

# Implicit word learning and verb knowledge in infants with typical and delayed language

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## Background

### Typical Language Development & Early Language Delay

- Typically developing infants easily and effortlessly implicitly learn novel words and link these to novel meanings (e.g. Graf Estes et al., 2007).
- Children at risk for Specific Language Impairment (SLI) often have delayed onset and slower acquisition of first words.
- Children with SLI have difficulty acquiring and using grammatical forms, inflectional morphology and complex syntax (cf. Bishop, 1997; Leonard, 1998).
- Language and cognitive processing deficits in children with SLI may be secondary to domain general deficits in implicit learning (Evans, et al., 2009; Hedenius, et al., in press; Lum, et al., in press; Lum, et al., 2010; Tomblin, et al., 2007).

### Implicit Learning & Specific Language Impairment

- SLI may be secondary to deficits in implicit procedural learning (Ullman & Pierpont, 2005).
- The Procedural Deficit Hypothesis (PDH) derives from Ullman's declarative-procedural (DP) model of normal language acquisition and use (Ullman, 2001; Ullman, 2004; Ullman & Gopnik, 1999; Ullman & Pierpont, 2005).

Type of memory	Responsible for	Example
Declarative	Acquisition, representation and use of mental lexicon, arbitrary, form-meaning association (i.e. word meanings)	Nouns; Irregular verbs
Non-declarative (procedural)	Computations and use of rule-based procedures, sequential representations (i.e. syntax and morphology)	Regular verbs

## Predictions & Question

- The PDH account of SLI predicts that aspects of grammar that depend on the procedural system -- such as regular verb morphology -- should be impaired in children with SLI.
- According to the PDH account, we *should* begin to see a relationship between infants' implicit learning abilities and acquisition of regular and irregular verbs
  - In both typically developing infants and those at risk for SLI
- Is there a relationship between implicit word-learning abilities and regular and irregular verb acquisition in typically developing infants and infants with language delay at 18-months?

## Inclusion Criteria

- Full-term
- Passed infant hearing screenings at birth and 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) and normal nonverbal abilities (6 of 11 items)
- No neurological damage or significant birth history based on parent report

## Methods

### Participants

- Two groups of 18 month-old toddlers (N = 42)\*
- All infants had normal hearing, and normal nonverbal intelligence.
  - Delayed Language N=23
    - Varied percentiles in comprehension and/or production vocabulary at/below 10<sup>th</sup> percentile\*
    - May have had some family history or speech or language delay
  - Typical Controls N=19
    - At or above 20<sup>th</sup> percentile on both comprehension and production\*
    - No family history of speech or language delay

MacArthur Bates CDI:Words & Gestures (MB-CDI:WG) and Words & Sentences (MB-CDI:WS).

- Prior to the visit, parents were sent the MB-CDI: WG & WS forms.
- Forms were scored and child language percentiles were calculated after the testing.
- Infants were classified based off of the MB-CDI:WG (see Table 1)
- Verb knowledge was derived from MB-CDI:WS (see Figures 3 & 4)

	Typical Language Group (N=19)	Delayed Language Group (N=23)
Bayley MDI	107.5 (8.05)	101.08 (10.18)
MB-CDI: WG Words Understood	51.57 (26.38)	36.52 (31.11)
MB-CDI: WG Words Produced	62.57 (17.36)	26.86 (27.67)

## Procedures

### Experimental Task

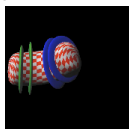
#### Phase 1- Language Exposure Phase

- 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



#### Phase 2- Habituation (Training)

- 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.



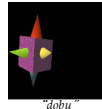
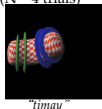
"Timay"

"Dobu"

#### Phase 3-Test Phase

- Infants learning of object-label pairs was examined using a *Same/Switch* trial paradigm
- Presented with two types of pairings, one at a time in random order
- Learning was measured by increased look time to incongruent compared to congruent pairs

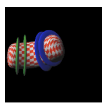
1. **Congruent "Same" Trials** where the original object-word pairing from the habituation phase was maintained (N = 4 trials)



"timay"

"dobu"

2. **Incongruent "Switch" Trials** where original object-word pairings from habituation phase were switched. (N = 4 trials)



"dobu"

"timay"

### Habituation Phase

The two groups did not differ in the number of trials to reach habituation criterion  $F(1,41) = .005, p = .946$  (Figure 1)

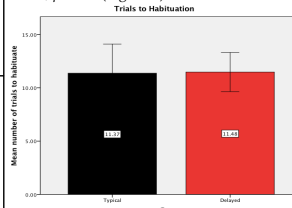


Figure 1. Number of trials to habituation

### Test Phase

Typical group showed the expected pattern and approached a significant difference by looking longer to the incongruent "switch" trials than same trials,  $t(1,18) = 3.65, p = .07$  (Figure 2)

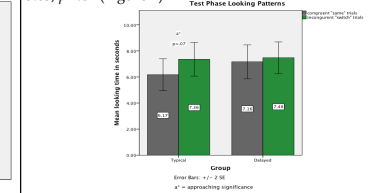


Figure 2. Looking time in seconds to same and switch trials during test phase

The delayed group did not show evidence of learning with no difference in looking times between congruent "same" and incongruent "switch" trials  $t(1,22) = .167, p = .686$

### Regular Verb Knowledge

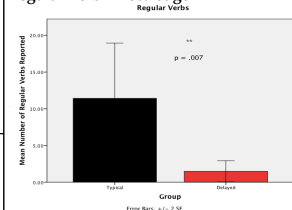


Figure 3. Typical and Delayed Groups Average Regular Verbs

The groups were significantly different in the number of regular verbs (TYP = 11.42, SD = 16.39, DL = 1.47, SD = 3.44) in their reported vocabularies, with TYP infants having significantly more regular verbs than DL infants,  $F(1, 41) = 8.06, p = .007$ .

### Irregular Verb Knowledge

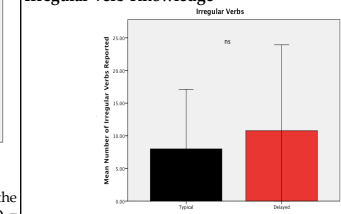


Figure 4. Typical and Delayed Groups Average Irregular Verbs

However, the groups did not differ in the number of irregular verbs (TYP=8, SD= 19.8, DL = 10.7, SD=31.4) in their reported vocabularies,  $F(1,41) = .111, p = .740$ .

## Summary

- Consistent with the prediction, infants in the DL group did not differ from the TYP group in the number of irregular verbs reported in their vocabulary.
- However, compared to the TYP group (who were able to show the expected pattern to implicitly learn novel words), the DL group showed no evidence of implicit learning and had significantly fewer regular verbs.
- This project suggests implicit learning abilities may also show up in the earliest stages of regular and irregular verb acquisition
- This may be an important factor to consider for young infants and toddlers at risk for SLI.
- Future work should explore the relationship of the words infants are reported to say and the various characteristics of those words.