Response to Reviewers (ArticleID #933 (version: 1), Rasmussen et al.)

Dear Dr Maxine Sherman and reviewers,

Thank you for assessing our revised stage two manuscript; *On the neural substrates of mind wandering and dynamic thought: A drug and brain stimulation study*. We have provided a detailed response to each of the reviewer comments in this document. We have also uploaded the revised version of the manuscript to our bioRxiv submission, and have attached a version with the changes tracked to this submission.

Reviewer #1 (Anonymous):

R1.1: *The study reported no significant effect of HD-tDCS on thought modulation but highlighted a potential link between dopamine availability and reduced mind wandering. While the findings were comprehensive, I have a question for the discussion. The authors emphasized task sensitivity for internal thoughts, yet HD-tDCS showed no effect on task performance. Could varying task difficulty levels increase the likelihood of observing HD-tDCS effects? Are there studies that explore this relationship? Are there methodological challenges in designing tasks with varying difficulty within subject for HD-tDCS?*

> We found evidence that task performance during periods of task unrelated thought varied by stimulation group, and this effect interacted with the addition of levodopa. Thus, there is some support for the task being sensitive to the mind wandering measures, and the stimulation and drug administration. Specifically, in the manuscript we state (page 37):
>
> "While these results suggest there may not be a direct interactive effect on self-reported mind wandering, the current study did find an opposing effect of stimulation alone, compared to the interactive effects of stimulation and dopamine on participants behavioural variability during periods of task unrelated thought. Specifically, for HD-tDCS with placebo, those with active stimulation had greater variability in their responses during periods of mind wandering, compared to those who received sham stimulation. In contrast, for HD-tDCS with levodopa, those with active stimulation had less variability in their responses during periods of mind wandering. This aligns with research in other fields where the effect of tDCS is reversed with the administration of levodopa (e.g., motor sequence learning; Leow, Jiang, et al., 2023). Thus, whilst there was no evidence for interactive effects between stimulation and dopamine on propensity to mind wander, there was preliminary evidence that the behavioural consequences of mind wandering may show such an interaction."
>
> We agree with the reviewer that task difficulty manipulations would be an interesting addition to future work. It is possible that varying task difficulty could alter underlying mind-wandering propensity, and thus the likelihood/nature of HD-tDCS and levodopa affecting task performance. For example, Seli et al. (2018) found individuals report more deliberate mind wandering during easy tasks and more spontaneous, unintentional

mind wandering during difficult tasks. In addition, a systematic review looking at the effects of HD-tDCS on enhancing working memory also found that overall, studies that observed stimulation effects used more challenging tasks (Müller et al., 2022). However, to our knowledge, no such investigation of task difficulty has been conducted systematically for mind wandering – let alone the effect of stimulation or levodopa on mind wandering – and this would be an interesting direction for future research.

We have included a section in our discussion to acknowledge the potential role of task difficulty. Please refer to page 38.

"Overall, our findings suggest the FT-RSGT can discriminate between heterogeneous dynamic thought types on task performance during a cognitively demanding task. However, despite this apparent sensitivity, it is important to note that these effects may change depending on the demands of the task, as there is evidence that individuals report more deliberate mind wandering during easy tasks and more spontaneous, unintentional mind wandering during difficult tasks (Seli, Konishi, et al., 2018). The influence of task difficulty on the propensity and nature of mind wandering – alongside the potential for this factor to affect HD-tDCS and levodopa manipulations – would be an interesting route of investigation for future studies in this field."

R1.2: Add titles to the graphs in Figure 6 to provide context at a glance.

We have now added titles to the Figure 6 graphs.

"Complete dataset winning model" and "Stimulation block dataset winning model" (p. 28)

R1.3: Cross-reference the hypotheses in the results section to connect these findings back to the introduction and research plan.

We have added in the hypothesis numbers to the results section to better connect the findings to the research plan. For example, "Thus, we hypothesised anodal HD-tDCS would reduce freely moving thought, relative to the sham group, across participants in the placebo drug condition (H_{1a}). However, we found no evidence to support this hypothesis." (p. 26). We have also added the cross-referencing in for our additional research questions. These changes can be seen below.

"We predicted there would be no change in heart rate, blood pressure or mood with the administration of levodopa. Overall, the findings supported this hypothesis." (p. 30)

"We hypothesised there would be no differences in the relevant traits between the four groups, which was supported by the results." (p. 30)

"We found evidence to support our hypothesis that both participants and the experimenter would be unable to correctly identify their stimulation group." (p. 31)

"These findings also supported our prediction that both participants and the experimenter would be unable to correctly identify whether they were in the levodopa or placebo condition." (p. 31)

Please also see our response to R2.1 where we have added an additional column to our design table to directly link each result back to the research plan.

Reviewer #2 (Chris Chambers):

R2.1: *In the study design table, it would great to add a column to the far right called "Observed outcome" which states for each cell, very simply, whether the hypothesis was supported or not supported (based strictly on whether the results for that test met the preregistered inference criteria). For a complex study with many hypotheses, the inclusion of this additional column will provide a useful overview for readers and will make the outcomes easier to summarise in future SRs/meta-analyses.*

Thank you for this suggestion, we have now added in the additional column to the table which outlines whether each hypothesis was supported. Please refer to page 6-9.