Statistical Word Learning and Vocabulary in 18-Month Olds

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Abstract

The purpose of this study was to investigate the relationship between statistical word learning (SWL) abilities and vocabulary levels in young children at 18 months. Infants are able to discover word boundaries within a stream of speech using only statistical regularities (Saffran, 2003). This skill appears to be connected to word learning in infants (Graf Estes et al., 2007) and vocabulary knowledge in school-aged children (Evans, Saffran, & Robe, 2009). SWL may also be useful to investigate implicit learning abilities on children at-risk for delayed language. The current study examined the ability to segment words from a statistical language and attach meaning to those newly segmented words in typical and low-vocabulary groups of toddlers. Results suggest, as in prior work, typical-developing children were able to learn statistically segmented words as object labels. In contrast, toddlers in the low-vocabulary group were unable to learn object labels, even with prior word segmentation experience and similar patterns of habituation.

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Background and Purpose

Implicit Learning in SLI

- Children with Specific Language Impairment (SLI) have difficulty learning language despite normal nonverbal IQ.
- Recent work shows that children with SLI also have impaired implicit learning (Evans, Saffran, & Robe, 2009, Tomblin, Mainela Arnold, Zhang, 2007),
- Statistical word learning (SWL) -- a paradigmatic measure of implicit learning in children-- is the unconscious ability to track patterns and regularities in the input.
- 17 mos. typical infants easily implicitly track statistical regularities in a speech stream, using this information to discover word boundaries that can subsequently map to novel meanings (Graf Estes, Evans, Alibali, & Saffran, 2007).
- SWL is related to vocabulary knowledge in children with/without SLI, however children with SLI require *double* the exposure to implicitly track statistical regularities in a speech stream (Evans, Saffran, & Robe, 2009).

Late Talkers

- Typically developing children acquire language rapidly and effortlessly, but some children do not. These children, often referred to as Late Talkers, are usually identified at about 24 months of age by parent report questionnaires.
- In past research Late Talkers have been identified many different ways, for example, by being below the 10th percentile in language abilities; having less than a 50 word productive vocabulary; very few, if any, word combinations; and are at risk for continued language impairment (Ellis & Thal, 2008)
- To date the best predictors of SLI are composite measures of: (1) family history of language impairment, (2) delay in comprehension *and* production, and (3) little use of gestures (Ellis & Thal, 2008).
- Might statistical word learning ability be a better measure to identify children at risk for SLI?

Question

- Using the same paradigm as Graf Estes, et al., (2007), do 18 mos. infants with low vocabulary -- after the same exposure to the target novel words in statistical learning stimuli -- perform the same as typically developing age and nonverbal matched controls on a novel word learning tasks?
- Do they require the same number of trials to habituation?
- Do they look longer on "switch" as compared to "same" trials during testing?

Methods

Participants

Two groups of 18 month-old toddlers (N = 37) *

1. Low Vocabulary (Low Vocab)
   - 1-19th percentile on CDI:WS
2. Typical age - and nonverbal IQ-matched controls (Typical)
   - 22nd to 99th percentile on CDI:WS

Inclusion/Exclusion Criteria:

- Full-term
- Passed infant hearing screenings at birth
- Passed tympanometry screening in at least one ear at testing
- Fewer than 3 ear infections.
- Normal Mental Developmental Index (MDI) score on Bayley Scales of Infant Development-II (BSID-II) (MDI,17-19 month range)
- Normal nonverbal abilities (6 of 11 items)
- No neurological damage or significant birth history based on parent report

• Eight participants excluded due to low nonverbal items (7) or fussiness (1).

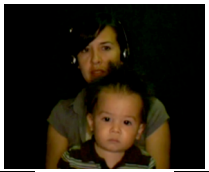
Methods

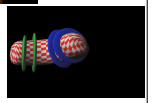
Procedures

- MacArthur Bates CDI:Words & Sentences (MB-CDI:WS).
  - Prior to the visit, parents were sent the MB-CDI: WS form. Parents brought completed form to the lab visit.
  - Forms were scored and child language percentiles were calculated after the testing.

Language Exposure Phase

- Same as Graf Estes et al., 2007
- Infants were exposed to one of two artificial languages.
- Each language was 2.5 minutes
- Natural speech
- Only reliable cue to the word boundaries was transitional probability





"Dobu" "Timay"

Habituation Phase

- Immediately following exposure phase
- Infants participated in a novel object-label habituation task.
- Two novel 3D objects were paired with two words from the exposure language using Habit 2000 Software (Cohen, Atkinson, & Chaput, 2000).
- Infants saw/heard two different label-object pairs, one at a time as novel objects moved side to side across screen
- Order of object-label pairings randomly presented
- Habituation criteria was met once looking time across three consecutive trials decreased 50% from looking time for the first three trials or max. of 25 trials.

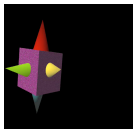
Table 1. Mean and Standard Deviations for the Low Vocabulary and Typical groups for the Bayley MDI, nonverbal items, MB-CDI:WS words produced and percentile.

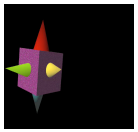
	All subjects N=29	Low Vocab N=9	Typical N=20	*p* value
Bayley MDI: 17-19 mos.	105 (8.5)	105 (7.2)	105 (9.2)	n.s.
Nonverbal items	8.3 (1.4)	7.8 (1.2)	8.5 (1.4)	n.s.
MB-CDI: WS Words produced	101.9 (125)	19.7 (12.1)	138.9 (135)	p < .01
MB-CDI: WS percentile	41.1 (27.9)	10.2 (7.8)	55 (21.6)	p < .001

Methods

Test Phase

- Immediately following habituation phase, infants learning of object-label pairs was examined using a *Same/Switch* trial paradigm
- Children presented with two types of pairings, one at a time in random order
  1. *Same -Trials* where the original object-word pairing from the habituation phase was maintained (N = 4 trials)
  2. *Switch -Trials* where original object-word pairings from habituation phase were switched. (N = 4 trials)





Example: Same "*dobu*" Switch "*timay*"

Results

Habituation Phase

- The two groups did not differ in the number to trials to reach habituation $F(1,27) = .263$, $p = .613$ (Figure 1)

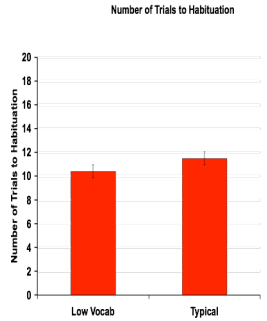


Figure 1. Number of trials to habituation

Test Phase

- There is a significant group by trial type interaction (Figure 2). $F(1,27) = 6.6$, $p = .016$, partial eta squared = .197, d = .698.
- Typical group looked longer at the switch trials than same trials $t(1,19) = -2.25$, $p < .036$

Results cont

- No difference in looking times between same and switch trials for Low Vocab group $t(1,8) = 1.45$, $p = .18$

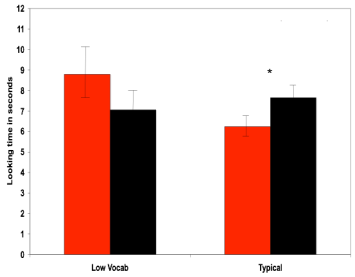


Figure 2. Looking time in seconds to same and switch trials during test phase

Summary

- Typically developing 18-month olds data replicate prior work of Graf Estes et al., (2007)
  - Similar number of trials to habituation
  - Looked longer at "switch" trials during testing
- Low Vocab infants showed different pattern
  - Same number of trials to habituation as Typical infants
  - No difference between look times to *same* versus *switch* trials
- Results suggest that Low Vocab infants at 18 months are unable to learn object labels, even with the same prior exposure to novel words and similar patterns of habituation.
- These results also suggest that using criteria based on decreased looking time during habituation may reflect different phenomena in Low Vocab and Typically Developing 18 month olds.
- One question is whether decreased looking during habituation reflects "learning" in typical children, but fatigue or poor vigilance/attention in children at risk for SLI?
- Research shows that children with SLI have poor sustained attention (Montgomery, Evans, Gillam, 2009).
- Future research should examine the role of attention on learning in infants and toddlers at risk for SLI.

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