Can baseline performance metrics on a SART predict the effectiveness of mindfulness and positive fantasizing at reducing perseverative cognition within rMDD and ND patients?

Can baseline SART performance predict the efficacy of depression interventions in modifying perseverative cognition in rMDD and ND individuals?

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Abstract: Given the significant challenge Major Depressive Disorder (MDD) poses in our global society, both in its prevalence and sinister ability to plague people on and off, it is paramount to find approaches and intervention techniques to prevent people from relapsing and keeping these thoughts of perseverative cognition - characterized as ruminative, negatively-valenced thought - at bay. To this end, this study investigated the effects of two types of intervention, mindfulness and positive fantasizing, on participants' performance at a sustained attention response task (SART), the participants being either remitted MDD patients (rMDD) or never-depressed individuals. The results highlighted distinct intervention impacts; fantasizing significantly reduced response times (RTs) in the ND control group, whilst mindfulness reduced RTs, improved self-reported on-task thinking in the rMDD group, and also increased SART accuracy in the control group. These findings suggest that the interventions succeed at reducing mind-wandering and increase attention, both of which are important factors of maintaining one's mental health and reducing the risk of a depressive relapse.

1 Introduction

Understanding major depressive disorder (MDD) and the myriad ways one can treat it is of paramount importance in today's society, given that it is the worlds' most prevalent mental health disorder with no signs off this changing soon; the global population with depression has increased by 49.68% from 1990 to 2017, which translates to 178 million adults in 1990 to 258 million in 2017 (Liu, 2019). However, the intervention techniques used to combat MDD haven't had anywhere near a comparable growth, with one 2017 study highlighting that only 16.5% of MDD patients across 21 countries received *minimally adequate treatment*, let alone those who received none, drastically emphasizing the need for intervention prevalence and quality to significantly increase so as to prevent relapse into MDD(Thornicroft, 2017).

A key characteristic of people suffering with MDD, and one that has been signalled as a harbinger of another depressive episode, is *perseverative cognition* (PC), an umbrella term for "a variety of types of negative, repetitive thought processes, the most common of which are rumination and worry" (Mao, 2022). Although closely linked, ruminative thinking describes thought patterns that fall under "repetitive negative thinking about past events" (Nolen-Hoeksema, 2015), and has been shown to be a "vulnerability factor for the onset, maintenance and recurrence of MDD" (Ottaviani, 2016), whereas 'worry' tends to focus on negative, future threats, with one of many definitions within the literature being "a chain of thoughts and images, negatively affect-laden, and relatively uncontrollable" (Borkovec, 1983) , (Borkovec, 1998). Both play a major role in negatively influencing one's daily thoughts and perceptions of events, and the extent of the afflictions it causes aren't solely psychological; a significant body of research has highlighted the physiological and somatic effects PC exerts on the body. A meta-analysis of studies on physiological concomitants related to PC found that heart rate, systolic and diastolic blood pressure, and cortisol activity were higher during PC (Ottaviani, 2016), and the important note here is that PC prolongs these symptoms due to the uncontrollable and persistent nature of the thoughts; Brosschot et al defined the crucial pathogenic property of PC is "not its acute, short-term effects on any given system but rather its duration". (Brosschot, 2006). Given this, it is clear why more effort

must be focused on reducing the long-lasting effects of PC on people in order to reduce relapse risk, and determining efficacious intervention methods to do so is at the forefront of these relapse reduction efforts.

Of the intervention techniques used in practice today, this project investigated two methods of PC treatment, namely *mindfulness* and *positive fantasizing*. Mindfulness, as originally defined by Kabat-Zinn in 1982, means "paying attention in a particular way; on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1982), with more modern defintions in the same vein defining it as a "non-judgemental awareness and acceptance of present experience" (Mao, 2022), and is a commonly described thought process undergone by people every day. Mindfulness-based interventions, then, focus not on reframing negative thoughts - in contrast to other popular types of therapy such as cognitive behavioural therapy (CBT) - but instead it focuses on encouraging the patient to accept these negative thoughts as part and parcel of their human experience and how to healthily process them as to avoid any negative affectivity from them. Existing research into the efficacy of mindfulness interventions, the one from which the mindfulness intervention in this study was taken being Mindfulness Based Cognitive Therapy (MBCT), which as shown promise at reduce symptoms of depression, anxiety, and bipolar disorder to name a few, with a particular 2017 study highlighting the effects mindfulness interventions have on "reducing rumination and improve the ability to regulate emotions" (Joseffson, 2017). A 2004 study conducted by by Ma & Teasdale revealed a "reduced relapse from 78% to 36% in patients with 3 or more previous MDD episodes" (Ma and Teasdale, 2004), while another review conducted in 2011 that gathered multiple studies into mindfulness treatments and rMDD concluded with a similar finding to Ma's 2004 study, concluding that "MBCT effectively reduces relapse risk in patients with recurrent major depressive disorder in remission". (Piet and Hougaard, 2011). A more recent meta-analysis conducted in 2022 by Mao accumulated 61 studies with some 4229 participants in total, and their results highlighted "a significant intervention effect on ruminative thinking", along with "significant improvements on the Ruminative Reflection Questionnaire, Ruminative Response Scale and Rumination on Sadness scale" (Mao, 2022).

Positive fantasizing is a key component of Preventive Cognitive Therapy (PCT), and has been defined by Bockting et al as a method of "challenging dysfunctional attitudes and schemas by using positive fantasy with help of imagery, enhancing positive affect and positive cognitions" (Besten et al., 2024). A study conducted by de Jonge et al on optimizing long-term outcomes of depression prevention found that including a PCT intervention on top of the rMDD patients usual care significantly delayed the time to relapse compared to patients who did not undergo a PCT intervention over a 15 month period (Bockting et al., 2019). Another study that utilized the concept of positive fantasizing was conducted by Macrynikola, which found that "engaging in a positive fantasy about the future was associated with the brooding subtype of rumination" (Macrynikola, 2016), with another 2002 study concluding that "daydreaming about successful goal attainment was previously found to be associated with increased depressive symptoms" (Langens and Schmalt, 2002). A different study by Besten et al from 2023 investigated the role of repetitive negative thinking's in patients with different degrees of MDD. Using a cross-over design, participants performed a Sustained Attention to Response Task (SART) after positive fantasizing and stress induction, and the results showed that positive fantasizing increased positive affect and decreased negative affect, while stress increased negative affect (Besten et al., 2023).

This study takes after the Besten et al study in the sense that a SART task was used here to assess the levels of PC within rMDD patients, as such an attentional task serves as an indirect indicator of mind-wandering and off-task thinking during the SART. Some research does exist on using the SART and self-reported measures of rumination to assess attentional deficits and how it interacts with PC. A study by Kaiser also utilized a SART in this context, reasoning that "including the SART allows us to investigate how this objective measure of executive control relates to momentary subjective measures of distraction and rumination" (Kaiser, 2022). In their 2004 study Weiland-Fiedler found that, despite correcting for residual depressive symptoms, rMDD patients suffered in sustained attention tasks compared to healthy controls (Weiland-Fiedler et al., 2004). Another study found similar results, in which 40 euthymic MDD patients performed significantly worse than their controls on 3 different tasks assessing attention and executive function, including a sustained attention task (Paelecke-Habermann et al., 2006). Outside of attention-specific tasks, however, much research also exists highlighting the physiological damage PC can do to the brain and therefore impact cognitive performance; one review of 12 studies that put MDD and rMDD patients under an fMRI scan whilst undergoing a cognitive go/no-go task (akin to the SART used in this thesis' experiment) to uncover functional alterations their brains revealed quantitative differences between them and healthy controls in the majority of the included studies (Piani, 2022). Furthermore, previous studies have

highlighted differences in the hippocampus and amygdala complexes in current MDD patients compared to healthy controls, suggesting impaired ability to reason with one's emotions properly (Tang, 2007), (Vasic, 2008), providing biological evidence of the damage MDD can do to people who suffer with it.

In light of the evidence suggesting the profound impact of PC on the recurrence of MDD and the varying effectiveness of current intervention techniques, it is crucial to explore tools that can help tailor these interventions more effectively and reduce the rates of depressive relapse. The SART has shown potential in cognitive and clinical settings for its ability to assess attentional deficits, which are linked with detecting PC. This in combination with self-reported measures of PC answered by the participant makes this line of research somewhat novel, as SART tasks are predominantly used in more cognitive science domains and clinical settings. Given all this, the research question of this study is as follows: Can baseline performance metrics on a SART predict the effectiveness of positive fantasizing and mindfulness interventions in modifying PC and attention in individuals with rMDD and never-depressed (ND) counterparts? Addressing this question could open new avenues for personalized treatment strategies, ensuring that individuals receive the most beneficial intervention based on their unique cognitive profiles, ultimately contributing to more effective management and prevention of depressive relapses.

2 Methods

In order to examine the effects of the interventions on PC in rMDD and ND individuals and whether this efficacy was reflected in their SART scores, data collected from a previous study that utilized two intervention techniques on rMDD and ND patients was analysed. This was the MIND-COG study conducted by Besten et al (2024), and further details regarding experimental design can be found in that paper.

2.1 Participants

To examine the contrasting influences of mindfulness and positive fantasizing on PC and attention among those susceptible to depressive relapse, two participant groups were needed; one of 50 rMDD participants, all of whom had to meet 2 additional requirements; they must have experienced at least 2 depressive episodes (as defined in the DSM-5) over the last 10 years, and should have scored 21 or fewer points on the Inventory of Depressive Symptomatology - Self Report(IDS-SR30). The other group was meant to be comprised of 50 ND (never-depressed) control individuals, one requirement of which being they have never received a diagnosis of any mental disorder listed in the DSM-5. This was checked by them undergoing the SCID-5 interview as part of the screening process. Unfortunately, some recruitment complications and delays arose due to the onset of the COVID-19 pandemic, and the participants pools halved for each group (n = 25), with another phase of the experiment being completed online. The participants in the ND group were matched to the rMDD ones based on age, sex and educational level.

2.1.1 Randomization

The way in which participants were assigned to either mindfulness or the fantasizing groups was conducted in a pseudo-random counterbalanced way, to ensure equal numbers across the conditions and no inherent biases in which order they underwent the interventions. Any new participants that joined onto the experiment after the T1 stage had started were assigned to each condition in an alternating order, to maintain the equal split across the conditions.

2.2 Experimental Design

The original study by Besten et al. was a randomized cross-over trial design to explore the effects of mindfulness and positive fantasizing on perseverative cognition. Participants underwent both interventions in a counterbalanced order separated by a one month washout period, providing a robust framework for comparing the impact of each intervention on the same individuals. Leveraging the cross-over design, my analysis focuses on the initial SART performance as a potential predictor of intervention success. By examining baseline cognitive performance, along with the thought probes participants completed in tandem with the SART, this research seeks to identify whether initial cognitive control and attention deficits correlate with the efficacy of targeted mental health interventions.

The aforementioned thought probes consisted of 4 questions, each of which occurred after a set of SART trials. The thought probes serve to gain a momentary insight into the mental state of the participant while completing the SART, reflecting their attention and levels of PC at that time. This resulted in response times coupled with accurate reflections of the participants' mental state at the time of answering, which served well for my analysis of whether the two are correlated. Utilizing the thought probes in tandem with the SART, including the framing of the questions, was adapted from McVay & Kane's study from 2013 (McVay

and Kane, 2013) The probes themselves can be seen below:

Question 0: What were you just thinking about?

1. I was fully focused on the task
2. I was evaluating aspects of the task
3. I was thinking about personal things
4. I was distracted by my environment
5. I was daydreaming/I was thinking about task-unrelated things
6. I was not paying attention, but was not thinking about something specific

Question 1: How difficult was it to let go of the thought?

1. Very difficult
2. Difficult
3. Not difficult nor easy
4. Easy
5. Very easy

Question 2: Were your thoughts negatively, neutrally or positively valenced?

1. Negative
2. Neutral
3. Positive

Question 3: What was the temporal orientation of your thought?

1. Past
2. Present
3. Future

The data I am using, namely the SART scores at the beginning and during the interventions, come from the main body of the experiment, consisting of the pre and peri-intervention measurements. These measurements include - besides the SART, of course - momentary ESM questions, actigraphy, ICG/ECG, laboratory EEG measures, and additional self-report questionnaires. These measurements are consistent across each pre-and peri-intervention session, and form the datasets I analyzed in order to answer my research question. Figure 2 provides a more comprehensive breakdown of when these tests were administered during phases T1-T4. It is important to note that T1 and T3 are pre-intervention stages, and T2 and T4 are the peri-intervention ones. The only difference between these stages is that the pre-intervention ones (T1, T3) do not have the intervention training and home sessions, as given in the name 'pre-intervention'.

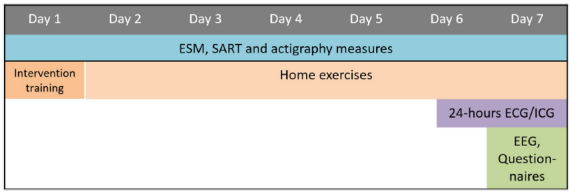

Figure 2.1: Day-by-day view of the peri-intervention stages of the MINDCOG study. The pre-intervention stages are identical, with the removal of the home sessions and intervention training.

2.3 SART & Thought Probe Data

In order to answer my research question, I took the SART results collected in stage T1 and T3 as my 'baseline' statistics for each intervention, and compared them respectively against their peri-intervention counterparts. This data was gathered from the WANDER mobile app that all participants completed the SART and thought probes on. These daily phone-based measurements are interesting as they capture the momentary thought patterns of everyday life and reduce the mundane realism of the task. After completing the data pre-processing, a research partner and I matched the SART results collected across different intervention periods to the same user ID. This was a crucial step, as each participant received 2 unique user IDs for the separate interventions. PC was measured through taking averages of the responses to each thought probe, in order to see which specific aspects of PC may have overshadowed other, however a compounded score was also created that averaged the responses to each probe per participant in order to assess more generally the inclination of their thoughts during each SART block. This measure was used to glean whether the participant was generally 'on-task' or 'off-task'.

2.4 Statistical Measures

To ensure I chose the correct methods for analyses and statistical tests befitting the data, I conducted some exploratory data analysis to grasp the general tendencies and spread of the response time and thought probe data. The observed distributions highlighted the non-normality of the response times, and due to this I opted for linear mixed effect models to help answer my research question, as they can robustly handle repeated measures designs, missing and unbalanced data, and account for the random variance inherent within each participant.

For testing changes in accuracy to the SART, I created 3 generalized linear mixed effect models per intervention; one which only tested for main effects, another which included two-way interactions between the variables, and the third that tested the complete interaction effects between all three main effects. I then used an ANOVA test to compare the three nested models to observe which variable affected the participants' predicted task status the most.

A key decision was made to combine the data collected in the two measurement periods (m1 and m2) due to the dropouts observed in the second period. This was done in order to ensure a relationship between SART metrics and the dependent variables of group and intervention could be statistically significant without the risk of too small a participant pool, and this was more of a primary concern in order to answer the research question at hand rather than trying to determine differences across the measurement periods. In total, we had 25 controls and 20 rMDD participants in the first phase, and due to dropouts influenced by COVID and other individual reasons, the second phase consisted of 19 controls and 15 rMDD, and so we combined the data of the participants who did not dropout for the analyses.

3 Results

In order to test whether changes in performance metrics to a SART task from baseline measurements to peri-intervention measurements indicate a reduction in perseverative cognition (PC), changes in response times (RTs) and thought probe answers were examined with predictors of group membership, accuracy on the SART, and the intervention stage. In addition to the independent variables' main effects, interaction effects between them were also tested for in order to gain a comprehensive view of how performance on the SART changed, and whether these changes were linked to the participants reporting less PC-inclined thoughts as measured by the thought probes.

3.1 Response Times

I first tested whether the response times changed from baseline to peri-intervention with group and intervention. Due to the non-normality of the response time distributions as highlighted in the data exploration, I created linear mixed effect models in order to test all the main effects on response time while accounting for the random variability within the participants, as well as any possible interaction effects between group and intervention.

To test for significant changes in response times, the LME varied response time with fixed effects of group and intervention stage (baseline v peri-intervention), with a random effect of the participants' ID number. The model was built such that main effects could be interpreted individually, along with any interaction effects between the variables. For the fantasizing intervention, the model showed a significant reduction in response times compared to the baseline scores for the ND controls ($t = -6.544$, $SE = 4.708$, $b = -30.81$, $p < 0.01$), however for the remitted group no significant change was observed ($t = 1.281$, $SE = 6.033$, $b = 7.73$, $p = 0.200$).

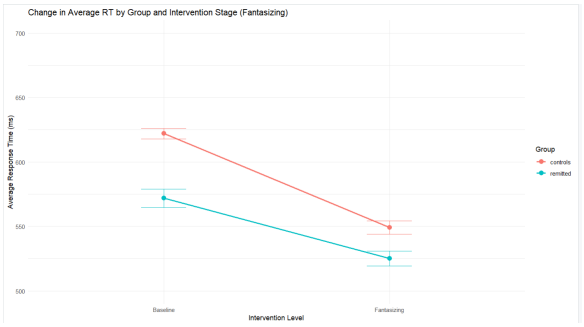

Figure 3.1: Significant decrease in average response time for the control group after undergoing the fantasizing intervention.

For the mindfulness intervention, there was a significant reduction in response time for the remitted group ($t = -5.618$, $SE = 4.463$, $b = -48.08$, $p < 0.01$), and no significant reduction in RTs was observed for the control group ($t = 1.247$, $SE = 6.77$, $b = 8.45$, $p = 0.212$).

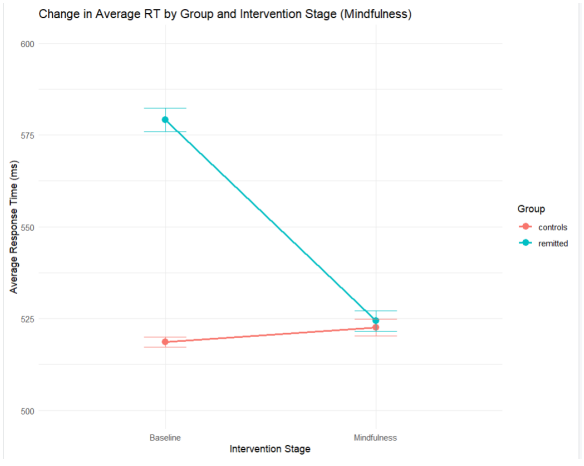

Figure 3.2: Change in average RT for both groups from their baseline measurements to post-mindfulness.

There was no significant interaction effect between group and intervention on response times, as indicated by the chi-squared test ($\chi^2 = 3.08$, $p = 0.38$). This means that the reduction in response times can be sufficiently explained by the

main effects of the group and the intervention stage independently, rather than by their interaction. Although the difference shown in the graph seems to be a larger difference in response times between the groups, this difference was not statistically significant according to the model. Hence, the main effects model is adequate for explaining the observed changes in response times.

3.2 Accuracy

I tested for any significant changes in accuracy on the SART, represented by the binary variable 'correct' attached to each recorded response time. Due to its binary nature, I used a generalized linear mixed effect model with a binomial distribution to model if/how the accuracy changed from baseline measurements to the peri-intervention ones. In the fantasizing intervention, no significant change in the accuracy - with response time, group and intervention stage as predictors - was found from baseline to peri-intervention in the fantasizing intervention in the first measurement period, an observation persistent in both the control (z = 0.807, p = 0.420) and remitted (z = -0.741, p = 0.459) groups.

A significant effect of the mindfulness intervention on accuracy was found for the control group (z = 3.122, p = 0.0018), whereas no significant effect was found for the remitted patients (z = 0.08, p = 0.94).

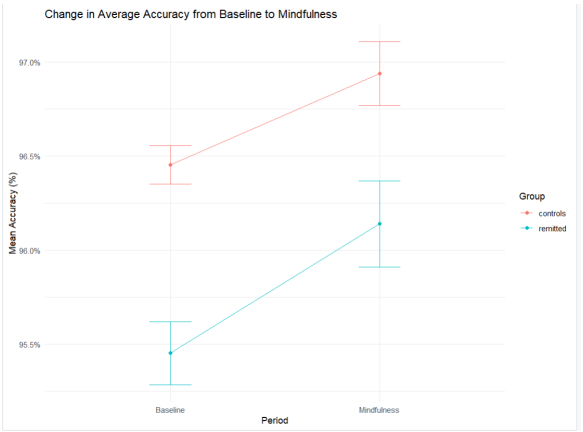

Figure 3.3: Change in average accuracy for both groups post-mindfulness intervention. Although the change in the accuracy was larger for the remitted patients, the effect was not found significant.

3.3 Thought Probes

For investigating how the content, stickiness and other measures of self-reported PC changed from baseline to peri-intervention in both groups I again used linear mixed effect models, with the same main effects of group and intervention type along with the random effect of the subject number. I investigated how the responses to each thought probe changed from baseline to peri-intervention, in order to assess how specific aspects that contribute to PC as a whole may have changed with intervention and group, however for each set of 4 thought probes answered after 4 SART questions, as set in the experimental design, I also created a compounded score of the probe responses that represented whether the participant was on or off task during that specific round of SART questions. This was done in order to assess more generally whether participants reported less PC-inclined thoughts - represented as being more 'on-task' - in the peri-intervention stage compared to the baseline stage.

The model that accounted for three-way interactions between the predictors in the fantasizing intervention significantly improved upon the other two (χ^2 = 26.805, p < 0.001), and highlighted that a reduction in RTs - in tandem with intervention stage and group - was significantly linked to the participant being more on-task for the rMDD group (z = 5.017, p < 0.001). Moreover, as the mean response time to each set of SART trials increased, this significantly corresponded to a much lower probability of being on-task, illustrated by the massive negative gradient in Figure 3.(β = -0.08, z = -3.765, p ¡ 0.01). No significant change in on-task thinking was found for the control group.

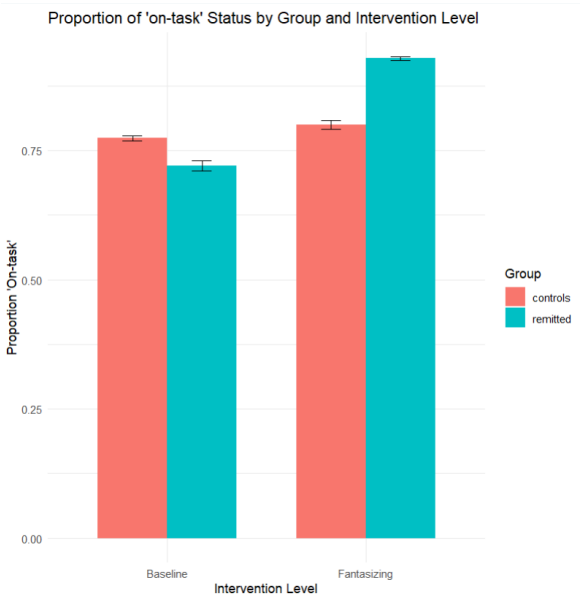

Figure 3.4: Change in frequency of on-task thinking from baseline to post-fantasizing intervention measurements.

On a per-probe basis, there were significant interaction effects of group and intervention on improving the responses to the first and second probe (t = -3.738, p < 0.01; t = 9.309, p < 0.001), the former pertaining to the content of their thoughts during

the SART and the latter asked about the stickiness of their thoughts. The bar graph below illustrates the average increase observed in the responses to the stickiness probe. For this specific probe, a increase in the mean answer indicates their thoughts became less sticky, as the possible answers to the probe represented by the higher numbers signify more ease at letting go of thoughts. For example, answer 1 was 'Very difficult', whereas answer 4 was 'Easy'. The full list of probe answers can be seen in Section 2.2 .

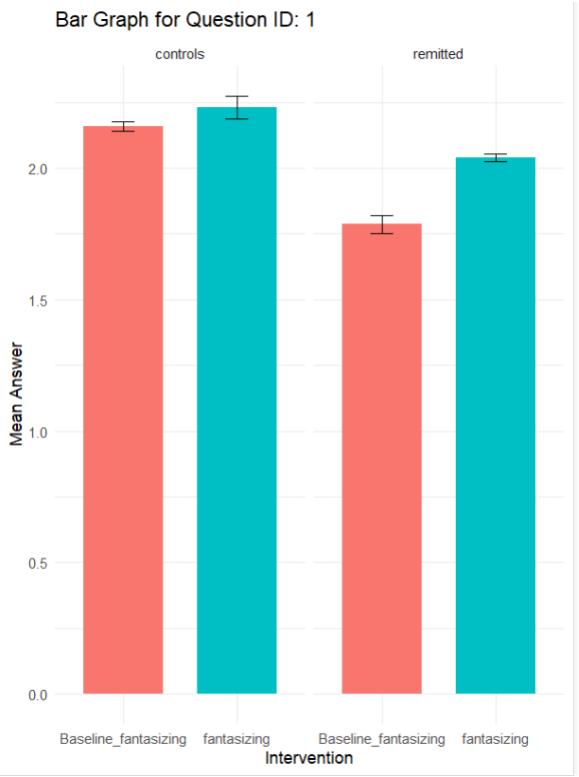

Figure 3.5: Stickiness Probe Answers - shows how the mean answer to the stickiness probe increased for both groups from the baseline measurements to peri-intervention, with a higher mean answer corresponding to them reporting lower stickiness of their thoughts.

In the mindfulness intervention, the three-way interaction effects between response times, group membership and being more on/off-task were not significant on changing the average thought probe responses, however there was a highly significant relationship between an increase in mean response times and a decrease in the probability of being off-task in the remitted group a ($z = -5.880$, $p < 0.001$). Furthermore, solely the intervention type as a main effect significantly improved the ND controls participants' ability to stay on-task when compared to their results at baseline ($z = 2.493$, $p = 0.012$) , suggesting that the mindfulness intervention alone can bring more mental clarity to the participants' during the SART.

4 Discussion

This study aimed to investigate whether baseline performance metrics on a SART could predict the effectiveness of positive fantasizing and mindfulness interventions in reducing PC among individuals in remission from MDD compared to those never diagnosed with it. Although the baseline metrics did not reveal or hint at the efficacy of the interventions, the findings presented suggest that the interventions had distinct impacts on improving baseline response times to the SART and also swayed the answers to the thought probes in less PC-inclined way, with notable differences between the rMDD and ND groups. Specifically, a significant reduction in average RTs were observed in the ND control group for the fantasizing intervention, whereas the same is true for the rMDD group in the mindfulness intervention. The rMDD group reported being more on-task post-intervention, particularly in the fantasizing condition, aligning with their significant reduction in RTs. Additionally, accuracy on the SART was significantly improved by the mindfulness intervention for the control group, indicating that mindfulness may enhance attentional performance in this population, despite not exhibiting a decrease in their average RT. For both groups of participants, their self-reported levels of stickiness of thought reduced after undergoing the interventions, as well as an improvement in their content of thought - meaning their thoughts became less PC-inclined and more pertinent to the task at hand. Overall, these results imply that mindfulness may be the better option for reducing the risk of relapsing into MDD due to the significant effectiveness it had on response times, accuracy and some of the thought probe responses.

The results found for response time changes provide support for other results that have highlighted the role positive fantasizing and mindfulness play in improving cognitive performance on such tasks, with mindfulness appearing to triumph over positive fantasizing as a more effective technique for reducing relapse risk. For the fantasizing intervention, Kappes et al found that engaging in more positive fantasy led to a reduction in response times to a flanker task (Kappes and Oettingen (2011)). Albeit not a SART, response times to these cognitive tests serve as indicators of perseverative cognition, and therefore a significant reduction in response times as found here provides support for those results at least for the control population. An important point to note is that the styles of positive fantasizing used in this study and the Kappes study are indeed slightly different, which could explain these gaps in findings. However, as for the efficacy of mindfulness, a study that also used the same MINDCOG data in this study that investigated

SART metric changes in rMDD and ND patients in mindfulness and positive fantasizing also found a reduction in average response times for rMDD individuals in the mindfulness intervention, supporting the findings of this paper, and in addition they also found a lack of significant changes in response times and accuracy's for those in the fantasizing condition (Kaiser (2022)). The observed improvements in response times and accuracy with the mindfulness intervention also align with other findings from similar mindfulness based stress reduction (MSBR), such as those from Zeidan et al. (2010) who found that even just 4 days of mindfulness training can "enhance the ability to sustain attention" (Zeidan et al. (2010)). Albeit not exactly the same mindfulness as MBCT, both fields utilise similar training techniques and these findings do provide some support to the hypothesis that mindfulness can foster a more focused and less distracted, PC-inclined cognitive state, therefore improving performance on tasks requiring sustained attention.

As seen, the groups seemed to be affected differently by each intervention, with some experiencing reductions in response times from baseline and improved thought probe responses. These differences could be attributed to different baseline cognitive and emotional states of these populations, in the sense that the reason rMDD individuals might benefit more from mindfulness is due to their history with depression, which mindfulness specifically targets by enhancing present-moment awareness and reducing ruminative thinking. In contrast, the ND group, not having experienced the same extent of (or any) depressive symptoms, might find fantasizing more effective as it promotes positive, future-oriented thinking which could be beneficial for them, as they never dwell on the past anyways and therefore don't need help with being present, but aligning themselves with future goals is more natural for them.

An intriguing result that arose is that of the stickiness probe changes, as they exhibit an opposite trend as to what has been found in other research papers such as Besten et al, in which no significant interaction of intervention on the stickiness of these thoughts thinking was found (Besten et al. (2023)). This potentially could be due to other moderators of stickiness not accounted for in the current study, such as the severity of the PC thoughts plaguing the participant at the time of the SART that wasn't picked up in the thought probes, or perhaps some other baseline cognitive differences that would alter the participants' reception of the intervention treatment. Another reason this discrepancy could have arisen is because in this study, the fantasizing intervention lasted for 10 minutes and not a multi-session design fully guided by a fantasizing professional. On the other hand, the reduction in stickiness is in line with conclusions drawn from van Vugt & Broers, which found that with higher self-reported stickiness levels comes a higher probability of off-task thinking and response time variability on a SART (van Vugt and Broers (2016)). This supports the findings of this paper, along with the fact that the accuracy changes we observed here were reminiscent of those in this paper too, which strengthens the suggestion of the efficacy of these interventions at reducing frames of PC-related thought within rMDD individuals.

A strength of the Kaiser paper that was overlooked in this study was that they included the SART trial number as a variable within their statistical models and found that with each additional trial, the average response time decreased by 4.59ms for those undergoing the mindfulness intervention. This exposes a potential gap in this paper, as temporal changes the intervention may have induced in the participants was not explicitly investigated here. It would be prudent for future research to heed this when investigating the long-term effects of these interventions on reducing the risk of relapse into MDD. Another avenue for future research—currently being pursued by other researchers—is to investigate the neural pathways and substrates underlying sticky, negatively-valenced modes of perseverative cognition and whether they differ in ND patients and their rMDD counterparts. Assessing changes in brain activity associated with cognitive stickiness could yield insights into key brain areas mediating states of PC in these individuals, thereby refining intervention efforts to target specific brain regions related to PC and depression.

5 Conclusions

In conclusion, this study investigated the differential impacts of positive fantasizing and mindfulness interventions on perseverative cognition (PC) using a SART among individuals in remission from major depressive disorder (rMDD) and corresponding healthy control participants. The results indicated that both mindfulness and positive fantasizing interventions led to improvements in sustained attentional performance and reductions in response times. However, mindfulness interventions were particularly effective for individuals with rMDD, significantly improving their response times and reducing thought stickiness. Positive fantasizing showed beneficial effects mainly in the healthy control group, where it improved performance on the SART from their baseline metrics to those recorded post-intervention.

These results imply that these interventions could be a valuable tool for relapse prevention in rMDD individuals by reducing maladaptive

thought patterns, as seen in the improvements to the SART they underwent, and combatting these perseverative cognition mindsets using mindfulness and fantasizing practices could help sustain remission and reduce the likelihood of relapse into major depressive episodes.

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