Cross-situational learning of word-gesture pairs in children and adults: a behavioral and event-related potential study

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Presentation

- Background
- Research questions
- Methods
- Results
- Conclusions
- Next studies overview

Acknowledgments

- Dr Varghese Peter
  University of the Sunshine Coast, Brisbane

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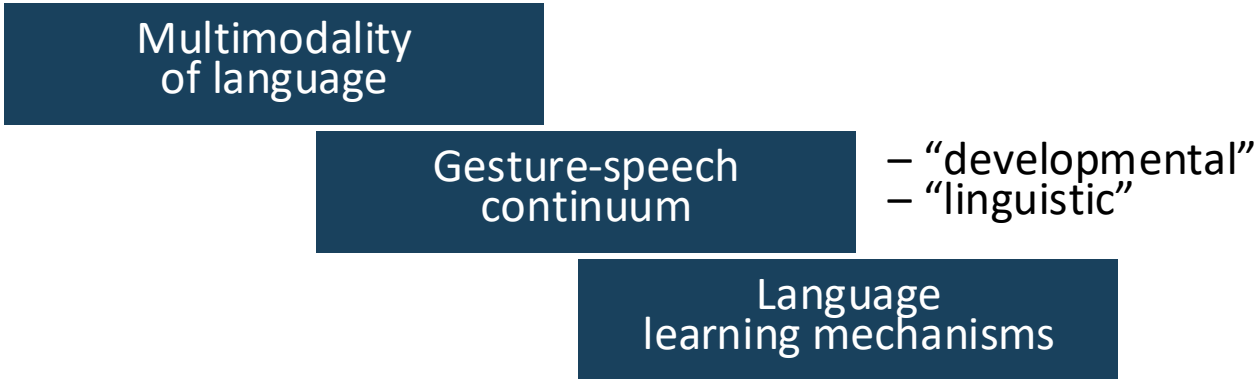
  Lab group at Macquarie University, Sydney

Background

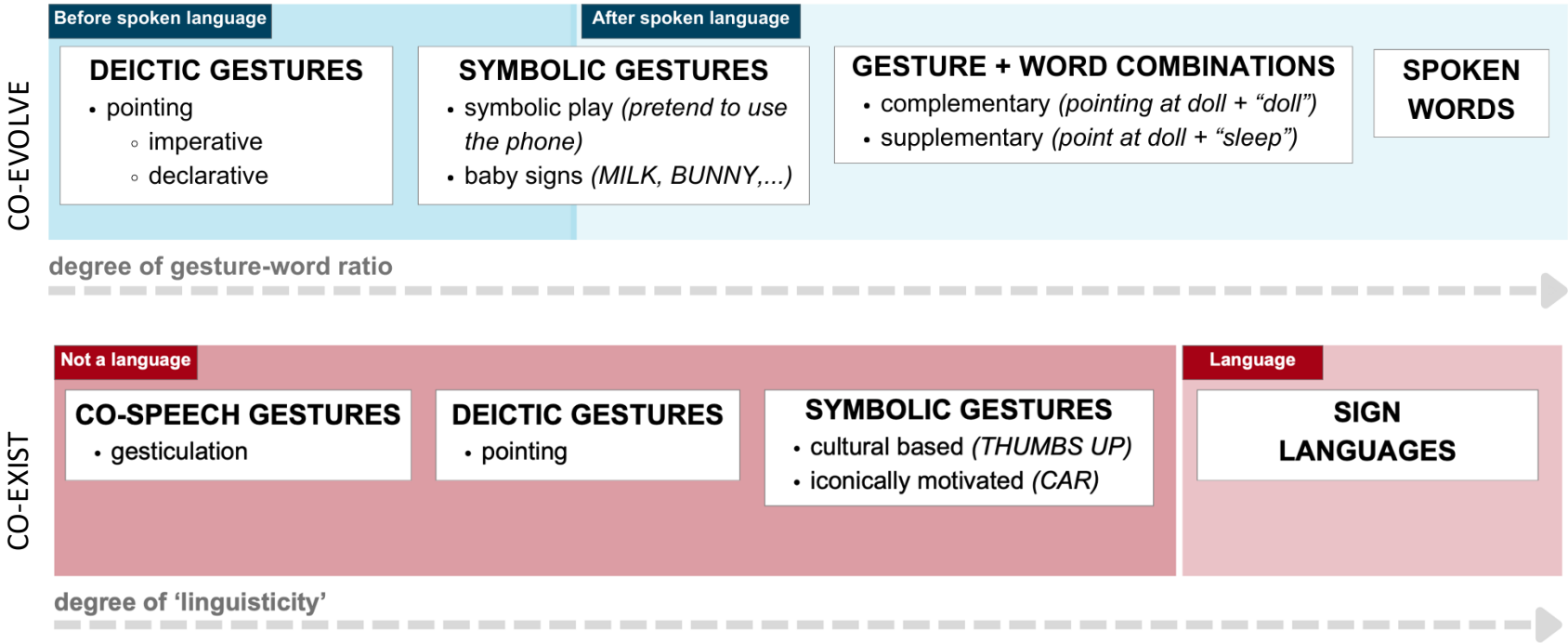
Background



- Gestures and words share a common neural system
- They develop on a gesture-speech continuum
- Language is learned through innate ability of detecting regularity

Xu et al., 2009; Fabbri-Destro et al., 2015; Bates et al., 1979; Capirci & Volterra, 2008; Yu & Smith, 2007

Gesture-speech continuum



Adapted from Kendon, 1988; Bates et al. 1979

Gestures vs. signs

SYMBOLIC GESTURES

- arbitrary
- context-independent
- semantic information
- specific referent
- **produced in isolation**
- **produced with speech**

≠

SIGN LANGUAGE SIGNS

Experiment 1

Research questions

Cross-situational learning of word-gesture pairs in children and adults: a behavioral and event-related potential study

1. Is it possible to associate **novel symbolic gestures** with familiar spoken words?
2. Is it possible to **build semantic categories** of the novel symbolic gestures?
3. In case of semantic violation, do symbolic gestures elicit **similar brain responses** to words?
4. Is it possible to learn thanks to statistical learning abilities (cross-situational learning)?

Methods

Methods

Participants

- Children (8–11 y.o) N = 24
- Adults (18–35 y.o) N = 19

Stimuli: 8 word-gesture pairs

- 8 words (8 semantic categories) matched with 8 novel symbolic gestures

Measures:

- Behavioral tasks (yes/no task)
- Electrophysiological responses (ERP - N400)

Paradigm:

- Cross-situational statistical learning

Static depiction of the 8 symbolic gestures and matched target words

Paradigm

Cross-situational statistical learning (Yu & Smith, 2007)

- ambiguous learning trials
- multiple referents and labels
- no explicit indication of word-referent correspondences

→ ability to identify the correct association by **implicitly detecting co-occurrences** across the trials →

LEARNING

Chosen to recreate a naturalistic learning environment

Escudero, Mulak, & Vlach, 2016; Smith & Yu, 2008; Mulak et al., 2019

Paradigm

1. **Familiarization phase (46 trials)** →
   - cross-situational learning of word-gestures pairs

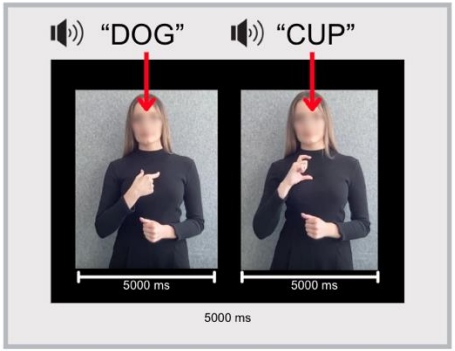
2. Recognition task (96 trials)
   - check learning of gesture forms (yes/no task)

3. Categorization task (96 trials)
   - check semantic learning (yes/no task + EEG and N400)

Static depiction of the familiarization task

Paradigm

50%



OR

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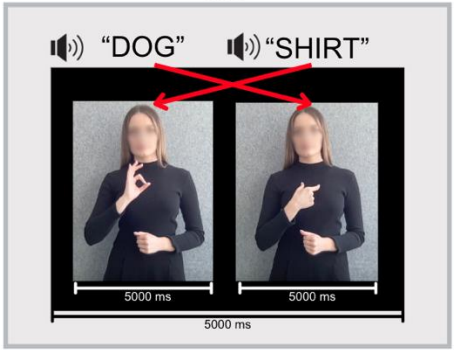

Familiarization task running in the lab

Paradigm

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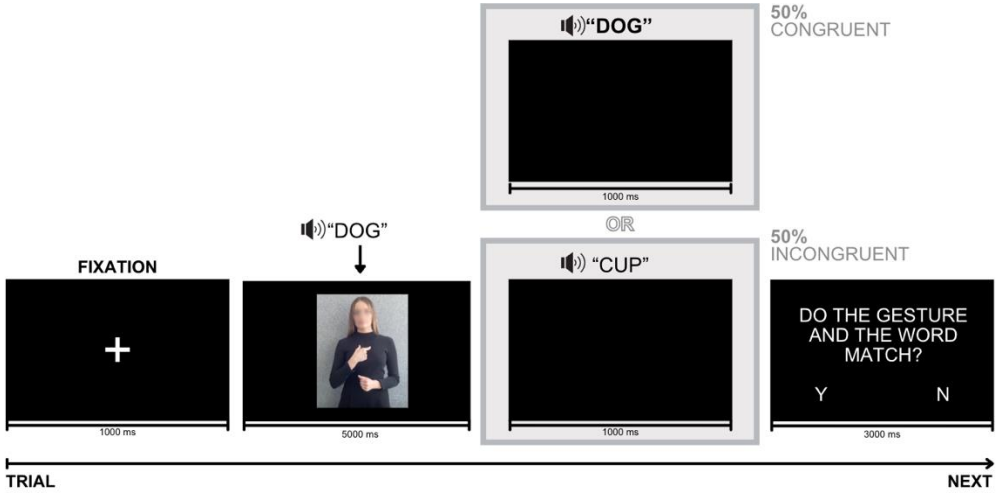

Static depiction of the recognition phase

Paradigm

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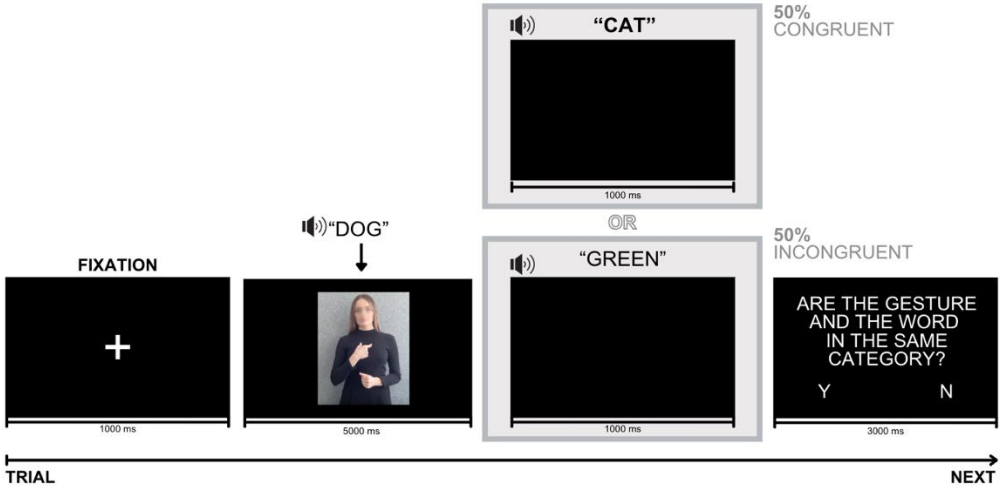


Static depiction of the categorzation phase

Analysis

Behavioral data:

- Accuracy = percentage of correct answers on total number of trials
- D-prime = measure of sensitivity that takes into account participants' response strategy

ERP data:

N400

- associated to semantic access/retrieval of the meaning of a word form
- interpreted as a mark of semantic processing (Kutas & Federmeier, 2011)

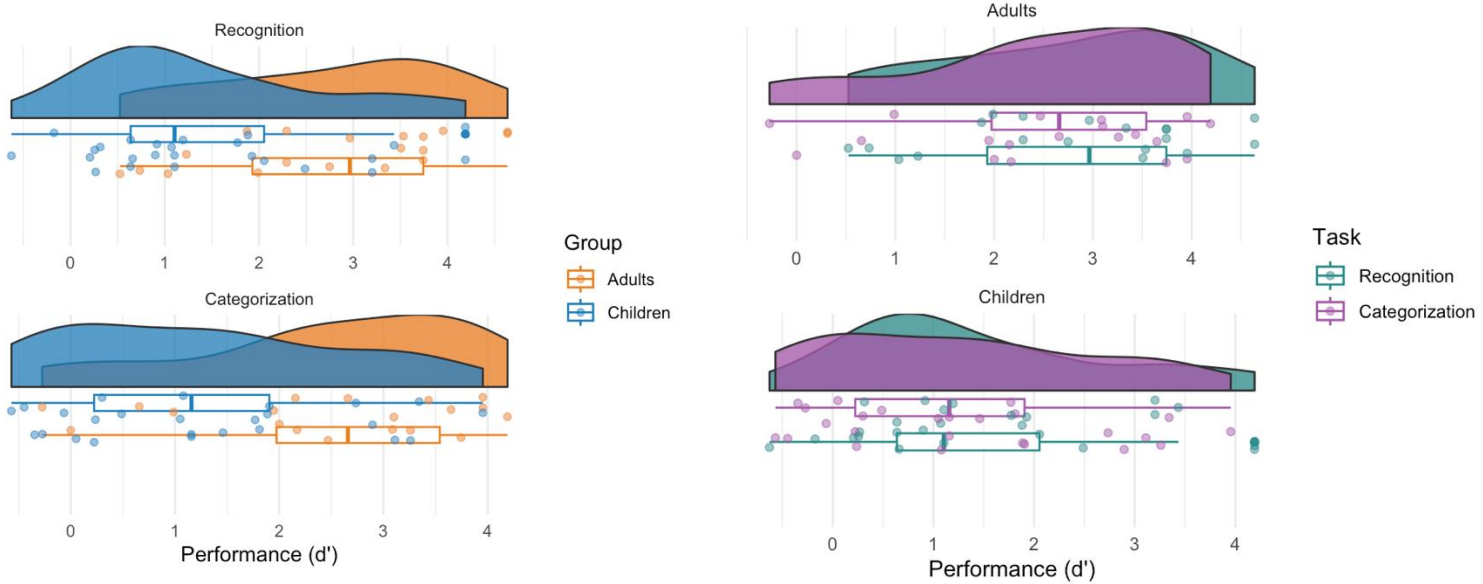
Hypothesis

1. Both groups could learn the gesture-word associations
2. Adults better children
3. Recognition task better than categorization task
4. Presence of N400, which reflect the activation of semantic information

Results

Statistical analysis

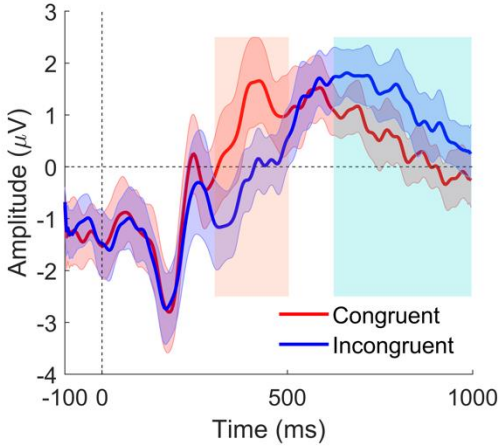
d-prime ~ (Task * Group)



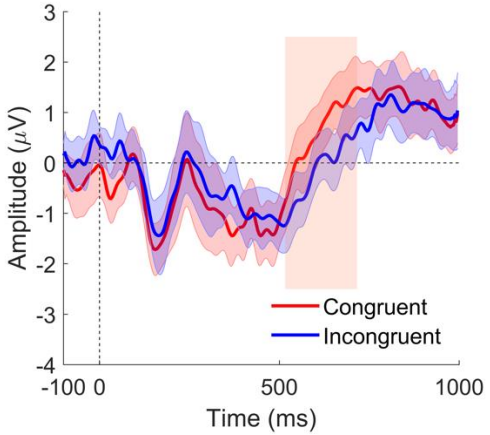
- Significant effect of group
- No effect of task

ERP results – Adults

Recognition Task



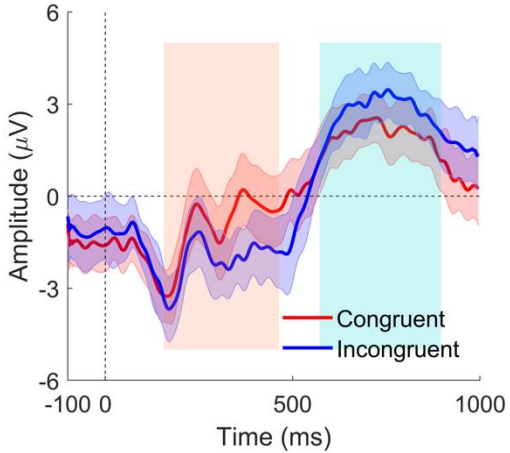
Categorization Task



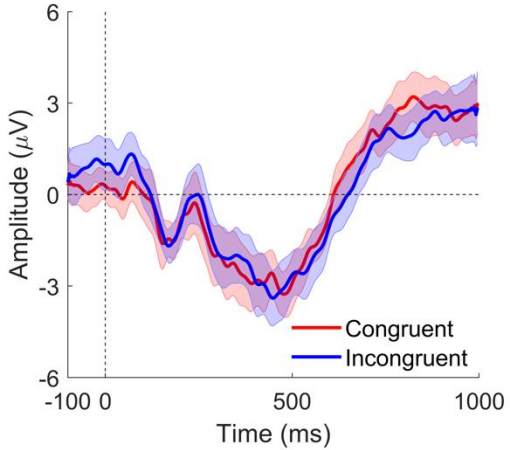
N400 effect is shown in **both tasks** (red shade)

ERP results – Children

Recognition Task



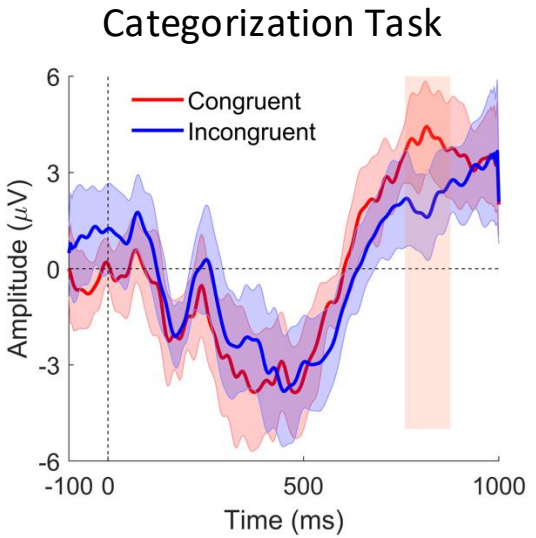
Categorization Task



N400 effect is shown in **recognition task only** (red shade)

ERP results – Children

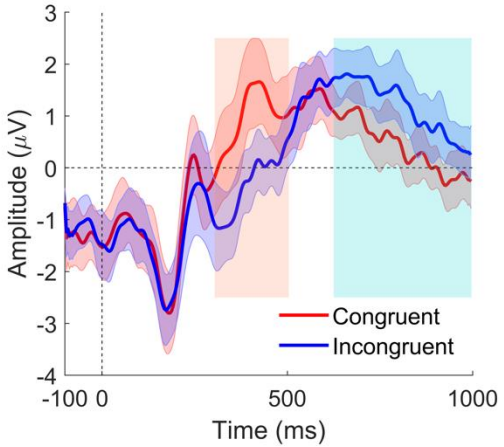
Additional analysis on
correctly identified trials only



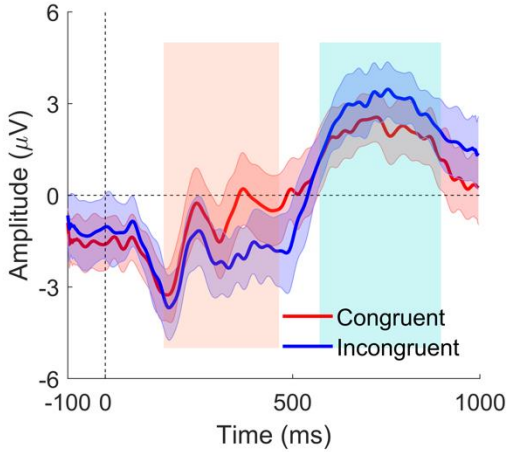
Correct trials —> N400 effect is also shown in **categorization task** (red shade)

ERP results – Late positivity (P600 effect)

Adults



Children



P600 effect is shown in both groups in **recognition task** only (blue shade)
Syntactic processing / Integration effort index (Aurnhammer et al., 2023)

Conclusions

Summary

Behavioral results:

	RECOGNITION	CATEGORIZATON
Group	Adults better than children	
Task	No effect of task	

- Adults significantly better than children in both tasks
- No significant difference between tasks

ERP results:

	RECOGNITION	CATEGORIZATON
Adults	N400 - P600	N400
Children	N400 - P600	N400 (correctly identified trials)

- Adults: N400 in recognition and categorization
- Children: N400 in recognition; in categorization, after additional analysis
- For both group, P600 in recognition but not in categorization

Open questions

Why no N400 in categorization task for child group?

- Task is too hard
- Categorization task was always the second task -> noisy data
- Small sample (n=24)
- High variability

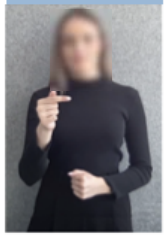
Future directions

Behavioural results

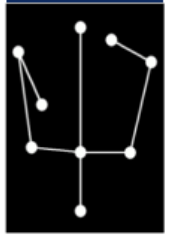
EXPERIMENT 1

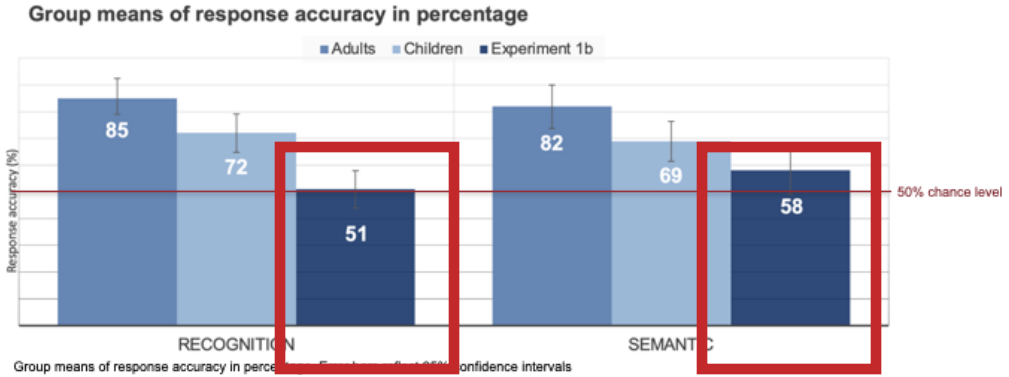
MACQUARIE University
SYDNEY·AUSTRALIA

1a



1b





- Results from experiment 1a (symbolic gestures) are **not replicated with low level visual stimuli**

Conclusions

- Despite the ambiguous learning context
- No instruction on the task
- No associative cues
- Naive to gestural communication languages (i.e., sign languages)

Children and adults could:

- form word-gesture associations (recognition task)
- associate the gestures with the word meaning (categorization task)

⇩

Gesture as an **integral part of language**
Gesture as an **ecologic language input**

Next studies

Thesis structure

Title: Cross-situational learning of word-gesture pairs from infancy to adulthood: an exploration of behavioral, eye-tracking, and ERP data

	Year 1 – Macquarie University		Year 2 – Universität Potsdam		Year 3 – Universität Potsdam
Exp.1	Cross-situational learning of word-gesture pairs in children and adults: a behavioral and event-related potential study	**Exp.2**	Cross-situational learning of word-gesture pairs in toddlers: an eye-tracking and pupillometry study	**Exp.3**	Cross-situational learning of word-gesture pairs in toddlers: an eye-tracking and pupillometry study
	Children (8–11) Adults (18–35)		Toddlers (1–3)		Infants (12–14 m.o)
	Novel gestures + familiar words Cross-situational learning EEG		Novel gestures + familiar words Cross-situational learning Eye-tracking / pupillometry		Novel gestures + non-words + novel objects Cross-situational learning Eye-tracking / pupillometry

Thank you

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