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BACKGROUND

Why do we forget our earliest childhood memories?

Infantile amnesia: Inability to recall early childhood episodic memories¹

2nd year of life: transition period for episodic memory abilities²

- Shift towards flexible, longer-lasting representations^{3,4}
- Maturation of hippocampus^{2,5}
- Offset of infantile amnesia⁶

Research question: How do toddlers begin to form and retain long-lasting episodic memories?

Study aim: Investigate neural correlates of episodic memory formation, retention, and forgetting in the second year of life

METHODS

Participants: 104 German toddlers aged 18-20 months

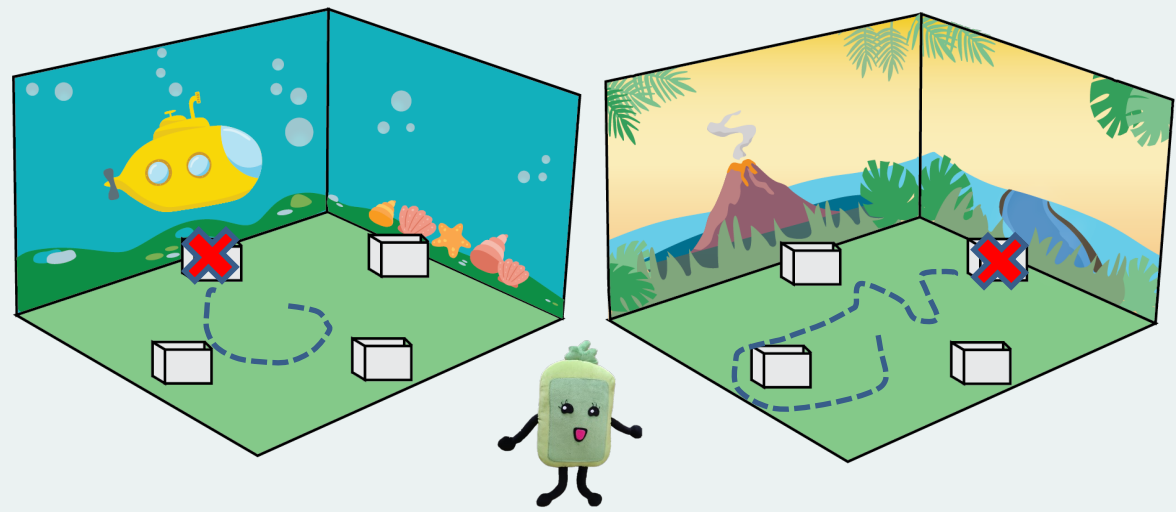
Episodic memory paradigm: Object-location-context association task⁷

- Human adaptation of Barnes maze⁸
- Longitudinal design:



Mobile EEG:

- 32-channel, active electrode system
- Toddlers freely moved during task
- Development of custom preprocessing pipeline



RESULTS

Toddlers form associative memories and retain them for up to 3 months

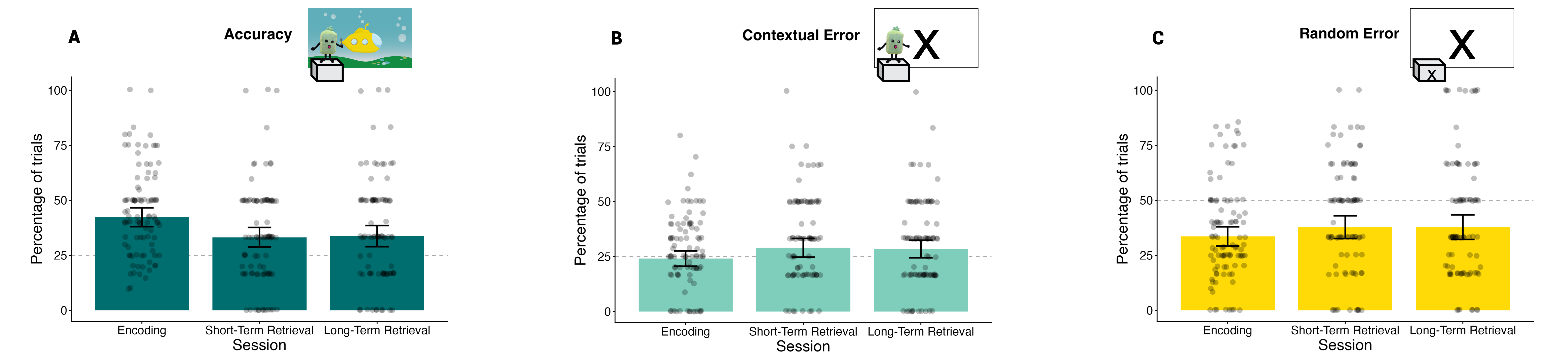


Figure 1. Percentage of correct (A), contextual error (B), and random error trials (C) in all three sessions (encoding, short-term retrieval, long-term retrieval). Chance level is 25% for correct and contextual error, and 50% for random error.

Lower oscillatory power before correct vs. incorrect responses

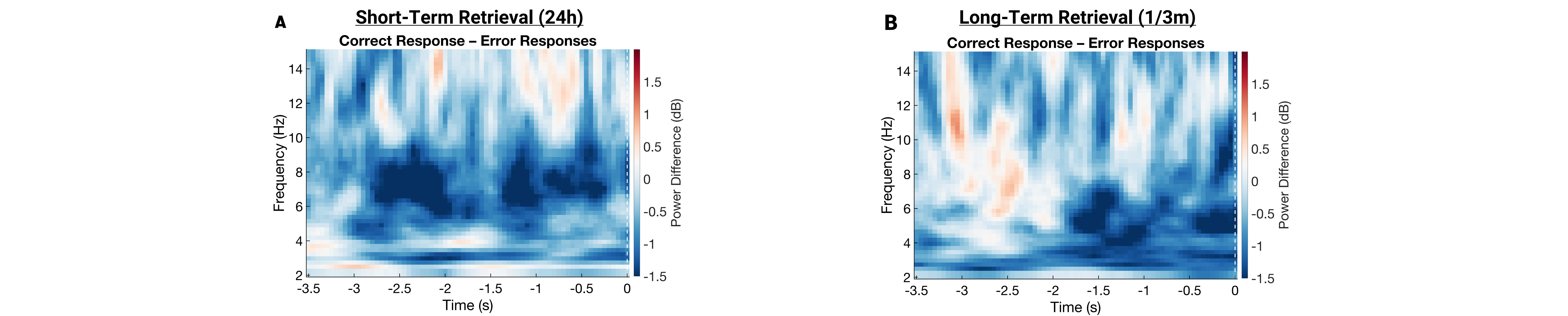


Figure 2. Time-frequency plots for short- (24h) (A) and long-term retrieval (1 month/3 months) (B) showing lower low-frequency power before correct vs. error responses.

Theta band effects are stable, alpha/beta band effects attenuate over delays

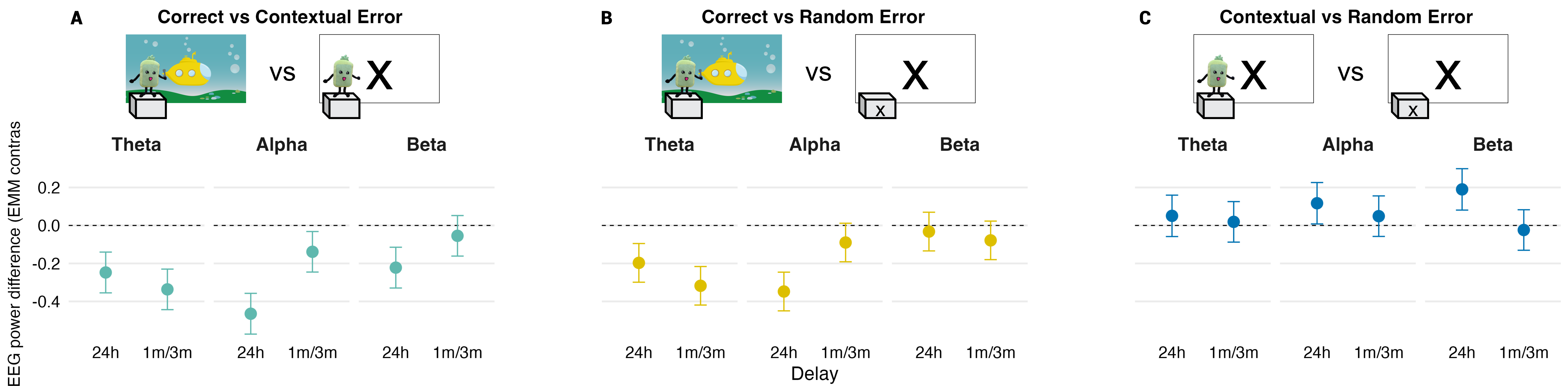


Figure 3. Estimated marginal mean (EMM) contrasts derived from linear mixed models for theta (2 – 5 Hz), alpha (5.5 – 8.5 Hz), and beta (9 – 15 Hz) frequency bands across delays. Contrast represent pairwise differences between (A) correct response vs. contextual error, (B) correct response vs. random error, and (C) contextual vs. random error. Positive values indicate higher EEG power in the first condition of each contrast.

SUMMARY AND CONCLUSIONS

- Toddlers retain behavioral and neural memory signatures for months after encoding, even in the infantile amnesia period
- Theta effects differentiate correct from incorrect responses and remain stable across months, alpha/beta effects scale with memory specificity and attenuate over delays
- Mobile EEG in naturalistic tasks opens new possibilities for investigating early cognitive and memory development in real-life settings