

Facilitating problem solving with targeted memory reactivation during in-lab overnight sleep

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BACKGROUND

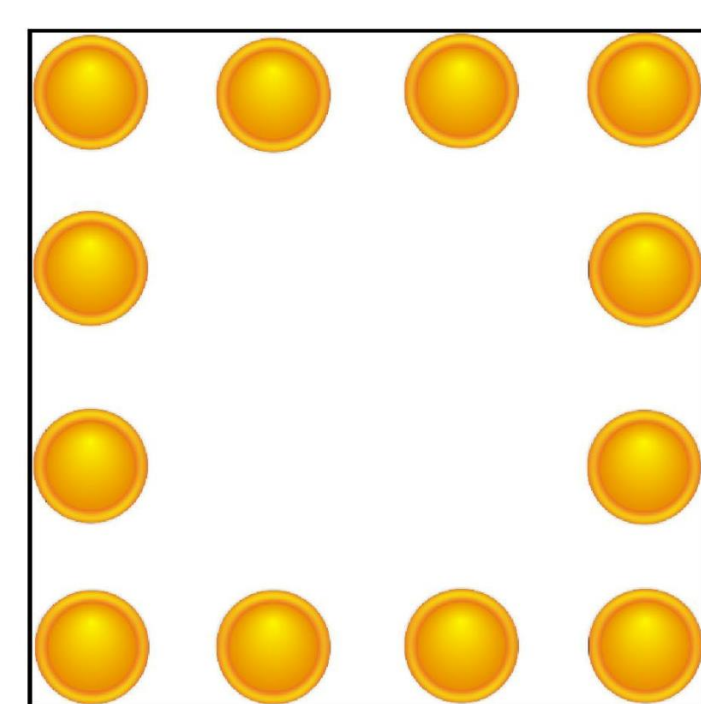
- Sleep facilitates problem solving both anecdotally¹ and experimentally².
- One mechanism of this effect may be the reactivation of memories during sleep which is associated with memory strengthening³ and restructuring⁴.
- In a recent study, we demonstrated that participants were more likely to solve puzzles that were reactivated while participants slept at home overnight than puzzles that were not reactivated⁵.
- The current study sought to replicate our previous finding in a laboratory setting to identify neural markers of sleep-cueing-facilitated problem solving.

METHOD

Participants: N = 40 (26 Female)

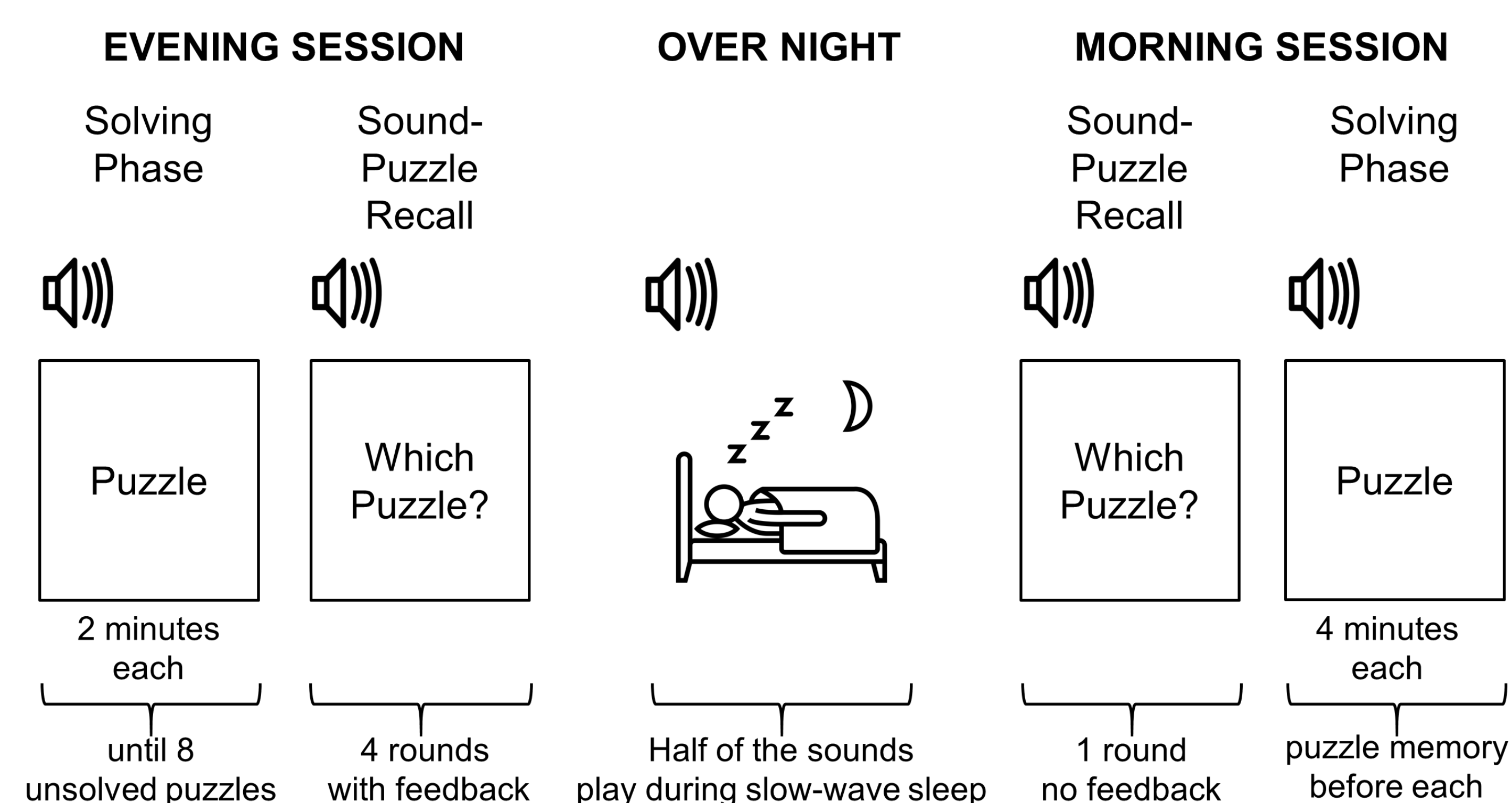
Materials: subset of 25 puzzles from previous study, four categories (matchstick, rebus, spatial, verbal) and 26 randomly paired, distinct sounds (one additional sound presented as a baseline sound during overnight cueing)

Example puzzle:



This square uses 12 coins to form a square with 4 coins on each edge. Using 12 coins, create a square that has 5 coins on each edge.

Procedure:



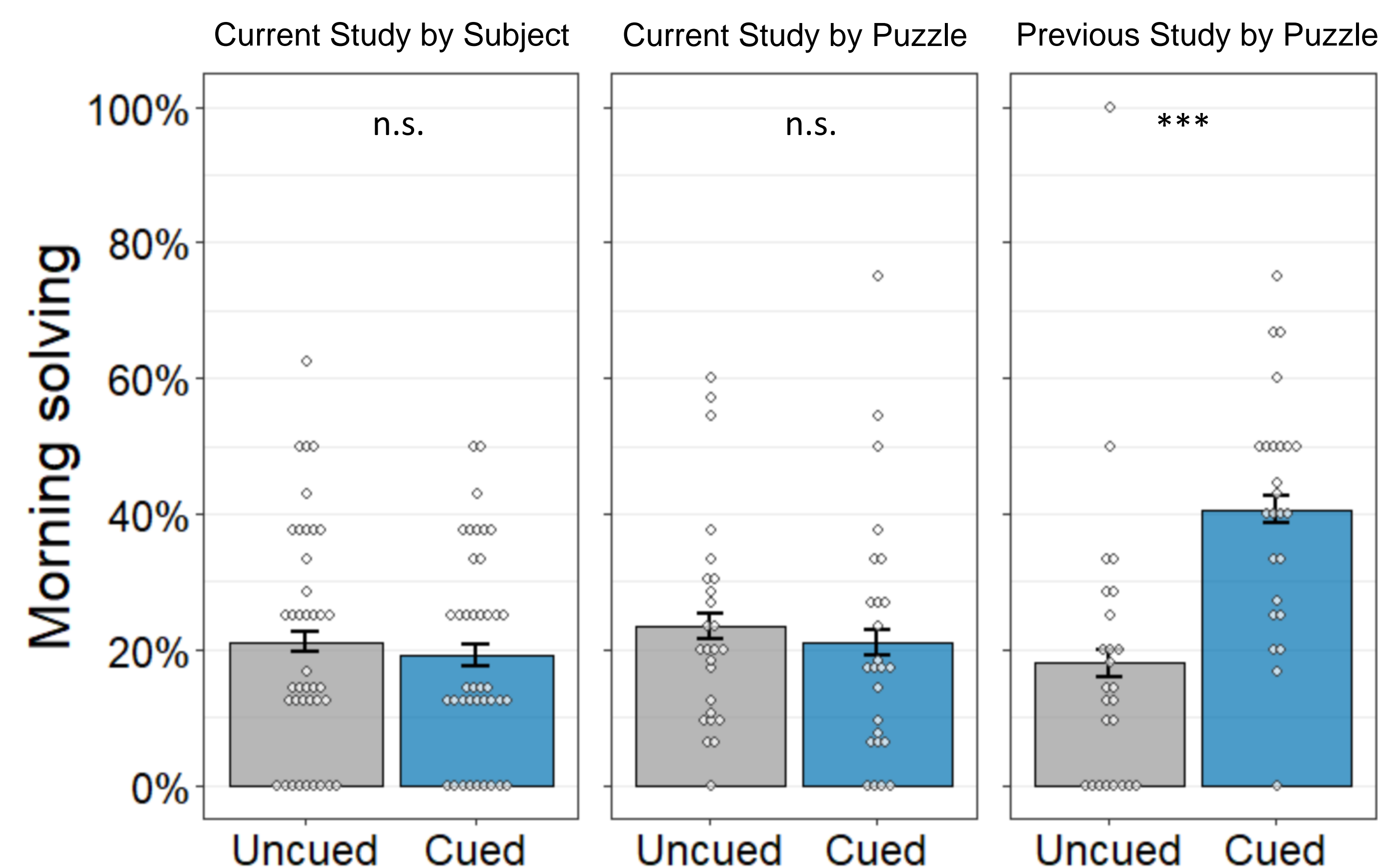
****Participants completed the same procedure twice in consecutive sessions with different sounds/puzzles to increase power**

ACKNOWLEDGEMENTS

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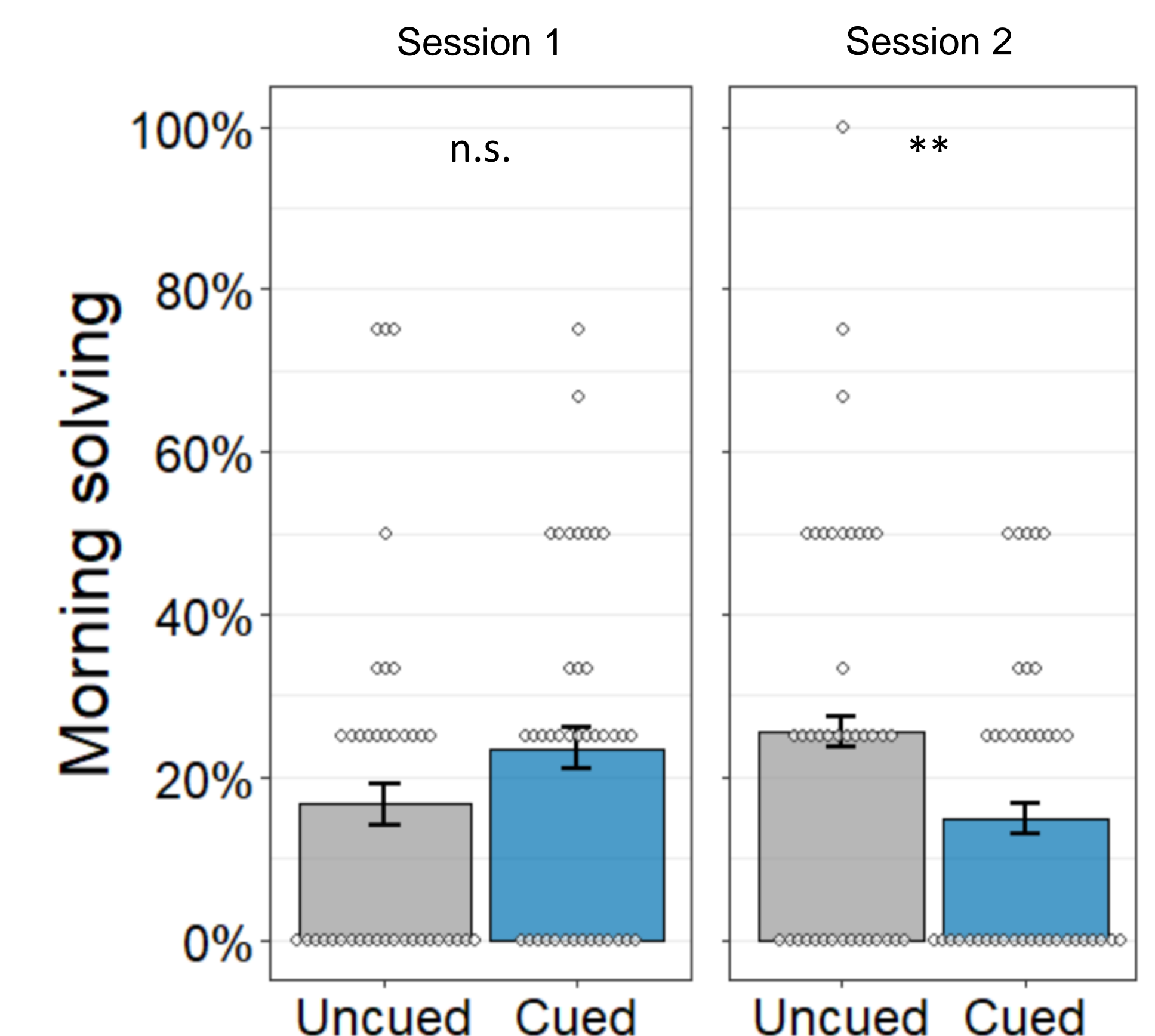
RESULTS

Cueing did *not* improve problem solving in this study



Percent of Uncued compared to Cued puzzles solved averaged by subject (n = 40, left), by puzzle (n = 25, center), and by puzzle for the same 25 puzzles in a previous experiment with at-home cueing (right). **Cueing Effect = Cued – Uncued solving**

Cueing had a different effect on the first and second nights of the experiment



Percent of Uncued compared to Cued puzzles solved on the first (left) vs. second (right) morning of the study. Participants completed the same procedure with different puzzles and sounds on consecutive days.

Sleep Differences between first and second sessions

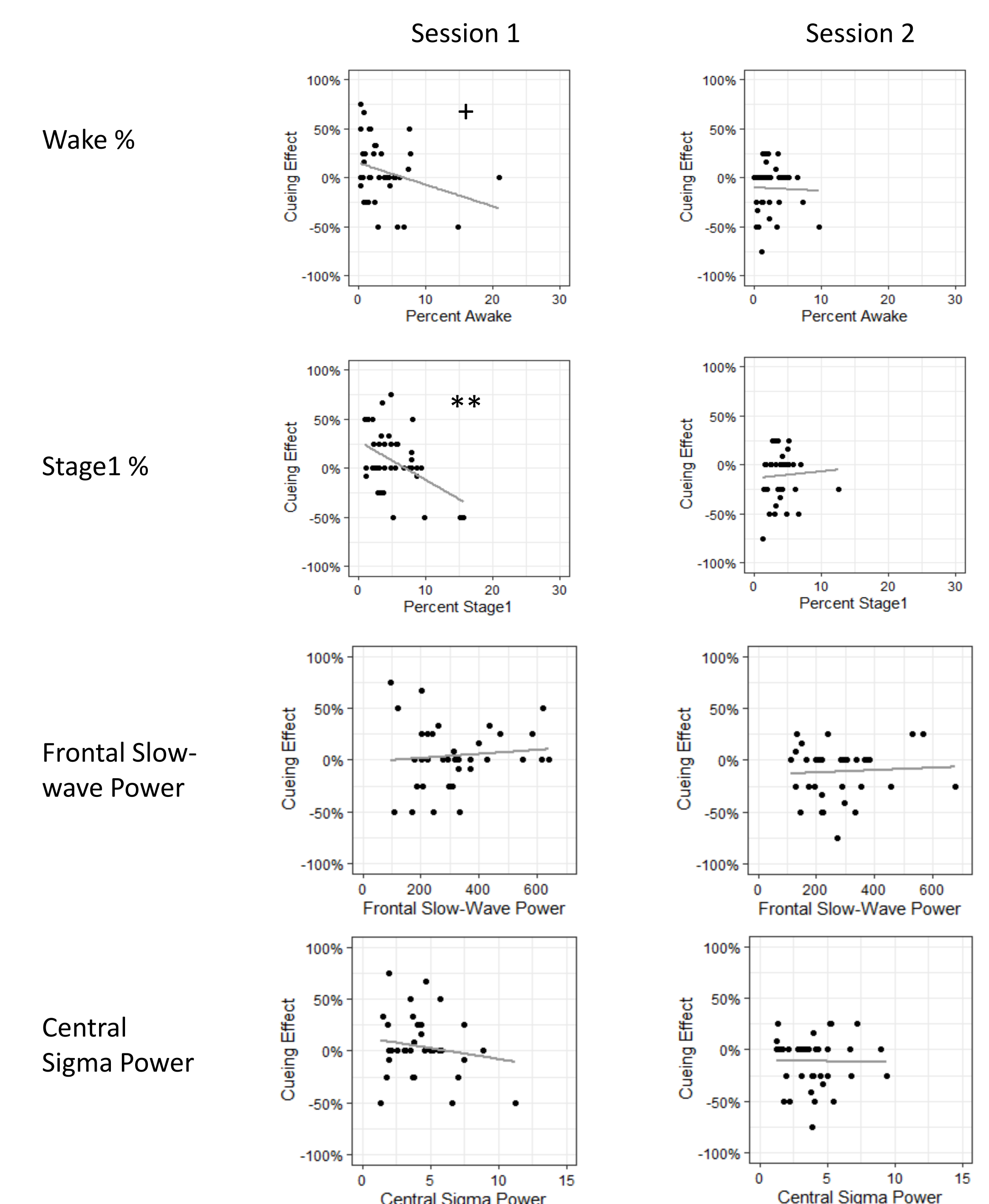
Comparison of Session 1 and Session 2 Sleep Data

	Session 1 Mean (SD)	Session 2 Mean (SD)	t	p
Wake %	3.66 (4.11)	2.40 (2.09)	2.20	.03*
Stage 1 %	5.21 (3.47)	4.12 (1.96)	2.10	.04*
Stage 2 %	45.29 (11.30)	46.25 (11.58)	-1.31	.20
SWS %	31.38 (10.97)	31.71 (10.35)	-.03	.97
REM %	14.46 (4.33)	15.52 (5.81)	-1.37	.18
Total Minutes Asleep	445.99 (27.03)	458.26 (33.75)	-2.97	<.01**
Subjective Sleep Quality (1 very good – 4 very bad)	2.25 (0.66)	2.00 (0.59)	1.71	.10
SWS frontal slow-wave power (0.6-1.2 Hz)	319.63 (150.07)	277.04 (127.65)	2.14	.04*
SWS frontal delta power (1-4 Hz)	295.65 (134.96)	266.81 (127.44)	1.40	.17
SWS central sigma power (12-15 Hz)	4.27 (2.22)	3.91 (2.01)	2.61	.01*
SWS occipital alpha power (8-12 Hz)	5.18 (3.82)	4.63 (2.85)	1.52	.14

SUMMARY & FUTURE DIRECTIONS

- Unlike previous at-home studies, we did not find that cueing unsolved puzzles overnight facilitated problem solving the following morning.
- We found the study session moderated the cueing effect and participants' sleep differed between the two sessions; but, so far session differences do not explain the cueing-effect differences.
- Next, we will further analyze the data for sleep architecture e.g. sleep spindles, k complexes and the neural response to specific cues.
- Future studies could more closely replicate previous at-home studies in the laboratory environment.

Session differences did not predict solving cueing effect



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