A behavioural and electrophysiological investigation of novel word learning

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Words in the World 2020

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What does it mean to learn a word?

Encoding and storing

- phonological form

- concept

- association between the word form and the concept

Integrating
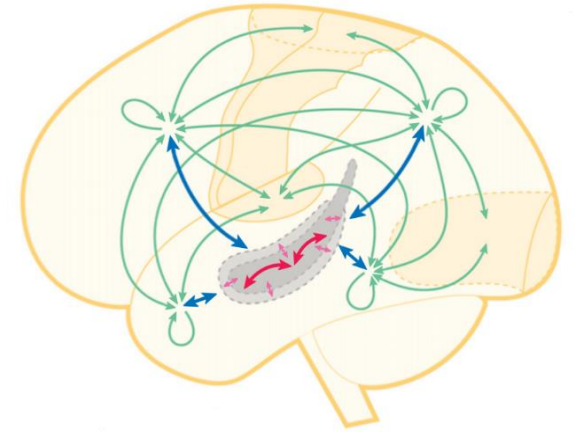
- in the network of familiar words and connections

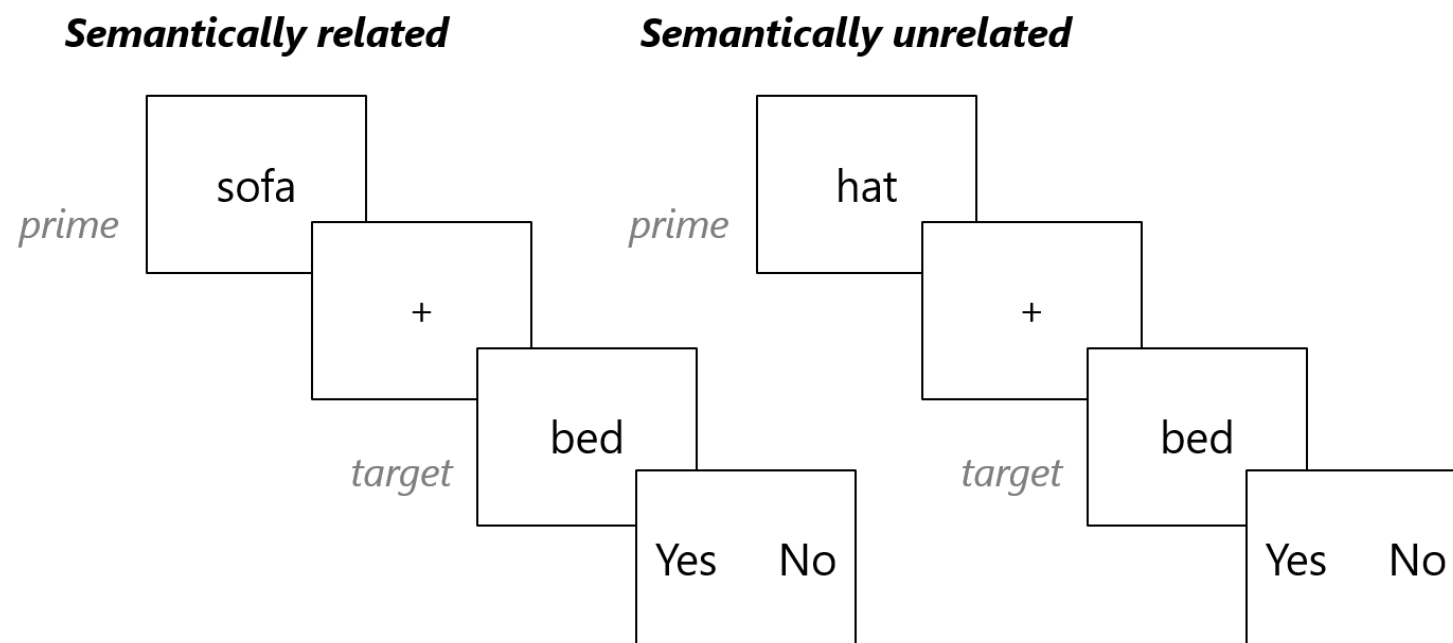McMurray et al., 2016

Complementary Learning Systems (CLS)

2 systems ➔ **2 stages** of word acquisition

• Formation of traces in episodic memory (MTL)

• Integration into neocortex through systems consolidation

> ➢ **Lexical plasticity**: update predictions

> ➢ **Pattern completion**: fill in associations

> ➢ **Bottom-up processing**: align mappings within & across the lexical system

➔ In tasks that require activation flow over multiple pathways, only integrated novel words can compete for selection

Davis & Gaskell (2009), updated in McMurray et al. (2016); based on McClelland et al. (1995; 2013), Kumaran et al. (2016)

Semantic priming

Semantically related   **Semantically unrelated**

sofa   hat
prime   *prime*
+   +
bed   bed
target   *target*
Yes   No   Yes   No

(e.g. McNamara, 2005)

Semantically related condition:

- **Shorter RTs**
- **Reduced N400** ➔ automatic processes of lexical-semantic retrieval (e.g. Kutas & Federmeier, 2011)
- **Enhanced LPC** ➔ episodic memory retrieval & explicit semantic access (e.g. Rugg & Curran, 2007)

Semantic priming with novel words

At targets preceded by semantically related primes

Familiar words as primes & targets	Primes: trained novel words; targets: familiar words	Primes: familiar words; targets: novel trained words
Shorter RTs	• Shorter RTs (e.g. van der Ven et al., 2015) • No difference in RTs between conditions (e.g. Batterink & Neville, 2011)	Shorter RTs (Bakker et al., 2015)
Reduced N400	• Immediately after exposure (e.g. Borovsky et al., 2013; Perfetti et al., 2005) • 24h after exposure or later (Breitenstein et al., 2007; Coutanche & Thompson-Schill, 2014; Tamminen & Gaskell, 2013; van der Ven et al., 2015)	No reduction in N400 either immediately or 24h after exposure (Bakker et al., 2015)
Enhanced LPC		Immediately after and 24h after exposure (Bakker et al., 2015)

Semantic priming with novel words

Suggested interpretation

- **reduced N400 & enhanced LPC**

➔ novel words at least partly integrated

Behavioural effect co-occurring with…

- **enhanced LPC only**

➔ behavioural effect is subserved by episodic rather than semantic memory

Why all this inconsistency?

Methodological limitations?

- **Word-to-word association priming** through co-occurrence during learning
  (Breitenstein et al., 2007; Perfetti et al., 2005)

- **Strategic thinking and awareness of manipulation**

  ➢ Prime-target relatedness or animacy judgements at targets (Bakker et al., 2015; Breitenstein et al., 2007; Perfetti et al., 2005)

  ➢ Word judgements done at targets only (Bakker et al., 2015; Batterink & Neville, 2011; Breitenstein et al., 2007; Perfetti et al., 2005; van der Ven et al., 2015)

Different training procedures?

- words paired with pictures (Breitenstein et al., 2007) or definitions (Bakker et al., 2015; van der Ven et al., 2015)
- presented in sentences or texts (Batterink & Neville, 2011; Borovsky et al., 2013)

Current study

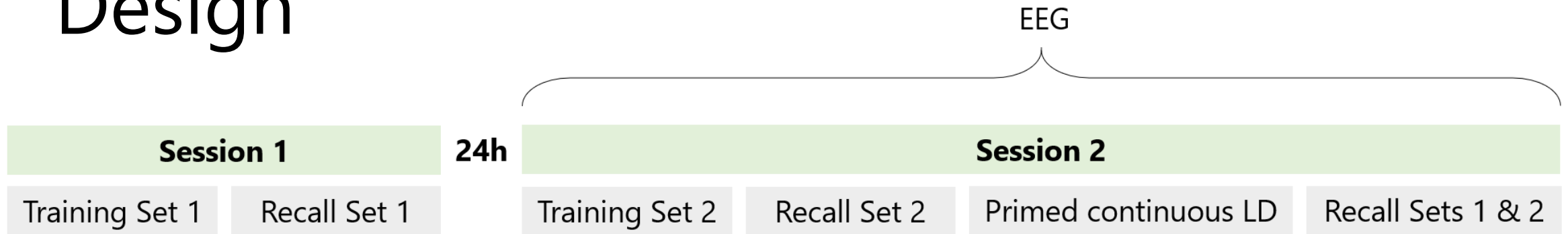In learning of novel names for novel concepts, …

Integration

- *RQ 1*: How do behavioural markers of integration map onto electrophysiological markers of integration?

Encoding

- *RQ 2.1*: Does LPC amplitude during encoding predict subsequent recall success?

- *RQ 2.2*: How do neural oscillatory patterns change during encoding?

Design

- 2 sessions with 24h in between
- 2 sets of novel concepts with 20 novel names per set

- Training
  - ➢ novel names paired with definitions (4 sentences per concept)
  - ➢ 4 EEG measures per name in Session 2

- Primed continuous LD
  - ➢ Targets: novel names from both sets
  - ➢ Primes: familiar words, semantically related or unrelated to targets
  - ➢ LD at both primes and targets

- Recall: oral & typed responses

To conclude…

We will analyse whether

Integration

- RTs, N400 & LPC at newly trained words are modulated by
  - ➢ prime-target relationship
  - ➢ time after exposure: 24h (Set 1) vs. 0h (Set 2)

Encoding

- LPC amplitude to novel words during training predicts later recall performance

- How neural oscillatory patterns change during training *(exploratory)*

  - ➢ Power increase in theta band (4-7 Hz) ➜ memory formation & activity within hippocampal-neocortical loops? (e.g. Klimesch, 1999)

  - ➢ Beta desynchronization (16-21 Hz) ➜ lexical-semantic processing? (e.g. Hanslmayr et al., 2012)

Pre-registration to be released soon!

Thank you for your attention!

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