Generalisation over semantic cues in child and adult artificial language learning

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Artificial language learning in children

majority of artificial language learning studies are with adults

studies with children generally use infants (up to around 2 years)

only a handful with school aged children

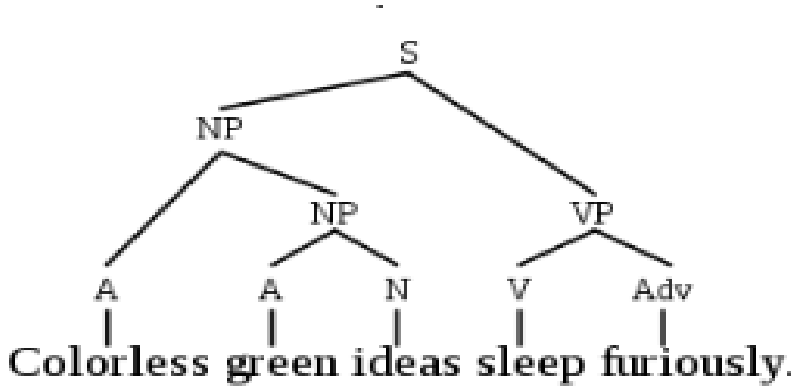
Artificial language learning in children

TODAY:

Experiments exploring **generalization over semantic cues** in artificial languages comparing 6 year olds and adults

Language learning and generalization

- learning a language involves generalization



- how do we work out what groups of words pattern together?

- *statistical learning approach:* learners extract generalizations from the input by identifying recurring patterns and using that information to form grammatical generalizations

Language learning and generalization

- **distributional cues:** – categorising words according to the linguistic environments in which they occur
- **phonological cues:** – categorising words according to sound similarities
- **semantic**: – categorising words according to meaning similarities

today

Semantics based generalization

- long standing tension as to the extent to which language learning is driven by function/form
- e.g. earlier arguments that first grammars are entirely semantic in nature (e.g. Macnarma 1982)
- “semantic bootstrapping” hypothesis, e.g. Pinker (1989); Ambridge (2013) hybrid statistical/semantics approach

Semantics based generalization

- **Studies with <u>adult learners</u>**

	Semantic cues
Braine (1987)	natural gender cues
Mirkov et al (2011)	people versus animals
Leung & Williams (2012)	animate versus inanimate
Ferman & Karmi (2013)	animate versus inanimate

- in all of these studies: two classes of nouns which co-occurred with different function words / morphology
- all show that adults pick generalize new nouns in accordance with semantics

Semantics based generalization

- **Studies with <u>child learners</u>**

- Saffran & Lany (2010; 2011) - study with two year olds

  animals: two syllable words, co-occur with “org” and “erg”
  vehicles: one syllable words, co-occur with “alt” and “ush”

- evidence that patterns are learned and use in word learning task
- e.g. know a new 2 syllable words with ong/erg is more likely to refer to an animal than a vehicle

Semantics based generalization

- **Studies with <u>child learners</u>**

	Semantic cues
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Semantics based generalization

- **Studies with <u>child learners</u>**

	Semantic cues
Ferman & Karmi (2013)	animate versus inanimate

- compared 8 year olds, 12 year olds and adults

  animate-noun + verb+*ev*

  inanimate-noun + verb+*ar*

- 12 year olds and adults learned trained pairs and were to generalize new nouns correctly on the basis of animacy
- **8 year olds learned trained pairs but were not able to generalize correctly**
- **despite up to 15 training sessions for some 8 year olds**

Current Experiments

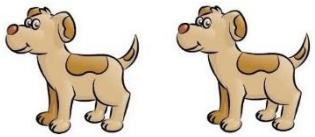
Artificial language paradigm established in Wonnacott (2011)

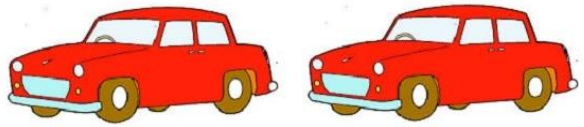
- 1 novel verb: *glim* (THERE ARE TWO)
- "borrowed" English nouns: e.g. *dog, car*
- 2 novel "particles": e.g. *kem/ bup* (NO SEMANTICS)

SENTENCE VERB NOUN PARTICLE

glim dog kem

glim car bup





create languages where semantic cues determine particle usage:

vehicle-noun + kem animal-noun + bup

Questions

- Can 6 year olds (and adults) learn and generalize over the semantic cues?

- Is generalization affected by statistics?

  <u>TYPE FREQUENCY MANIPULATION</u>

  Low type frequency : 4 exemplars per class

  i.e. 4 animals with kem; 4 vehicles with bup

  High type frequency : 8 exemplars per class

  i.e. 8 animals with kem; 8 vehicles with bup

High type frequency provides better evidence for generalization.

Questions

- Can 6 year olds (and adults) learn and generalize over the semantic cues?
- Do semantic cues affect both novel nouns ***and trained items***?
- **SEMANTICS MANIPULATION**
    - **Languages with semantic cues**
    - **Control languages without semantic cues**

Consistent semantic cues: high type frequency
• 8 animals occur with kem • 8 vehicles occur with bup

Consistent semantic cues : low type frequency
• 4 animals occur with kem • 4 vehicles occur with bup

No semantic cues: high type frequency match
• 4 animals occur with kem • 4 animals occur with bup • 4 vehicles occur with kem • 4 vehicles occur with bup

No semantic cues: low type frequency match
• 2 animals occur with kem • 2 animals occur with bup • 2 vehicles occur with kem • 2 vehicles occur with bup

test: 4 trained animals & 4 trained vehicles

4 untrained animals & 4 untrained vehicles

Method

- Participants
  - 5-6 year olds (mean: 5y 7m; range 5y;2m : 6y;1m)
  - adults (Warwick undergraduates)

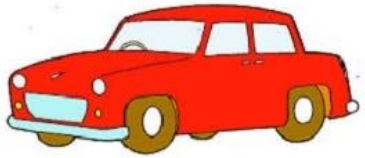
	5-6 yrs	adults	
consistent-high	10	10	
consistent-low	10	10	
inconsistent-high	6	10	
inconsistentlow	6	10	

planned sample n=15 per condition (preliminary results)

Method

e.g. see hear

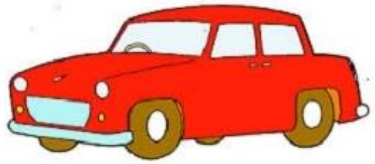
- Procedure
  - ➢ Day 1
    - **noun practice**

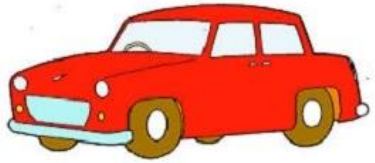


“car”

COPY ALOUD

- **exposure:**
  (8* each noun)





“glim car bup”

COPY ALOUD

- **production test:**
  (trained + untrained)

“glim….”

COMPLETE SENTENCE

  - ➢ Day 2: **noun practice + exposure**
  - ➢ Day 3: **noun practice + exposure**
  - ➢ Day 4: **noun practice + exposure + production test**

data from first and final day

Results

- trials coded as **correct/ incorrect**
- correct = produce noun + correct particle
- incorrect trials include
  - using the alternative particle
  - producing a different word in place of the particle (i.e. not one of the two in the input)
  - producing noun and no particle
  - refusing to produce anything
  - something else (e.g. *“glim rabbit likes carrots”*)
- analysed using logistical LME

Results: Children, trained nouns

- reliable effect of day ($p < 0.001$)
- all groups performance > 50% on day4
- no reliable main effect of semantic cues ($p = 0.15$)
- interaction semantics * type frequency ($p<0.05$)

high type frequency

- semantic cues > no semantic cues ($p<.005$)

low type frequency

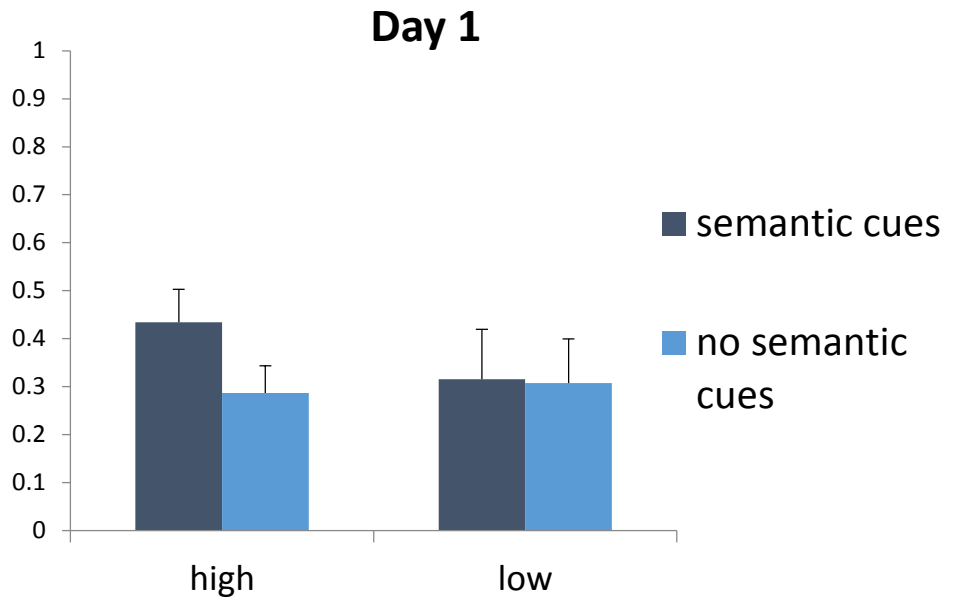
- no reliable difference ($p>.4$)

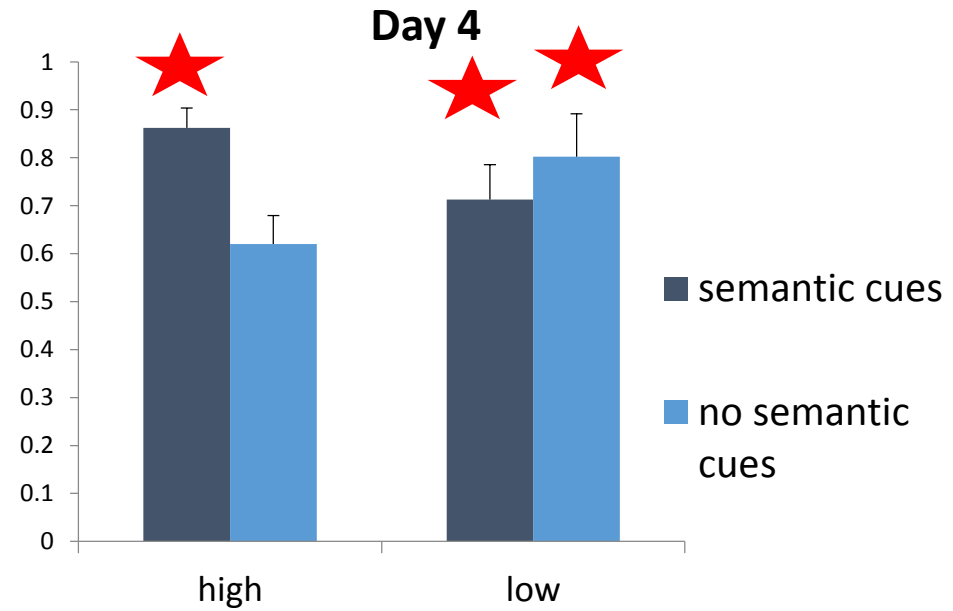
semantic cues

- high type frequency > low type frequency ($p<.005$)

no semantic cues

- no reliable difference ($p>.1$)

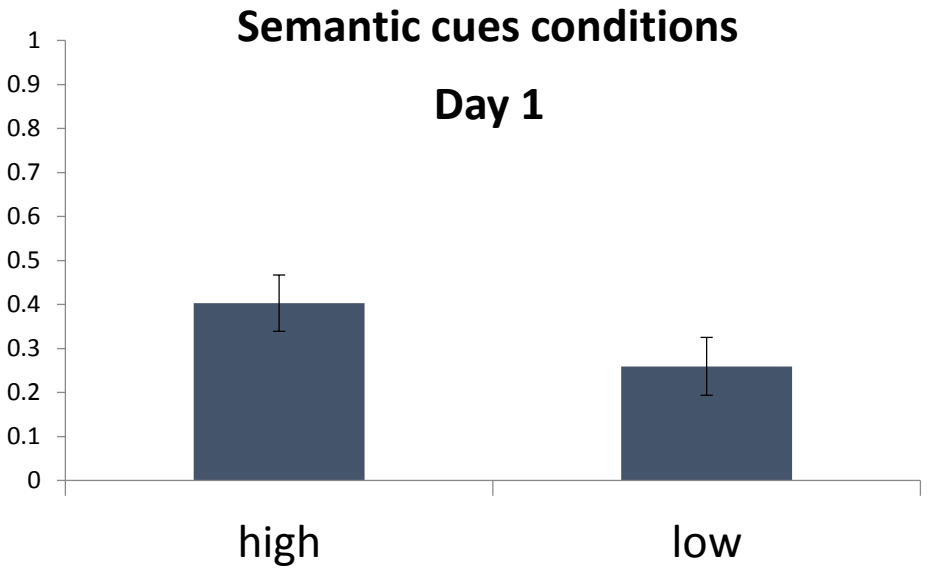


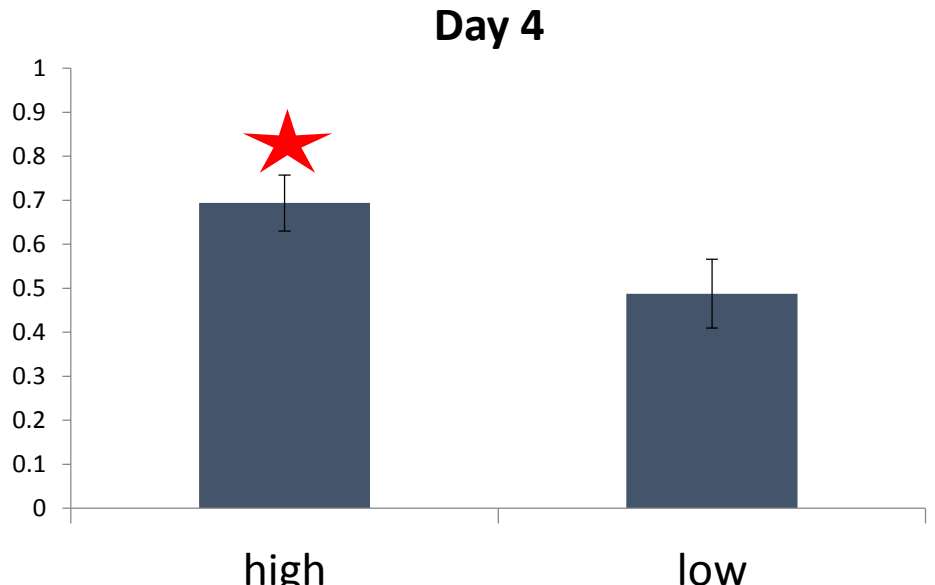


Results: Children, untrained nouns

- "correct" production = using the particle in line with semantic class

- effect of day ($p < .001$) and type frequency ($p < 0.001$)





Results: Children, trained nouns

- reliable effect of day ($p < 0.001$)
- all groups performance > 50% on day4
- no reliable main effect of semantic cues ($p = 0.15$)
- interaction semantics * type frequency ($p<0.05$)

high type frequency

- semantic cues > no semantic cues ($p<.005$)

low type frequency

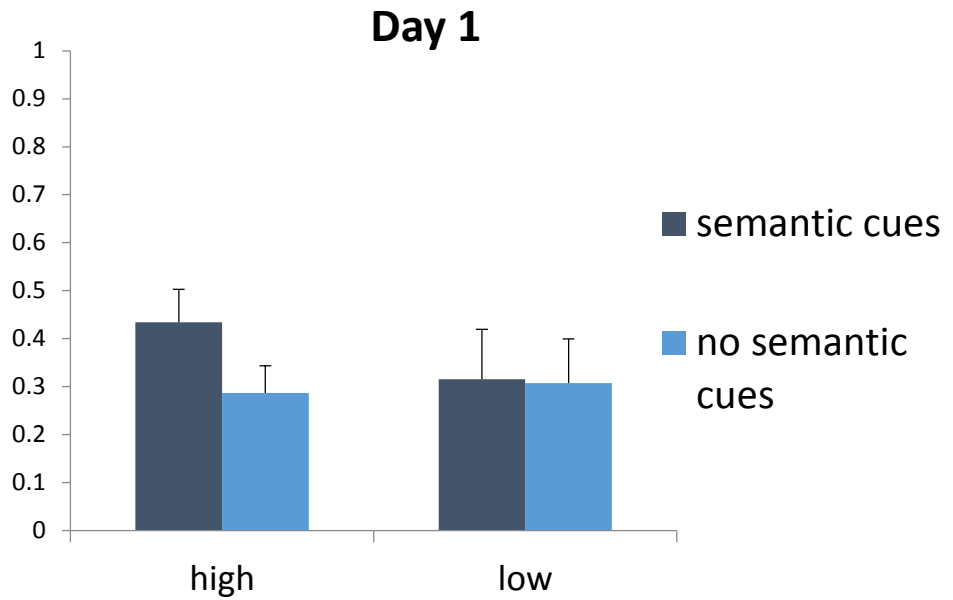
- no reliable difference ($p>.4$)

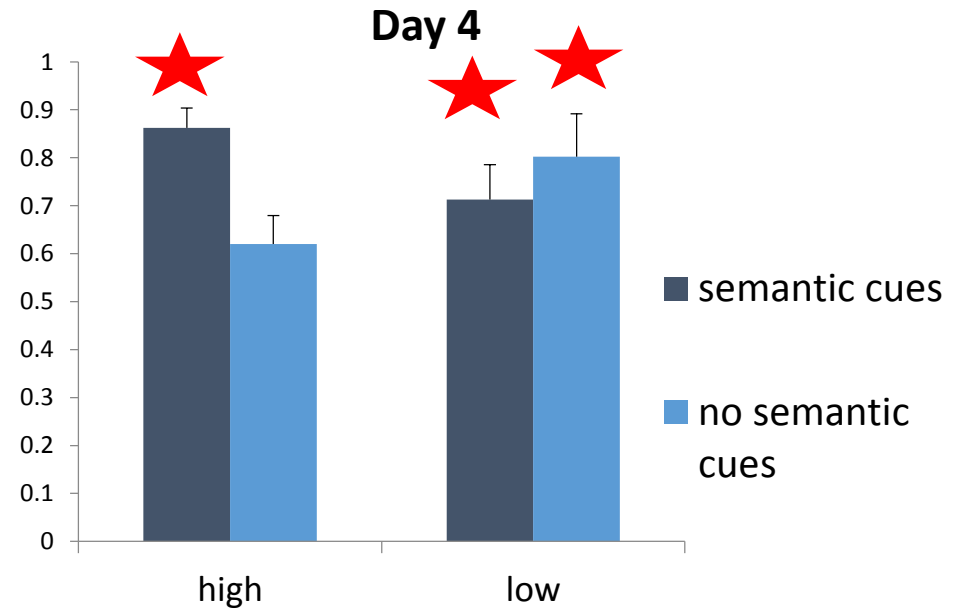
semantic cues

- high type frequency > low type frequency ($p<.005$)

no semantic cues

- no reliable difference ($p>.1$)

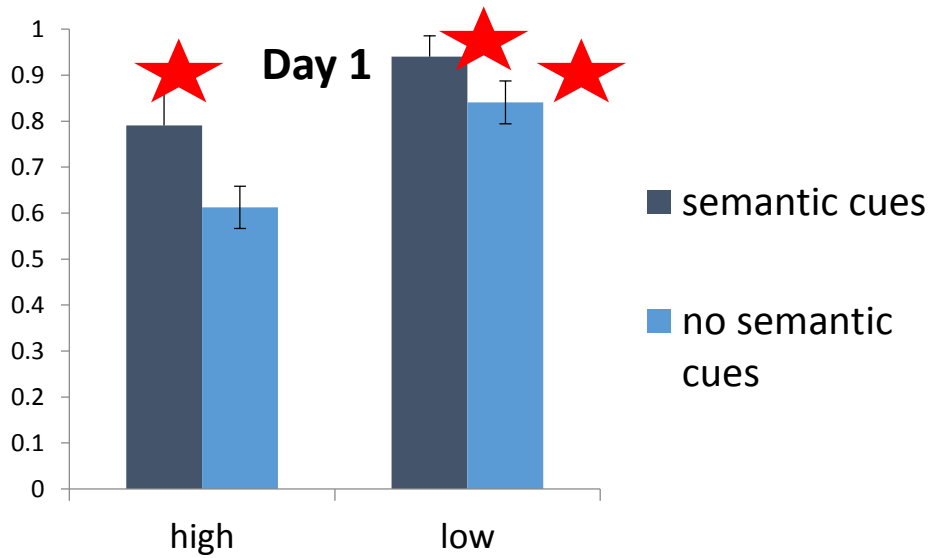


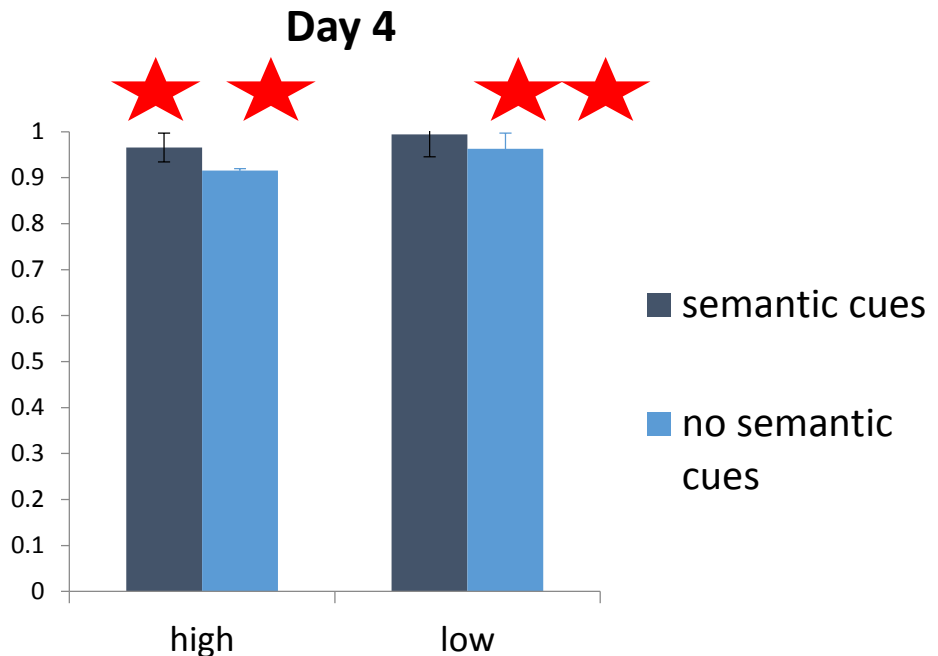


Results: Adults, trained nouns

- reliable effect of day ($p<.0001$)
- all groups performance > 50% on both days

- reliable main effect of semantic cues ($p< .005$)
- no reliable semantics * type frequency interaction ($p<0.1$)

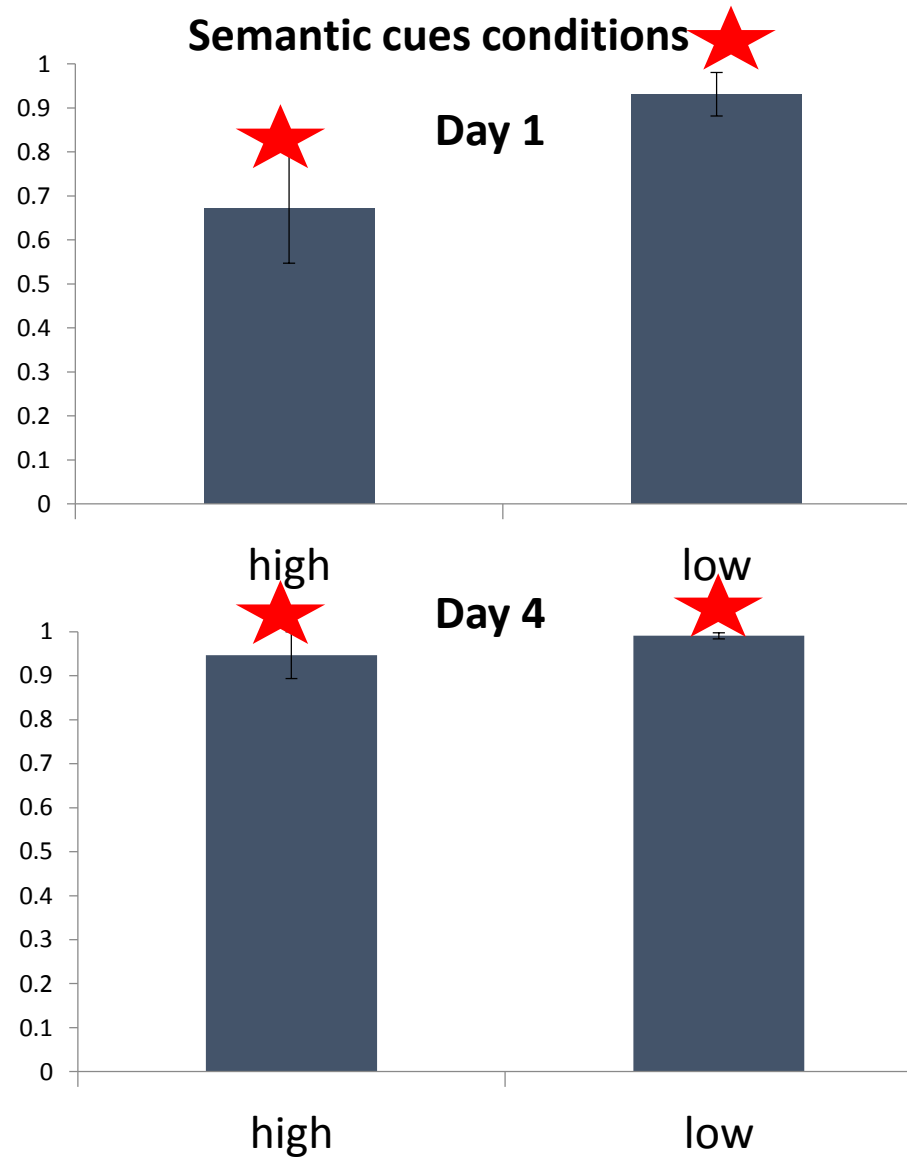




Results: Adults, untrained nouns

- "correct" production = using the particle in line with semantic class

- no effect of day (p=0.2) or type frequency (p=0.4)



Summary

MAIN TAKE HOME

- children generalize noun behaviour on the basis of a semantic cue (animals/vehicle)
- however generalization is determined by input statistics
  - need multiple exposure sessions
  - need to witness multiple exemplars: 4 per category isn't sufficient

fits with a rational statistical learning perspective: don't generalize without good evidence

- adults in this experiment – generalize quickly on the basis of 4 examples per category

Summary

OTHER FINDINGS

- both children and adults can learn arbitrary associations between nouns and particles

- where semantic cues are used with novel nouns (adults: both conditions, children high type frequency) these also boost performance at the item level

- adult performance is also stronger at the level of reproducing item level associations

Conclusions for human language acquisition

- children are able generalize over semantic cues and use this to determine the behaviour of novel nouns (rule like behaviour)

➢ however their may be constraints on the usage of semantic cues - usage may depend depends on sufficient exposure and reliability of cue in the input

Ongoing questions

- Can children pick up on cues when they are only partially correlated with semantic usage?
- Ongoing experiment

Consistent semantic cues: **high type frequency**
• 8 animals occur with kem • 8 vehicles occur with bup

Partial semantic cues: **high type frequency match**
• 7 animals occur with kem • 1 animals occur with bup • 7 vehicles occur with bup • 1 vehicles occur with kem

- Are there constraints on the types of cues that children will generalize over?