THE ROLE OF DISTRESS TOLERANCE IN COGNITIVE CONTROL TRAINING FOR DYSPHORIA

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Cognitive Control Training (CCT) is an area of research which has been hypothesized as a way to decrease symptoms of depression. The purpose of this study was to replicate the results found by others using the PASAT, and to examine potential mechanisms behind the effects of CCT, particularly the role of distress tolerance. Seventy-two participants were randomly assigned to 1 of 3 conditions, a waitlist control, and 2 treatment conditions. Participants in the treatment conditions were given an electronic tablet to practice the attention task over a 2 week period. One condition was paced and time-pressured, the other was self-paced and developed to be less stressful (an active control). There was not a significant effect of condition when examining differences in depressive symptoms; however, the active control condition showed increases in distress tolerance, compared to the waitlist control condition.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

CCT.....Cognitive Control Training.

PASAT.....Paced Auditory Serial Addition Task.

AC.....Attentional Control.

dlPFC.....Dorsolateral Prefrontal Cortex.

DT.....Distress Tolerance.

BDI.....Beck Depression Inventory.

DTS.....Distress Tolerance Scale.

RRS.....Ruminative Response Scale.

RRS-b.....Brooding Subscale of the Ruminative Response Scale.

STICSA.....State-Trait Inventory for Cognitive and Somatic Anxiety.

CAGE.....Measure of problematic alcohol use.

PSS.....Perceived Stress Scale.

SART.....Sustained Attention to Response Task.

SAT.....Serial Addition Task.

T1.....Time 1.

T2.....Time 2.

ANCOVA.....Analysis of Covariance.

INTRODUCTION

Cognitive Control Training (CCT) has been explored as a means to treat several psychiatric and neurological issues, including depression, traumatic brain injury, and obsessive compulsive disorder (Alvarez et al., 2008; Anguera et al., 2013; Bowie et al., 2013; Calkins et al., 2011; Calkins & Otto, 2012; Onraedt & Koster, 2014; Segrave, Arnold, Hoy, & Fitzgerald, 2014; Siegle et al., 2014; Siegle, Ghinassi, & Thase, 2007). CCT for depressed individuals draws from several theories regarding vulnerabilities to depression. Many cognitive models of depression have suggested that depression is caused, in part, by deficits in working memory (Gohier et al., 2009; Levens & Gotlib, 2010; Rose & Ebmeier, 2006) and attentional control (AC) (De Raedt, Koster, & Joormann, 2010; Hsu et al., 2015; Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Some have postulated that these deficits lead to an inability to control or stop repetitive negative thinking or rumination (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Hsu et al., 2015; Joormann, 2010; Siegle et al., 2014), which increases the likelihood that one will become depressed.

CCT was developed according to a neurobiological model of depression, which posits that some symptoms of depression are associated with hyperactivity of the amygdala (Drevets, 2003; Siegle et al., 2014; Siegle, Ghinassi, & Thase, 2007; van Eijndhoven et al., 2011) and decreased activity in specific areas of the prefrontal cortex, notably the dorsolateral prefrontal cortex (dlPFC) (Siegle et al., 2007). These differences in brain functioning are thought to result in maladaptive thinking patterns. Hyperactivity of the amygdala contributes to increased negative affect and attention to negative information (Drevets, 2003; van Eijndhoven et al., 2011), while decreased activity in the dlPFC is thought to play a major role in attention control (AC) deficits (Hopfinger, Buonocore, & Mangun, 2000; Luks et al., 2010). This combination of

amygdala activation and decreased activity of the dlPFC sets up a troublesome loop in which increases in negative affect and decreases in attentional control makes it difficult to distract oneself from negative experiences, resulting in ruminative thought (Siegle et al., 2007).

The rationale for CCT is that it stimulates activity in the dlPFC, while also inducing increased amygdala activity. However, despite its sound reasoning, many studies seeking to measure the efficacy of CCT have yielded inconsistent results (Alvarez et al., 2008; Anguera et al., 2013; Bowie et al., 2013; Calkins et al., 2011; Calkins & Otto, 2012; Onraedt & Koster, 2014; Segrave, Arnold, Hoy, & Fitzgerald, 2014; Siegle et al., 2014; Siegle, Ghinassi, & Thase, 2007). Because this treatment is relatively new, the research designs vary across studies. Some of the many variations across studies include using different interventions to induce activity in these brain regions; some studies use tasks which traditionally measure inhibition, like the Stroop Task, while others use a working memory task, like dual n-back, and many include a variety of "brain training" programs and games. Previous studies also vary widely on the length of each session, and the number of sessions that participants partake in; some studies include as many as 64 sessions of CCT, while others have used as little as one session, and there is currently no research to show an ideal amount of sessions or a dose-dependent response. These studies also recruit participants from a wide variety of settings (including in-patient facilities, out-patient facilities, and non-clinical settings), and often do not control for things such as the length of time that participants have been on medications, or other forms of therapy that are being done in addition to CCT. Because of the many variations among studies, it's difficult to distinguish which aspects of CCT are effective, and which are not.

The Paced Auditory Serial Addition Task (PASAT; Gronwall, 1977) is one of several interventions that has been used in previous CCT studies. In this task, participants are asked to

listen to a stream of numbers which are being presented at a pre-determined rate. Participants must add the two most recently presented numbers, and state the sum. When the next number is presented, the participant has to calculate the new sum. This task can be relatively stressful, and has been shown to induce negative affect in participants (Feldner, Leen-Feldner, Zvolensky, & Lejuez, 2006; Holdwick & Wingenfeld, 1997; Parsons & Courtney, 2014). However, by completing the math problems, the participant is not only stimulating activity in the PFC, but is also having to use attentional control in order to focus on the task at hand while experiencing the stress and negative emotions which are induced by the task. Essentially, the participant is practicing control over a hyperactive amygdala, leading to more adaptive thinking patterns (Siegle et al. 2007).

The studies on CCT for depression that have been conducted by Siegle and colleagues have yielded the most consistent results. These studies have used the PASAT and the Wells Attention Training Task, which is a task that instructs participants to pay attention to specific sounds in a naturalistic environment, as their interventions. All of the studies by Siegle and colleagues have all found large effect sizes which range from 0.73-1.28 (Calkins, McMorran, Siegle, & Otto, 2015; Calkins & Otto, 2012; Siegle et al., 2007, 2014). The studies in 2007 and 2014 used the PASAT and the Wells Attention Training Task in addition to treatment as usual (TAU), and both found that using the PASAT and Wells Attention Training Task in addition to TAU was effective in reducing symptoms of depression. The 2015 study by Calkins et al. measured the efficacy of the PASAT plus the Wells Attention Training Task on depressive symptoms, compared to a sham treatment, peripheral vision training, which instructs individuals to pay attention to visual cues that are presented on a screen, without moving their eyes. This

study found that training using the PASAT and Wells Attention Task was significantly more effective than peripheral vision training at decreasing symptoms of depression.

Hoorelbeke, Koster, Vanderhasselt, Callewaert, & Demeyer (2015) examined the effects of the PASAT alone. They predicted that CCT could be an effective way to prevent depression by reducing rumination. Because Hoorelbeke and colleagues argue that stress is an essential component to efficacy of CCT, they proposed that the PASAT alone would be sufficient to decrease certain risk factors of depression, such as stress reactivity and rumination, and did not include the Wells Attention Training Task. Hoorelbeke and colleagues (2015) found evidence that one session of the PASAT led to lower levels of reactivity to a laboratory stressor and reduced levels of brooding one month following the session. Though this finding shows promise for the possibility of preventing depression in those who are vulnerable to it, depression outcomes were not measured, which prevents the ability to draw any conclusions regarding the effects of the PASAT alone as a treatment for depression.

Siegle and colleagues (2014) speculated that the effective mechanism of CCT is the reduction of rumination. They tested the idea that rumination is the key mechanism in CCT which leads to decreased symptoms of depression. While they found that CCT reduced rumination in their treatment group and not their control group, both the treatment and control groups showed decreases in depressive symptomology, as measured by the BDI-II. Siegle and colleagues explain this finding by proposing that rumination might be a vulnerability factor of depression, but changing depression symptoms might not change the vulnerability factor. Though there is evidence that CCT decreases rumination, one cannot be certain that rumination is the only mechanism that is targeted by CCT, especially considering the results found by Siegle and colleagues in 2014, which did not find changes in rumination to be associated with changes

in depression. The PASAT has been used widely in other areas of research due to its ability to reliably produce mild levels of stress and negative affect (Feldner et al., 2006; Holdwick & Wingenfeld, 1997; Parsons & Courtney, 2014). Though this is possibly what makes the PASAT more effective than other interventions that have been used for CCT, it presents an issue in identifying the mechanism. The presence of stress and negative affect opens the door to other mechanisms such as desensitization to negative emotions, as well as potential increases in Distress Tolerance (DT).

DT is one's ability to tolerate distressing emotions and mood states. DT is often discussed in literatures regarding Borderline Personality Disorder and Substance Use and Abuse, but has not been widely researched in depression. Motivation is high to study DT in populations such as individuals with Borderline Personality Disorder and Substance Use Disorder because, in those populations, low DT often results in impulsive risky behaviors which have the propensity to cause harm, such as non-suicidal self-injury and substance use (for a review, see Leyro, Zvolensky, & Bernstein, 2010).

I believe that DT may be an important component of mood disorders because an inability to tolerate stress will inevitably affect appraisals of stress and how one copes. Williams and colleagues (2013) suggest that individuals with higher levels of DT might be able to find helpful and productive ways to cope with negative emotions, while individuals with low DT may end up engaging in avoidance, substance use, and other harmful behaviors that tend to be associated with short-term reward.

The goal of the current study was to test the effects of the PASAT on symptoms of depression, while considering a few mechanisms that may underlie changes in depressive symptoms, notably AC, rumination, and DT. It was hypothesized that depressed individuals who

practiced the adaptive PASAT for 20 minutes per session for 6 sessions over the course of 2 weeks, would display a reduction in symptoms of depression, as measured by the Beck Depression Inventory (BDI), compared to individuals who were in an active control group and those who were in a no intervention condition. The amount of training was chosen to mirror the treatment done by Siegle and colleagues (2007, 2014). It was also hypothesized that decreases in depressive symptoms would be mediated by increases in DT. Because Siegle and colleagues predict that the effects of CCT on depressive symptoms is mediated by increases in AC and decreases in rumination, these hypotheses were also tested.

METHOD

Participants

Two-thousand fifty-five individuals participated in a screening questionnaire to determine eligibility for this study. Of those 2055 participants, 208 met the inclusion criteria and were invited to participate in the study. Of the 208 individuals invited to participate, 89 signed up for the study. In order to be eligible for the study, participants needed to have a minimum score of 10 on the BDI, and needed to have scored below a 2 on the CAGE, a measure of problematic alcohol use. Of those invited, 5 were excluded because the BDI score was below the cutoff when they arrived for the first session. Nine participants did not return for the post-intervention assessment. One participant was excluded because this person reported beginning therapy between the pre and post intervention sessions, and another was eliminated due to only completing two of the tablet sessions. One participant was referred to seek services elsewhere due to severe suicide risk.

The final sample consisted of 72 participants who were randomized into 3 conditions (waitlist = 25; active control = 23; intervention = 24). The reported genders included 18 male, 52 female, 1 male to female transgender, and 1 gender fluid. They ranged in age from 18-44 (M = 21.79; SD = 5.71). The majority of participants reported their ethnicity as Caucasian (83.3%), the next highest group was Asian (6.9%), then American Indian or Alaska Native (4.2%), then African American (2.8%), and 1.4% identified as "other." Age, gender, and self-report measures at T1 were not significantly different across the 3 conditions (all ps > 0.05).

Participants were recruited through the North Dakota State University Department of Psychology undergraduate participant pool (N = 34) and through a campus-wide email, explaining the purpose of the study (N = 38). Participants did not receive monetary

compensation for their participation in this study; however, students who were recruited from the psychology department participant pool were able to receive course credit for their participation.

Measures

Beck Depression Inventory (*BDI*; Beck, 1978). The BDI is a 21-item scale that measures depressive symptomology. For each item, participants are given 4 statements which are arranged in order of severity, and the participant is asked to choose the statement which best describes how he or she has been feeling in the past week. Each item has a possible score ranging from 0-3. The total score has a range of 0-63, and is calculated by summing the score from each item, with lower scores reflecting lower symptoms of depression, and higher scores reflecting higher symptoms of depression. The BDI has been shown to have coefficient alphas ranging between .81-.86 (Beck, Steer, & Garbin, 1988).

Distress Tolerance Scale (*DTS*, Simons and Gaher, 2005). The DTS is a 15-item scale that measures various aspects of distress tolerance. Each item in the scale is a sentence that describes how one might react or respond to distress. Participants are asked to think of times when they have been upset, then describe on a 1-5 scale how much they agree with each item, 1 being strongly agree and 5 being strongly disagree. The total score ranges from 4-20. Lower scores on the DTS reflect lower levels of distress tolerance, while higher levels of distress tolerance.

Ruminative Response Scale (*RRS*; Treynor, Gonzalez, & Hoeksema, 2003). The RRS is a 22-item scale that asks participants to rate how often they engage in thoughts and behaviors that reflect rumination on a 4-point scale, with options including almost never, sometimes, often, and almost always. The RRS includes three subscales: brooding, reflection, and depression. I will use the brooding subscale of the RRS (RRS-b), which consists of 5 items and is most associated

with risk for depression. Scores on the RRS-b can range from 5-20, with higher scores indicating greater amounts of brooding.

State-Trait Inventory for Cognitive and Somatic Anxiety (*STICSA*; Grös, D. F., Antony, M. M., Simms, L. J., & McCabe, R. E.,2007; Ree, M. J., MacLeod, C., French, D., & Locke, V., 2008). The STICSA is a 21-item scale that lists statements that reflect symptoms of anxiety, and participants are asked to rate how often they feel each symptom on a 4-point scale, with options including not at all, a little, moderately, and very much so. Scores on this measure can range from 21-84, with higher scores indicating greater anxiety.

CAGE (Ewing, 1984). The CAGE is a 4-item measure that was developed as a screening tool to detect problematic alcohol use among adolescents and adults. This measure consists of 4 yes or no items where yes = 1 and no = 0, such as, "Have you ever felt you needed to cut down on your drinking?" Individuals who score a 2 or higher are considered to have problematic alcohol use.

Perceived Stress Scale (*PSS*; Cohen, Kamarck, & Mermelstein, 1983). The PSS is a 14-item scale that measures the degree to which one perceives the situations and events in one's life as being stressful. Each item contains a question regarding how often participants have felt a certain way, for example, "In the last month, how often have you been upset because of something that happened unexpectedly?" Participants are instructed to indicated how often they have felt that way on a 0-4 scale, with 0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often. Scores range from 0-56 with higher scores indicating a higher perception of stress.

Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). The SART is task that measures one's ability to sustain attention. In this task,

participants are visually presented with 225 single digits (1-9). Each digit appears for 250ms, followed by a 900ms mask. Each digit is shown a total of 25 times. Participants are instructed to press a key each time a new digit is presented, with the exception of the number "3." When a 3 is presented, participants are instructed to refrain from pressing a key.

Errors that occur when an individual pressed a key when presented with a 3 are considered errors of commission, while errors that occur when individuals fail to press a key for numbers 1, 2, 4, 5, 6, 7, 8, 9 are considered errors of omission. In this task, sustained attention is measured by the number of errors that a participant makes throughout the 225 trials, with more errors indicating poorer sustained attention.

Interventions

Paced Auditory Serial Addition Task **(***PASAT*; Gronwall, 1977). The PASAT was originally developed as a tool to assess damage caused by traumatic brain injuries by measuring the speed of information processing (Gronwall, 1977; Tombaugh, 2006). During the PASAT, individuals listen to a stream of numbers which are being presented at a pre-determined rate, which is referred to as the inter-stimulus interval (ISI). Participants must add the two most recently presented numbers, and state the sum. When the next number is presented, the participant has to calculate the new sum. For example, if the participant hears the numbers 6, then 8, the participant would enter 14. If the next number is 4, the participant must recall the number 8, then add 4, and enter the sum. In a newer version of the PASAT, the adaptive PASAT, the ISI is adjusted based on the participant's accuracy. If the participant enters the correct sum for 3 consecutive trials, the ISI decreased, which increases the difficulty of the task. If the participant enters the incorrect sum for 3 consecutive trials, the ISI increases, making the

task easier. The task was automatically programmed to end after 20 minutes, so the participants did not need to keep track of time while doing this task.

Participants who were assigned to the PASAT condition were instructed to complete a total of 6 sessions of be PASAT over the course of 2 weeks, completing no more than 1 session per day.

Serial Addition Task. This task was developed to serve as an active control condition. This task is very similar to the PASAT, in sense that participants are essentially completing the same task; however, they are doing so without the stress of having time constraints of the adaptive PASAT. The difference between the two tasks is that in the SAT, participants will be in charge of their own pace by clicking a button that says "next" when they are ready to hear the next number or state the sum.

Similar to the PASAT condition, participants who were assigned to the SAT condition were instructed to complete a total of 6 sessions of be SAT over the course of 2 weeks, completing no more than 1 session per day. This task was also automatically programmed to end after 20 minutes, so participants did not need to keep track of time while completing the task.

Design

This study used a between-subjects design with three conditions. The three conditions included the primary intervention in which participants practiced the PASAT, an active control in which participants practiced the SAT, and a waitlist control, in which the participants completed only the pre and post assessments without engaging in the practice of the cognitive tasks. Participants in the waitlist control were offered the opportunity to complete the training following their second session; however, this data was not used in the analyses.

Procedure

Prior to the first lab session, potential participants took a survey which contained the BDI and the CAGE, and individuals who met the study criteria were contacted and invited to participant in the study.

The study took place in the Attention and Emotion Lab at NDSU. The first session began with an explanation of study. The informed consent made it clear to the participant that he or she would be assigned to one of the three conditions. After obtaining consent, participants completed a basic demographics form asking for age, gender, race, and ethnicity.

Following the informed consent, participants completed a BDI. In order to continue with the study, participants needed to obtain a score of 10 or higher. If an individual selected a 2 or higher on the item which measures current suicidal ideation on the BDI, suicide risk was assessed using the criteria set forth by Joiner, Walker, Rudd, & Jobes (1999), and anyone who displayed a severe or extreme risk was excluded from the study, and referred elsewhere.

After determining that eligibility criteria was met, he or she completed the DTS, RRS, PSS, and STICSA. After completing the questionnaires, participants completed the SART task to get a baseline measure of attentional control.

Once the participant completed the questionnaires and the SART, he or she was assigned to a condition. Individuals assigned to the waitlist control condition were then dismissed. If assigned to one of the active groups, the participant was then given a tablet, and was introduced to either the PASAT or the SAT. Once the participant verbalized that he or she understood the task, the research assistant left the room, and the participant performed the assigned task for 20 minutes. For those in the active groups, participants took the tablet to practice their respective

tasks for six twenty-minute sessions over the course of two weeks, to be completed at their leisure.

At two weeks following the initial visit, participants returned to the lab and completed the BDI, DTS, RRS, PSS, STICSA, and the SART task.

All data for this study were collected between March 2017 and November 2017.

RESULTS

Table 1 lists the descriptive statistics and Pearson correlation coefficients among the primary variables.

Depressive Symptoms

The hypothesis that practicing the PASAT would lead to decreased symptoms of depression was tested using ANCOVA. The covariate, BDI at T1, was significantly related to BDI at T2, $F(1, 68) = 111.37$, $p < 0.001$. There was not a significant effect of condition after controlling for the effect of BDI at T1, $F(2, 68) = 1.58$, $p = 0.21$. See Table 2 for pre and post intervention means by condition.

DT, AC, and Rumination as Mechanisms of Change

To test the hypothesis that DT would increase throughout the course of treatment, I ran an ANCOVA. The covariate, DTS at T1, was significantly related to DTS at T2, $F(1, 68) = 128.10$, $p < 0.001$. There was a significant effect of condition after controlling for the effect of DTS at T1, $F(2, 68) = 3.35$, $p = 0.04$. Post-hoc tests using a Bonferroni correction showed that the waitlist condition was not significantly different from the PASAT condition at T2 controlling for DTS at T1, $p = 1.0$; however, the SAT condition was significantly different from the waitlist condition at T2 controlling for DTS at T1, $p = 0.04$. The PASAT condition and the SAT condition did not differ significantly from each other at T2 controlling for DTS at T1, $p = 0.24$. See Table 3.

Table 1

Summary of Intercorrelations for variables at T1 and T2

Measure	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. BDI T1	__	-.52**	.56**	.56**	-.22	.78**	-.48**	.66**	.54**	.05
2. DTS T1	-.52**	__	-.47**	-.43**	.07	-.48**	.79**	-.52**	-.44**	-.08
3. RRS-b T1	.56**	-.47**	__	.41**	.09	.55**	-.43**	.69**	.43**	.05
4. STICSA T1	.56**	-.43**	.41*	__	-.12	.59**	-.39**	.46**	.65**	.05
5. SART errors T1	-.22	.07	.09	-.12	__	-.12	.08	.02	-.02	.30*
6. BDI T2	.78**	-.48	.55**	.59**	-.12	__	-.66**	.71**	.81**	.11
7. DTS T2	-.48**	.79**	-.43**	-.39**	.08	-.66**	__	-.63**	-.66**	-.04
8. RRS-b T2	.66**	-.52**	.69**	.46**	.02	.71**	-.63**	__	.64**	.12
9. STICSA T2	.54**	-.44**	.43**	.65**	-.02	.81**	-.66*	.64**	__	.16
10. SART errors T2	.05	-.08	.05	.05	.30*	.11	-.04	.12	.16	__

Note: BDI = Beck Depression Inventory; STICSA = State Trait Inventory for Cognitive and Somatic Anxiety; DTS = Distress Tolerance Scale; RRS-b = brooding subscale of Ruminative Response Styles Questionnaire; SART errors = total errors on the Sustained Attention to Response Task.
* = $p < 0.05$; ** = $p < 0.01$.

Table 2

Effects of Training across Time and Condition

	Waitlist Control (n = 25)				SAT (n = 23)				PASAT (n = 24)			
	Pre		Post		Pre		Post		Pre		Post	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
BDI	20.72	8.40	18.72	10.30	22.30	7.58	18.26	9.54	22.67	8.99	17.42	10.18
STICSA	44.20	10.79	44.36	13.24	46.35	10.12	41.52	13.49	43.42	8.94	42.17	11.36
DTS	10.13	2.94	10.26	3.55	9.31	2.05	10.86	2.53	11.01	2.73	11.48	3.17
RRS-b	15.44	3.25	14.68	3.83	15.39	2.67	13.91	3.01	14.71	3.13	14.54	3.08
SART errors	30.36	30.31	27.52	19.62	24.74	17.99	29.96	28.73	23.71	16.71	27.33	20.30

Note: BDI = Beck Depression Inventory (range = 0-63); STICSA = State Trait Inventory for Cognitive and Somatic Anxiety (range = 21-84); DTS = Distress Tolerance Scale (range = 4-20); RRS-b = brooding subscale of Ruminative Response Styles Questionnaire (range = 5-20); SART errors = total errors on the Sustained Attention to Response Task (range = 0-225).

Table 3

Bonferroni Comparison for DTS at T2 Controlling for DTS at T1

Comparisons	Mean DTS difference	Std. Error	95% CI	
			Lower Bound	Upper Bound
Waitlist vs. PASAT	-.38	.54	-1.71	.96
Waitlist vs. SAT	-1.39*	.55	-2.74	-.04
SAT vs. PASAT	1.01	.57	-.38	2.41

Note: * The mean difference is significant at the .05 level.

ANCOVA was used to test the hypothesis that brooding would decrease throughout the course of treatment. The covariate, RRS-b at T1, was significantly related to RRS-b at T2, $F(1, 68) = 65.52$, $p < 0.001$. There was not a significant effect of condition after controlling for the effect of RRS-b at T1, $F(2, 68) = 1.34$, $p = 0.27$.

ANCOVA was used to test the hypothesis that attentional control would increase throughout the course of treatment. The covariate, SART errors at T1, was significantly related to SART errors at T2, $F(1, 68) = 6.81$, $p = 0.01$. There was not a significant effect of condition after controlling for the effect of SART errors at T1, $F(2, 68) = 0.21$, $p = 0.81$.

DISCUSSION

There are a number of attention tasks which have been used in an attempt to decrease symptoms of depression. Among these tasks, the PASAT has been the most consistent in achieving significant reductions in symptoms (Calkins, McMorran, Siegle, & Otto, 2015; Calkins & Otto, 2012; Siegle et al., 2007, 2014). However, the PASAT has only shown decreased symptoms of depression when used in combination with the Wells Attention Training Task. In this study, the PASAT alone was tested as a measure of decreasing symptoms of depression.

Contrary to the primary hypothesis that practicing the PASAT would decrease symptoms of depression in comparison to a waitlist control and the SAT group, depressive symptoms did not vary by condition at T2 controlling for T1, and none of the conditions varied significantly from the others in change to symptoms of depression at T2.

One aspect of this study that set it apart from others was that the PASAT alone was used as a mode of delivering CCT. When considering the results from this study in comparison to those that have also included the Wells Attention Training Task (Calkins, McMorran, Siegle, & Otto, 2015; Calkins & Otto, 2012; Siegle et al., 2007, 2014), it seems possible that the Wells Attention Training Task could be a vital component to this treatment. One important thing to consider when interpreting this finding is that, while the Wells Attention Training Task is called an attention training task, it sounds very similar to mindfulness—it involves attending to specific sounds in a naturalistic soundscape, and encourages individuals not to react to negative emotions that occur during the exercise. While some individuals might argue that mindfulness practice is essentially an exercise in attention training, it is important to remember that mindfulness practice has an emotional component to it, in that individuals are encouraged to attend to their emotions

in a nonjudgement and nonreactive way. Given that the Wells Attention Training Task encourages individuals not to react to negative emotions that arise, it opens to the door to mechanisms other than increases in attentional control. It seems important to rule-out the idea that some of the previous results could have been due to increases in mindfulness.

Secondary hypotheses to this study were that being involved in the training conditions might lead to changes in some of the mechanisms proposed to be involved in different forms of CCT. It was hypothesized that changes in attentional control, brooding, and DT might account for changes in symptoms of depression. Since neither of the interventions led to a meaningful reduction in depressive symptoms, it did not make sense to study mechanisms in relation to depressive symptoms. However, analyses were run to see if the interventions led to changes in any of the proposed mechanisms. Attentional control and brooding did not vary by condition; however, there was a significant change in DT which varied by condition between T1 and T2. Contrary to what was predicted, it was the SAT condition which showed increases in DT. The SAT condition was designed to be less stressful than the PASAT condition and was meant to be a comparison which showed the effect of practicing only the cognitive (and not the stressful) aspect of the PASAT. It could be that simple practice in the absence of a lot stress helps one focus attention on a subsequent stressful task. Alternatively, considering that the overall change in DTS was relatively low, it could also be that the differences among groups could be due to random variations in the sample.

When considering the results, it is important to take into consideration some limitations to this study. In this study, there were limited data showing the performance of the participants on their training tasks. While we did have data that showed how many sessions participants completed, we did not have data to show if they were improving at the tasks, and we were unable

to measure the amount of effort put forth at practicing these tasks. If participants weren't truly buying into the treatment, and practicing the trainings, as recommended, it could explain the failure to replicate previous findings that show variations of CCT to be effective in reducing symptoms of depression.

Another limitation to consider is that the SAT condition was designed to be less stressful than the PASAT condition; however, there was not a measure of affect taken after the training sessions to prove that the SAT condition was actually perceived to be less distressing than the PASAT condition. Anecdotally, comments made to research assistants suggested that despite our intentions, participants still might have perceived the SAT to be stressful.

Like many other studies in this area, this study only tests one form of CCT on depression, and only has the potential to evaluate the effects of the PASAT. Results from this study provide only small contributions to the evaluations of CCT, as a whole, and should not be interpreted as either support or refutation of other modes of CCT, like the use of the dual n-back, Stroop tests, or other brain-training programs. It is also important to note that any studies which provide support for CCT for depression do not support any claims that CCT could be effective for other disorders, or for the prevention of cognitive decline in healthy aging.

Though the primary hypothesis of this study was not supported, there was still one interesting finding, which is that there was a condition which appeared to increase distress tolerance in dysphoric individuals. This finding was unexpected (it occurred in the condition which was expected to *not* be distressing), yet it could be an interesting new area to study. While it is irrefutable that depressed individuals experience a great deal of distress, there is almost no literature on distress tolerance in individuals with depression. There is a huge gap in the literature that should be explored by researchers to examine the relationship between DT and

depressive symptoms, as well as the possibility that increasing DT could be helpful for depressed individuals. While there are many reasons to evaluate the results of this study with caution, the findings could be exciting to many researchers, and I urge researchers to consider the effects of distress tolerance on depression to address this gap in knowledge.

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