

Peer Review

# Review of: "Fornix and Uncinate Fasciculus Support Metacognition-Driven Cognitive Offloading"

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Review of Zheng et al "Fornix and Uncinate Fasciculus Support Metacognition-Driven Cognitive Offloading"

(this review was completed with the help of Jasmine Sekhon, jsekhon@ualberta.ca, BA program, Dept. of Psychology, University of Alberta, Edmonton, Canada)

This study is a DTI investigation of four white matter tracts: the fornix, uncinate fasciculus, superior longitudinal fasciculus, and cingulum bundle, and their involvement in a metacognitive working memory/control task. Findings were derived from 34 participants and showed that people who were less confident in their ability to execute the working memory task without external cues relied more on those cues, and the use of external cues correlated with the structural integrity of the fornix. Higher structural integrity of the left uncinate fasciculus was further correlated with optimal cue use. Finally, the integrity of the right superior longitudinal fasciculus mediated the link between underconfidence in performing the task without reminder cues and actually using the cues, showing a positive relationship only for those with lower structural integrity of this white matter tract.

This manuscript is well-written, presents a sophisticated metacognitive task, and interesting results. A few comments below:

1. The study might be underpowered, but this is difficult to evaluate without a sample size/power calculation. Was this done?
2. Acknowledging the use of Bayes factors and bootstrapping, it would be reassuring to have some corrections for multiple comparisons given the large number of individual analyses carried out with a modest sample size. Could some of the bilateral FA values be combined across hemispheres, or was there a theoretical reason to keep them separate?
3. We had a bit of trouble parsing and then following this rather complex task and the multitude of behavioral indicators from it. A few questions about this task, plus suggestions around its presentation in the paper:
  - a. Reading through the task description, the element of reward and 'points' optimizing occurred too late in the paper, and we felt that it would have been helpful to first see the original instructions and what the participant's overarching goal for this task was.

b. The task contained very few trials (13 total), and the behavioural analyses were performed with one-sided t-tests. Is this different from the original task? How stable was the behaviour? Was there a ceiling effect for the external reminder trials?

c. A theoretical question: The ‘special circle’ fading to yellow color creates a temporary, short-lived working memory demand, and “offloading” occurs within that domain, not episodic memory. Although the exact trial timing is not clear, the duration of the delay is presumably not what one would expect of retrieval delays in episodic memory tasks. If this is true, do the interpretation and implications for involvement of the white matter tracts, e.g., the fornix, change? If that’s not the case, we would recommend making the episodic memory element clearer.

d. The authors did a great job with Figure 1, and the description of Figure 1A in the legend is clear. A slightly more extended explanation of the same content is provided in the manuscript itself, which is also helpful, but we would recommend making the in-text example match the Figure. Specifically, the Figure shows a “special” circle in blue, but the in-text example describes a “special” circle in orange. This is unnecessarily confusing.

e. The “confidence prediction” indicator that is later used in the imaging analyses is presumably derived from the participants’ confidence judgments of remembering “special circles” without the use of cues, i.e., their “internal memory”. This confidence judgement was made after task instructions and some practice trials, but there is no information about the instructions or practice trials (see also comment 3a), such as how long or how many practice trials were conducted, whether the number of practice trials was the same or different across participants, and so on. Furthermore, since there were two “confidence judgements” in the task (internal and external) but only one of them was used for analysis, this should be made clearer in the methods section.

f. Using absolute values of the metacognitive bias and the reminder bias occurs too late (in the results section) and should have been described already in the methods section. Using either raw bias scores or their absolute values would be less confusing than using both, but if both are retained, they should clearly be described in the methods section, in the form of higher values in XXX indicate YYY. It gets confusing to interpret the directions of the various correlations otherwise, throughout the paper.

4. Does the correlation survive without the person on the very right end of the regression line in Figure 2B (i.e., this may or may not be an outlier)?

5. The moderated regression might benefit from a citation to make the motivation for choosing the right SLF for this analysis clearer. The illustration of the effect along the three groups of people with ‘high’, ‘medium’, ‘low’ FA values of the right (why not also the left? The choice to focus only on the right SLF may be explained by the missing citation) SLF makes sense, but the grouping should be explained explicitly, i.e., how/why are there 12 people in the ‘low’ FA group, 11 in the ‘medium’ FA group, and 10 in the ‘high’ FA group? Also, conceptually, the correlation between the raw reminder bias score and the raw metacognitive bias score represents different things depending on negative or positive scores within each of the biases. Especially given that the reader was just presented with absolute (not raw) bias scores, it might be beneficial to (re-)explain here what a negative/positive score in each of these biases means and what their negative or positive correlation means. It might also be helpful to label the positive/negative anchors on both the x-axis and y-axis of figure 2C directly.

6. Although FA is a common metric for white matter integrity, it would be helpful to clearly spell this out early on in the paper's introduction.

7. The significance and implications of knowing white matter contributions to task performance metrics could be made more poignantly in the introduction and in the discussion. For example, the concluding sentences allude to the observed neural/WM differences involved in metacognition-driven cognitive offloading, versus metacognitive monitoring, control, local metacognition, and global metacognition. The subtle differences between these behavioural constructs are difficult to appreciate when presented in a list format like this. Perhaps focusing on the main construct of interest here (offloading?) and explaining the significance of the findings with this in mind might be an option, but we will leave this up to the authors.

8. The last paragraph of the introduction becomes very technical and hard to follow. Maybe adding a visual guide or breaking the section up could be helpful.

Wording/Typos:

- Page 7/18 "difference OIP and AIP as reminder bias" - make clear what the difference is between. Also, note the spacing.
- In the same paragraph, OIP is spelled "OPI"
- Page 11/18 - correct word spacing in the paragraph before the Discussion section

## Declarations

**Potential competing interests:** No potential competing interests to declare.