Thank you for the extremely thorough revision, which addresses all of the points raised in my previous decision letter. One of the original reviewers notes a couple of minor points to address in a final Stage 1 revision and response. We should then be in a position to award in-principle acceptance without further in-depth Stage 1 review.

We thank the editor and the reviewers for their expeditious review and are happy to address the remaining points of the reviewer below. Furthermore, I added the reference to the sleep scoring algorithm as in the last version this was accidentally omitted in the last version, and we moved the trail making test to the adaptation night (not analyzed within this RR). You can find our response in bold, sections from the manuscript in cursive, and changes sections in the manuscript highlighted in yellow.

Reviews

Reviewed by anonymous reviewer, 02 Dec 2022 07:37

The authors have done an excellent job with this revision. I only have two comments / suggestions:

Lines 135-6: “Hypothesis 2) TMR leads to the subsequent incorporation of the associated 135 image categories into dreams during both NREM and REM sleep stages.” Is there a memory prediction here? Will TMR-induced dream incorporation benefit memory in both NREM and REM? This is slightly different than the control analysis, in that dream incorporation may actually predict memory consolidation. If the authors do not have a strong hypothesis about whether dream incorporation in one or both stages would affect memory, they could also mention this as another planned analysis later (apologies if I missed this if they did).

We had not specifically included an additional analysis as we predict that the memory effects are the same for spontaneous and TMR induced incorporations. Therefore, H1 includes data from both nights. We do include the factor ‘Night’ (spontaneous vs TMR) in both H1 models, and therefore control for these differences within the model, but this will only detect general differences in memory performance (and not specific to dream incorporation). We think the best option is to do an exploratory analyses using a 3-term interaction (Night:Incorporation:Timepoint) in the H1 model, but not include this in the Registered Report at this point as we do not have a clear hypothesis.

Regarding waking subjects up 10-30 s after TMR, I imagine this range is to allow for some meaningful variability? If not, could the authors please explain this rationale? Also, I suggest that the authors log this information and include it as a predictor in their H2 multilevel generalized model. It could have a strong effect on dream incorporation, which would be instructive for later dream induction efforts.

We agree that we did not explain this choice well and that it is important to collect the data on this as it could influence dream incorporation. We have chosen 10s as a minimum because the direct TMR effects take place across the first 2-3 seconds (Lewis & Bendor, 2019; Schreiner et al., 2018), but potentially the incorporation into dreams could be a slower process and the minimum of a 10-s delay would allow for that. The variability was included for practical reason as the process is not automated and therefore has some innate variability. As we have markers in the EEG for both the TMR and the awakenings we can easily log this information and include this variable in a secondary H2 model. We agree that this is very informative also for future studies.

We have now included this information in the manuscript.

We added the following information to the statistics section (pages 14-15)

Additionally, we will run a following secondary generalized multilevel model (binomial distribution) using random intercepts:

Incorporation_Dreams ~ ***Cued_Topic*** *+ Sleep_stage + Time_cue_awakening + (1 | SubjectID)*

Incorporation_Dreams (numeric) will reflect the incorporation of the task category (separately) for each awakening individually across the task categories seen in this experimental night (% of 3 categories)

Cued_topic (dummy coded categorical) will reflect if the topic was cued prior to the awakening or not (yes = 0, no = 1)

Sleep_stage (sum coded categorical) will reflect the sleep stage from which the awakening occurred (NREM = -0.5, REM = 0.5)

Time_cue_awakening (numeric) will reflect the time delay between the last TMR cue and the awakening in seconds

If Cued_Topic is significant in any of the two models, we will interpret this as evidence for H2, meaning that TMR significantly influences dream content. Furthermore, if Sleep_stage is significant, we will interpret this as evidence that this effect depends on the sleep stage (i.e., it works better in one of the sleep stages). Lastly, if Time_cue_awakening is significant, we will interpret this as evidence that the

incorporation depends on the awakening timepoint (i.e., depending on the direction of the effect it can only be detected immediately or delayed).

As well as in Table 1 (pages 32-34)

Secondary multilevel model correcting for time between TMR and awakening
Incorporation_Dreams ~ ***Cued_Topic*** *+ Sleep_stage + time_between_cue_awakening + (1 | SubjectID)*

Time_cue_awakening

P < 0.05 Support that it's dependent on immediate/delayed awakenings

P > 0.05 no support that it is dependent on awakening time

If either model shows a significant effect this is support for H2, however, interpretation is different. If the secondary model is significant but not the primary this means that only when adjusting for time between cue and awakening the incorporation into dreams can be detected. Depending on the direction of the effect this means that either Incorporations can only be detected if awakenings are done immediately, or alternatively that incorporations need a longer time to happen and that immediate awakenings disrupt this process.

Lastly, we added more information and explanation in the supplemental methods (page 39).

This time window was chosen as TMR effects are usually seen within 2-3 seconds[107,108], but to account for the possibility that incorporation and experience in the dream might take longer. Additionally, the time window always for slight variability due to the practicality of stopping the TMR and awakening the participant. The time between last TMR cue and waking up will be logged using markers in the EEG data.

Additionally, we added information on the EEG markers into the manuscript as we realized that this was not previously described (pages 38 & 41).

The exact start and end of the awakenings will be logged using manually set markers in the EEG.

The task is implemented using Psychopy and automatically sends markers to the EEG to indicate the exact timing of item presentation and response.