along with results from omnibus ANOVAs comparing means across conditions, are presented in Table 3. While none of the omnibus ANOVAs reached statistical significance, follow-up pairwise comparisons revealed that participants in the Single Strategy condition recalled more treatment points at post than the No Strategies condition ($F = 3.91$, $p = 0.048$), corresponding to a small effect size (Cohen's $d = 0.24$) (Cohen, 1988). Additionally, participants in the Single Strategy condition recalled more treatment points than participants in the All Strategies condition at the one-week follow-up ($F = 4.80$, $p = 0.03$), also corresponding to a small effect size ($d = 0.32$). No other comparisons were statistically significant.

3.3. Aim 2: Investigate the relationship between memory and learning of treatment contents and outcome

Means and standard deviations by condition for the Irrational Procrastination Scale, Susceptibility to Temptation Scale, and New General Self-Efficacy Scale are shown in Table 4. As the three conditions did not differ on any of these measures at any timepoint, data was combined across conditions to probe whether any change occurred from baseline to follow-up (and thus whether there was any change variance to be explained by the memory and learning measures). Scores for each measure improved significantly over the course of the study (ts = 4.84 – 7.19, all ps < 0.001). Corresponding effect sizes for procrastination, susceptibility to temptation, and self-efficacy were 0.23, 0.27, and 0.17, respectively.

Table 5 shows multiple regression parameters predicting one-week follow-up scores for procrastination and related mechanisms from memory and learning task performance, controlling for baseline scores and experimental condition. Participants who recalled, generalized, and applied more treatment points reported less susceptibility to temptation at the one-week follow-up (Bs = −0.64 – −0.34, ps = 0.005 – 0.027). Memory and learning task performance was inconsistently related to improvements in self-efficacy. While better generalization task performance post intervention predicted higher self-efficacy at the one-week follow-up ($B = 0.37$, $p = 0.037$), treatment recall and application showed no relationship with self-efficacy. Memory and learning task performance did not show any relationships with procrastination.

4. Discussion

This study investigated memory and learning of treatment contents in the context of a brief treatment for procrastination. The first aim was to examine the effect of combining memory support strategy types on memory and learning of treatment contents relative to using a single strategy type and no strategies. Contrary to hypotheses, participants who received a version of the intervention that incorporated multiple types of memory support strategies (All Strategies condition) did not perform better on tasks assessing memory and learning of treatment contents than participants who received a version of the intervention that utilized only one type of memory support strategy (Single Strategy condition). Indeed, immediately

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following the intervention, only participants in the Single Strategy condition recalled more treatment points than those who received a control version of the intervention with no memory support strategies (No Strategies condition). Moreover, one week after the intervention, participants in the Single Strategy condition recalled more treatment points than those in the All Strategies condition. However, participants in the Single Strategy and No Strategies conditions did not differ in recall one week after the intervention. It is important to note that these between group effect sizes fell in the small range, corresponding to an average recall difference of approximately one treatment point. Participants in the three study conditions did not differ in their ability to generalize treatment points to hypothetical scenarios or apply treatment points in their own lives.

Overall, memory support strategies appeared to have only a modest influence on memory and learning of treatment contents in this study. Several factors may contribute to this finding. First, the overall frequency of memory support strategies in the Single Strategy and All Strategies conditions may have been too low. Recent analyses suggest that 14 – 18 instances of memory support are need to maximize the impact of the Memory Support Intervention in the context of treatment for depression (Lee, Dong, & Harvey, 2018), whereas the current study included only 12 instances in each memory support condition. It is possible that the optimal dose of memory support in the current, non-clinically distressed sample is similar to the optimal dose in a depressed sample. Second, participants may engage less with memory support strategies in an online setting, in comparison to a face-to-face setting. Although several measures were taken to prevent this possibility, incorporating engagement checks would have allowed us to evaluate how much effort participants put into the memory support prompts (Berinsky, Margolis, & Sances, 2014). Finally, requiring participants to traverse the intervention twice in the No Strategies condition may be conceptualized as the memory support strategy of repetition (Harvey et al., 2014). This design feature was selected to control for the extra time participants spent engaging with treatment contents in the Single Strategy and All Strategies conditions. However, the repetition in the No Strategies condition may have improved participants' performance on memory and learning measures beyond what would be ideal for a control condition.

Results favoring the Single Strategy condition could contain important implications for the Memory Support Intervention. The Memory Support Intervention may place a high cognitive load on therapists, who need to (1) recognize an opportunity to deliver memory support, (2) select a memory support strategy from the eight strategies in the Memory Support Intervention, and (3) deliver the strategy, all in the context of delivering treatment as usual (Sweller, 1988). Indeed, evidence suggests that therapists tend to reduce this cognitive load by relying most often on a subset of strategies that are relatively easier to implement, including attention recruitment, repetition, and practice remembering (Dong, Lee, & Harvey, 2017b). If using a greater variety of memory support strategy types is not superior to using a single memory support strategy type, then perhaps the Memory Support Intervention could be simplified to include less strategy types. Such a simplification might also promote the successful dissemination of the intervention (Damschroder et al., 2009). However, further replication of this finding, especially in the context of extended face-to-face therapy with a clinically distressed sample, is needed before major revisions to the Memory Support Intervention can be recommended.

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The second aim was to investigate the relationship between memory and learning of treatment contents and outcome. Contrary to hypotheses, memory and learning of treatment contents did not predict change in procrastination symptoms over the one-week study period. However, participants who recalled more treatment points and generalized more treatment points to hypothetical scenarios immediately after the intervention, as well as those who applied more treatment points in the week following the intervention reported less impulsiveness at the one-week follow-up. Memory and learning task performance was inconsistently related to changes in self-efficacy.

These results underscore the importance of memory and learning of treatment contents in facilitating positive treatment outcomes and support the rationale for the Memory Support Intervention. While memory and learning task performance did not predict change in procrastination over the brief course of this study, these variables did predict change in key mechanisms of procrastination. Though not captured in the brief duration of this study, changes in these mechanisms of procrastination may translate over time into changes in procrastination itself (Steel, 2007).

This study further contributes to findings that memory and learning of treatment contents are significantly associated with outcome when assessed over a shorter timeframe (i.e., week-to-week during treatment), whereas studies that assess these variables over a longer timeframe (e.g., months to years after treatment) have tended to not find a significant association (Chambers, 1991; Gumport et al., 2018; Hahlweg & Richter, 2010). Perhaps memory and learning of treatment contents exerts its strongest influence on outcome during treatment, while separate factors such as residual symptoms may better account for outcome after treatment (Taylor, Walters, Vittengl, Krebaum, & Jarrett, 2011). Alternatively, a declining relationship between memory and learning of treatment contents and outcome after treatment may reflect a shift in clients from declarative memory for treatment contents to implicit or procedural memory born from repeated practice and increasingly automatic use of treatment points (Schacter, 1987).

This study has several limitations. First, the mean level of procrastination in this study was lower than in other treatment studies of procrastination (Rozental et al., 2015), which may have decreased motivation to learn from the intervention. However, follow-up analyses did not suggest those higher in baseline procrastination performed better on memory and learning outcomes than those lower in baseline procrastination in this sample. Nonetheless, the results may have been stronger if participants exhibited more severe procrastination. Second, the scoring rubrics for the tasks assessing memory and learning of treatment contents assume that all treatment points are equally significant. While this counting method shows evidence of reliability and validity (Gumport et al., 2018, 2015; Harvey et al., 2016; Lee & Harvey, 2015), there may be important differences in the impact of various treatment points (Dong, Zhao, et al., 2017). Third, there was evidence of selective attrition in the All Strategies condition, which might be expected to artificially inflate the estimates of memory and learning of treatment contents in the All Strategies condition (Zhou & Fishbach, 2016). However, the All Strategies condition did not outperform the other conditions on memory and learning task performance. Finally, the brief, one-week intervention period for this study may have limited both (1) the amount of change in procrastination it was possible to evoke

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from participants, and (2) the amount of learning and memory that participants could demonstrate from the intervention.

4.1. Conclusions

In summary, this study partially supports the rationale for the Memory Support Intervention that improving client memory and learning of treatment contents is a promising pathway for improving treatment outcome. Better memory and learning of treatment contents consistently predicted improvement in one of mechanism procrastination (impulsivity), inconsistently predicted improvement in another mechanism of procrastination (self-efficacy), and did not predict improvement in procrastination itself. The findings also suggest that the Memory Support Intervention may be simplified to include fewer strategies without compromising overall efficacy, at least in a non-clinically distressed sample.

Acknowledgements, declaration of interest, and role of funding organizations

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Appendix

Causes of Procrastination

Treatment point 1: Procrastinators are typically less confident, especially about the tasks they are putting off. In other words, if you start believing your goals aren't achievable, you stop effectively pursuing them.

Treatment point 2: As the deadline for any task gets pushed further into the future, our motivation to tackle the task decreases. Tasks and goals with no clear deadlines are especially associated with procrastination.

Intervention Techniques and Rationales

Setting input goals

Treatment point 3: Input goals are goals that describe the intended amount of time to be invested in a task.

Treatment point 4: Output goals are goals that describe the desired results of engaging in task.

Treatment point 5: Unlike output goals, input goals are under our direct control.

Treatment point 6: Setting input goals can reduce procrastination by increasing confidence.

Treatment point 7: Setting specific input goals is important because it allows us to know exactly when we complete our goals.

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Treatment point 8: Setting realistic input goals is important because realistic goals keep our expectancy high.

Treatment point 9: Setting a mini input goals (e.g., work on a task for 15 minutes), can enhance the psychological benefits of setting input goals and help us get started on frustrating, anxiety-provoking, and difficult tasks.

Setting deadlines

Treatment point 10: For tasks with no established deadline, setting a deadline can reduce procrastination.

Breaking down large tasks

Treatment point 11: Breaking down large tasks into a sequence of smaller output goals, each with their own deadline, can reduce procrastination by increasing both confidence and by setting intermediate deadlines.

Treatment point 12: Setting a mini output goals (e.g., complete a small portion of a task), can enhance the psychological benefits of breaking down tasks and help us get started on frustrating, anxiety-provoking, and difficult tasks.

Increasing commitment to deadlines

reatment point 13: Deadlines are more motivating if they have consequences that are controlled by other people.

Treatment point 14: Establishing social commitments to meet deadlines can reduce procrastination.

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Highlights

- Client memory and learning is often limited for psychological treatment contents
- Memory support strategies aim to increase memory and learning for treatment
- Using multiple memory support types was not superior to using a single type
- Greater memory and learning for treatment content predicted better outcome

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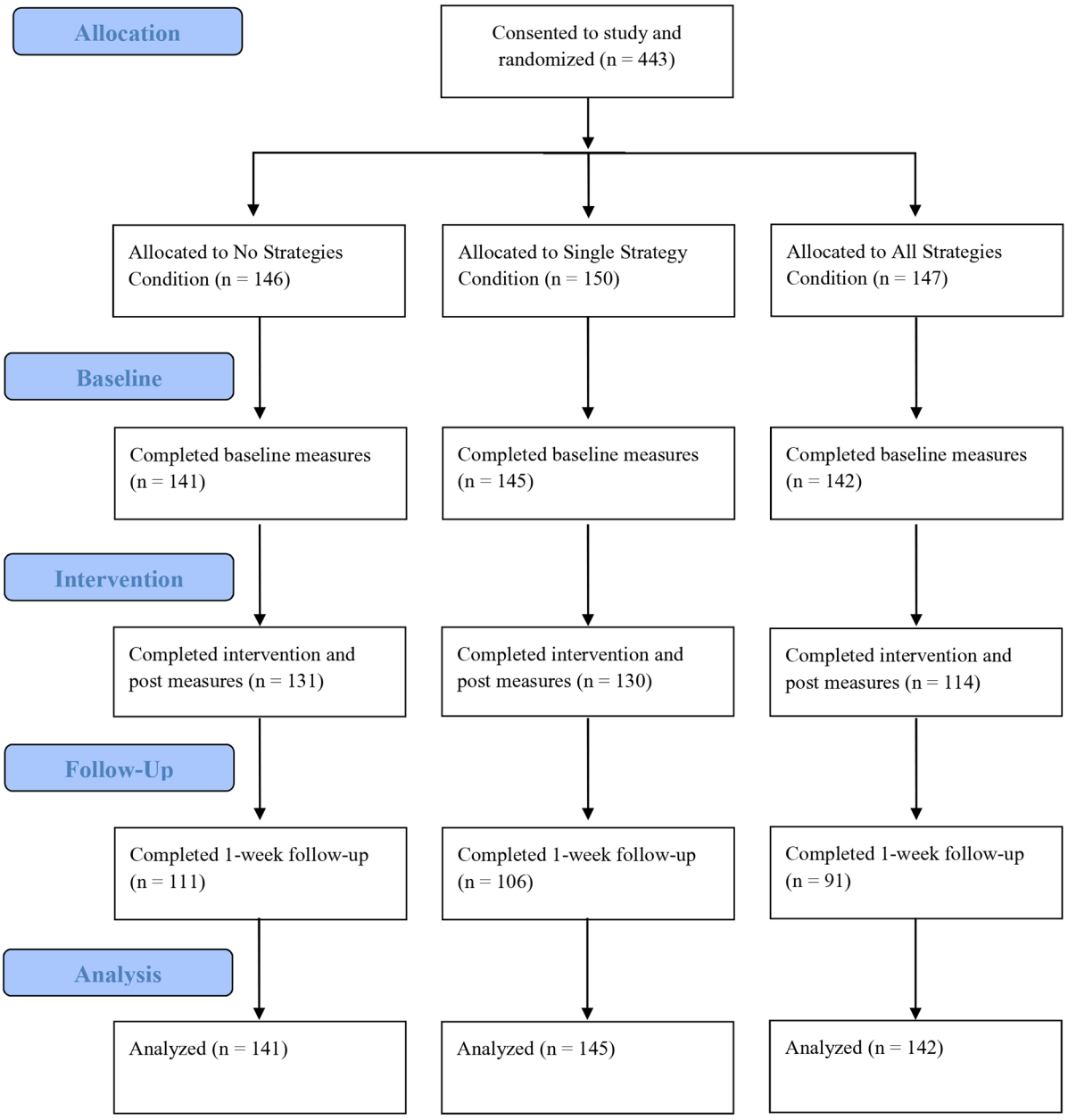

Figure 1.

Participant flow. As only eligible participants could view the study posting, this study did not include a distinct screening phase.

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Table 1

Memory support strategies

Strategy	Definition
Attention Recruitment	Involves the therapist using expressive language that explicitly communicates to the patient that a treatment point is important to remember (e.g., “if there is one thing I would like you to remember in ten years time, it is this skill”), or multimedia/diverse presentation modes (e.g., using a white board) as a means to recruit the patient’s attention.
Categorization	Involves explicit effort by the therapist to work with the patient to group treatment points discussed into common themes/principles (e.g., “Let’s create a list of ways we can work on waking up at the same time each morning.”).
Evaluation	Involves the therapist working with the patient to (a) discuss the pros/cons of a treatment point (e.g., “What would be some advantages/disadvantages of waking up at the same time each morning?”); or (b) use comparisons to compare a new treatment point to an existing or hypothetical alternative (e.g., “How would this new strategy of exercising more compare to your current habit of lying in bed when you are feeling depressed?”).
Application	Involves the therapist working with the patient to apply a treatment point to past, present, or future (real or hypothesized) scenarios (e.g., “Can you think of an example in which you might try this new method of coping to deal with your stress at work?”).
Repetition	Involves the therapist restating, rephrasing, or revisiting information discussed in treatment (e.g., “in other words,” “as we talked about earlier,” or “in sum”).
Practice Remembering	Involves the therapist facilitating the patient to regenerate, restate, rephrase, and/or revisit a treatment point (e.g., “Can you tell me some of the main ideas you’ve taken away from today’s session?).
Cue-Based Reminder	Involves the therapist helping the patient develop new or existing cues (e.g., text reminders) to facilitate memory for treatment points.
Praise Recall	Involves the therapist rewarding the patient for successfully recalling a treatment point (e.g., “It’s really great that you remembered that point!”) or remembering to implement a desired treatment point (e.g., “I’m so glad you remembered to step back and look at the evidence.”).

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Table 2

Participant baseline characteristics

Characteristic	No Strategies (n = 141)		Single Strategy (n = 145)		All Strategies (n = 142)		F or X^2	p
	M or n	% or SD	M or n	% or SD	M or n	% or SD		
Age	39.02	11.03	36.32	10.92	36.11	10.09	3.15	0.04
Biological Sex[a]							0.85	0.65
Female	80	56.74	74	51.03	78	54.93		
Male	61	43.26	70	48.28	64	45.07		
Other	0	0.00	1	0.69	0	0.00		
Race[a]							4.37	0.36
American Indian/Alaska Native	1	0.71	1	0.69	0	0.00		
Asian	7	4.96	13	8.97	6	4.23		
Black/African American	14	9.93	14	9.66	18	12.68		
Caucasian	114	80.85	105	72.41	106	74.65		
Native Hawaiian/Pacific Islander	0	0.00	0	0.00	0	0.00		
Other	1	0.71	6	4.14	3	2.11		
Mixed-race	4	2.84	6	4.14	9	6.34		
Ethnicity							1.62	0.44
Hispanic or Latino	8	5.67	14	9.66	12	8.45		
Not Hispanic or Latino	133	94.33	131	90.34	130	91.55		
Martial Status							2.51	0.64
Single, never married	71	50.35	72	49.66	75	52.82		
Married or domestic partnership	54	38.30	63	43.45	53	37.32		
Other	16	11.35	10	6.90	14	9.86		
Employment Status							3.49	0.17
Employed	115	81.56	127	87.59	126	88.73		
Not employed	26	18.44	18	12.41	16	11.27		
Education							4.00	0.41
High school or less	21	14.89	24	16.55	27	19.01		
Some post-secondary education	50	35.46	64	44.14	53	37.32		
Bachelors degree or higher	70	49.65	57	39.31	62	43.66		
Annual Household Income							1.12	0.89
$49,999 or less	78	55.32	81	55.86	78	54.93		
$50,000 – $99,999	53	37.59	54	37.24	50	35.21		
$100,000 or more	10	7.09	10	6.90	14	9.86		
Region of Residence							3.89	0.87
Midwest	22	15.60	25	17.24	31	21.83		
Northeast	37	26.24	33	22.76	29	20.42		
Southeast	44	31.21	40	27.59	39	27.46		

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Characteristic	No Strategies (*n* = 141)		Single Strategy (*n* = 145)		All Strategies (*n* = 142)		*F* or X^2	*p*
	M or *n*	% or *SD*	*M* or *n*	% or *SD*	*M* or *n*	% or *SD*		
Southwest	16	11.35	19	13.10	17	11.97		
West	22	15.60	28	19.31	26	18.31		

[a]Only cells with expected values > 5 were included in X^2 tests.

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Table 3

Comparison of memory and learning outcomes by study condition

	No Strategies (*n* = 141)		Single Strategy (*n* = 145)		All Strategies (*n* = 142)			
	M	***SD***	***M***	***SD***	***M***	***SD***	***F***	***p***
Post								
Treatment Recall Task	6.18	2.86	6.86	2.72	6.73	2.53	2.28	0.103
Scenarios Task	1.93	1.02	2.04	1.23	2.14	1.25	0.98	0.376
1-Week Follow-Up								
Treatment Recall Task	4.13	2.66	4.62	2.69	3.78	2.65	2.58	0.078
Scenarios Task	1.58	1.11	1.65	1.16	1.57	1.20	0.21	0.814
Application Task	1.98	1.88	1.75	1.72	1.96	1.97	0.49	0.613

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Table 4

Procrastination and related mechanisms by condition and timepoint

	No Strategies (*n* = 141)		Single Strategy (*n* = 145)		All Strategies (*n* = 142)			
	M	***SD***	***M***	***SD***	***M***	***SD***	***F***	***p***
Baseline								
Irrational Procrastination Scale	25.51	7.37	24.72	7.31	25.06	7.92	0.40	0.672
Susceptibility to Temptation Scale	30.20	8.80	29.10	8.69	28.86	9.52	0.89	0.410
New General Self-Efficacy Scale	30.08	6.02	30.32	6.51	30.84	5.98	0.56	0.571
1-Week Follow-Up								
Irrational Procrastination Scale	23.26	7.01	23.61	7.09	23.27	7.23	0.11	0.893
Susceptibility to Temptation Scale	27.07	8.81	26.90	9.05	26.36	9.13	0.20	0.820
New General Self-Efficacy Scale	31.38	5.32	31.10	6.05	31.91	5.59	0.681	0.506

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Table 5

Multiple regression parameters predicting one-week follow-up scores for procrastination and related mechanisms from memory and learning performance, controlling for baseline scores and experimental condition (n = 428)

	Irrational Procrastination Scale			Susceptibility to Temptation Scale			New General Self-Efficacy Scale		
	B	***SE***	***p***	***B***	***SE***	***p***	***B***	***SE***	***p***
Treatment Recall Task	−0.13	0.10	0.188	−0.34	0.12	0.005	0.01	0.08	0.935
Generalization Task	−0.43	0.23	0.071	−0.64	0.28	0.027	0.37	0.17	0.037
Application Task	−0.17	0.16	0.271	−0.56	0.20	0.007	0.11	0.11	0.329