Metamemory monitoring and control: A high definition transcranial direct current stimulation study
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**Introduction**

- Metamemory (i.e., knowing what you know and what you don’t know) involves monitoring, the ability to accurately assess the content of one’s memory, and control, altering behaviors based on that assessment (Nelson & Narens, 1990).
- Few studies have examined the relationship between monitoring and control at retrieval (Hanczakowski, Pasek, Zawadzka, & Mazoni, 2013; Hanczakowski, Zawadzka, & Cockcroft-McKay, 2014).
- Previous research has shown that HD-tDCS to the left DLPFC improves monitoring accuracy using a semantic feeling-of-knowing (FOK) task (Chua & Ahmed, 2016; Chua, Ahmed, & Garcia, 2017).

**Current Study Aim:**

- Determine the influence of metamemory monitoring on strategic control of memory & the role of the DLPFC in metamemory processes.

**Hypothesis:**

- Brain stimulation over the left DLPFC, compared to sham, will lead to improved metamemory monitoring, which in turn leads to better strategic control of memory.

**Initial Memory Performance Matched Across Stimulation**

![Graph showing initial memory performance matched across stimulation types.](Image)

Participants were matched on initial recall across stimulation type (p = .109).

**“Once-Knowing” the Answer Impacts Choice**

![Graph showing “Once-Knowing” the Answer Impacts Choice.](Image)

Participants were more likely to choose to re-answer an incorrect question again with a hint if they “Once-Knew-it” (OKI). Additionally, in the “DLPFC during” session, participants reported “once knowing” a higher proportion of items (non-recalled questions) compared to sham.

**Methods**

**3 HD-tDCS Sessions**

- **Stim A (DLPFC during):** 15 min during Phase 1
- **Stim B (Sham):** 15 min during Phase 1
- **Stim C (DLPFC after):** 15 min after Phase 1, but before phase 2

**Participants**

- 36 participants (25 females) ages 18 – 34 (M = 24, SD = 4.95) with no contraindications to HD-tDCS.

**Behavioral Task**

**Phase 1: Metacognitive Monitoring Task**

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  - “Once-Knew-it” (OKI):
    - Have you ever known the answer to the question?
    - How did NASA Scientists find rocks they nicknamed “Yogi” and “Scooby-Doo”?
    - Press enter when you are finished.
  - Recall:
    - Please type in the answer to the question.
    - How sure are you that you can recognize the correct answer?
    - Press enter when you are finished.

**Phase 2: Metacognitive Control Task**

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  - Re-answer Choice:
    - Would you like to re-answer the question again with a hint?
    - If yes, press “y”. If no, press “n”.
  - Counter:
    - Choices remaining: 12
    - Questions remaining: 5
  - Cued-Recall Stimuli:
    - 33 participant chosen from Phase 2
    - 33 researcher chosen

**Phase 3: Cued-Recall and Recognition tests**

- Cued-recall:
  - Please type in the answer: Starts with “m”.
  - Where did NASA scientists find rocks they nicknamed “Yogi” and “Scooby-Doo”?
  - Press enter when you are finished.
- Feedback:
  - Great Job!
  - 1 Correct
- Recognition:
  - Choose the correct answer.
  - Where did NASA scientists find rocks they nicknamed “Yogi” and “Scooby-Doo”?
  - More: Moon, Yellowstone, Mars, Nevada

**Conclusions**

- Participants used metamemory monitoring outputs to make decisions about what to answer again with a hint.
  - OKI (familiarity with question)
  - FOK (familiarity with answer)
  - Participants indicated that “once knew” the answer to more items for DLPFC during stimulation compared to sham, however this finding did not extend to FOK ratings. This may indicate that stimulation led participants to have an increased sense of familiarity for the question, as opposed to increased access to the answer.
  - Cued-recall performance was greater for items they chose to answer again with a hint, compared to those that the researcher chose. This finding, coupled with the participants tendency to choose items that they felt were within memory, shows that participants use the outputs of monitoring to make strategic control decisions, and that these decisions lead to increased memory performance.

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