Background

- Language learning involves forming generalizations over word classes
- Artificial language learning experiments suggest that adults can generalize based on shared distributional contexts and that "frames" provide a particularly useful context (Mintz, Wang, & Li, 2014).
- Literature on distributional learning in children is more limited; few experiments have investigated their learning of gender-like noun classes.
- There is some evidence that high type frequency aids generalization in children (Gomez 2002; Wonnacott, Boyd, Thomson, & Goldberg, 2012), however high type frequency may also create an additional burden on working memory, which may hinder learning (Brooks et al., 2006).

Research Questions

- Can 7-year-olds can acquire gender classes via distributional learning over frames using input from a real language (Italian: 2 gender classes)?
- Will type frequency promote (or hinder) generalization?

Method

Participants: 30 monolingual English speaking 7-8 year olds

Language input:

- Children were exposed to singular and plural Italian noun-phrases which have determiners and vowel suffixes marked for gender and number:
  - masculine singular: il noun[masculine] + o il letto
  - masculine plural: i noun[masculine] + i i letti
  - feminine singular: la noun[feminine] + a la balene
  - feminine plural: le noun[feminine] + e le balene
- "Determiner + Noun Stem + Vowel" forms a frame which can serve as a context for distributional learning.
- Two between-subjects experimental conditions (total exposure matched):
  - High Type Frequency = 12 nouns, 6 per gender class
  - Low Type Frequency = 4 nouns, 2 per gender class

Procedure:

- Exposure in 5 * 30 minute sessions over five consecutive days using a "word learning game": Hear a noun-phrase and choose between the correct picture and foil. Foils could differ in gender, number, or both.

Additional tests of comprehension and production were administered at the end of sessions 3 and 5 including:

(1) Noun-Phrase identification: Speeded version of training task
(2) 2AFC test of knowledge of frames: See picture and choose between the correct noun-phrase and a foil in which the determiner was incorrect for gender, number, or both.
(3) Production test: Hear singular NP and produce plural (or vice versa)

New nouns were included in the 2AFC & production tests to probe generalization.

Results: Test Tasks

(1) Noun-Phrase Identification

Accuracy

- Consistent with data from the training task, when pictures depicted different nouns, performance was higher on trials in which the nouns were different genders, but only in the low type-frequency condition (type frequency * gender agreement, z = -1.4, p = .08).
- Low TF: same gender 82%, different gender 87%, z = -2.51, p < .01
- High TF: same gender 81%, different gender 82%, z = 0.11, ns

Response times

- Faster when the foil is of a different gender (Session 5 only): same gender 1764 ms, different gender 1637 ms, t(29) = -2.03, p = .04.
- Children may be predictively using gender of the determiner to identify the upcoming noun (Lew Williams, & Fernald, 2007)

(2) 2AFC Test of Knowledge of Frames

- Strong performance with trained nouns but at chance with new untrained nouns: trained 91%, untrained 53%, z = 9.51, p < .001
- Strong item learning but no generalization of frames.
- For trained nouns there was a significant main effect of foil-type: gender incorrect 89%, number incorrect 85%, both incorrect 92%, z = -3.25, p = .01.
- Low type frequency benefited for trials in which the foil was incorrect for number: low TF 90.8%, high TF 78.8%, z = 2.49, p = .01
- Number marking learnt better under low type frequency conditions.

(3) Production Test

- Usage of determiners and vowels scored separately

<table>
<thead>
<tr>
<th>RESPONSE TYPE</th>
<th>DETERMINERS</th>
<th>VOWELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old nouns</td>
<td>New nouns</td>
<td>Old nouns</td>
</tr>
<tr>
<td>Correct</td>
<td>15%</td>
<td>22%</td>
</tr>
<tr>
<td>Incorrect gender</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Incorrect gender &amp; number</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>No change (incorrect number)</td>
<td>57%</td>
<td>64%</td>
</tr>
<tr>
<td>6%</td>
<td>10%</td>
<td>4%</td>
</tr>
</tbody>
</table>

- Most common pattern was to repeat given vowel/determiner.
- For both old and new nouns, when they did change number, they were more likely to produce a form with correct than incorrect gender.
  - Determiners: old $\chi^2 = 89.3$, p < .001; new $\chi^2 = 32.3$, p < .001
  - Vowels: old $\chi^2 = 79.2$, p < .001; new $\chi^2 = 4.17$, p = .04
  - The preference for using a gender-matched determiner with new nouns provides (tentative) evidence of generalization.

Control Experiment

Question: Are children really generalizing (i.e. showing knowledge of word classes), or are results due to phonetic similarity between gender matched forms?

Method: Children only hear individual nouns as either singular or plural during training. Do they still show generalization in the production task?

Determiners: marginally more likely to produce correct than incorrect gender, $\chi^2 = 3.13$, p = .08, but effect is weaker than in main exp, $\chi^2 = 31.70$, p < .001

Vowels: equally likely to produce correct/incorrect gender (both 7%), marginally weaker effect than in main exp, $\chi^2 = 3.75$, p = .052.

Summary and Discussion

- Strong item level learning: Children can identify errors in the vowel (2AFC) test and may also use the gender of the determiner to predict the upcoming noun (RT in noun-phrase identification).
- Weak learning of number marking: Only acquired in the smaller low type frequency condition.
- Generalization: No evidence of generalized learning of frames in 2AFC test; some tentative evidence of generalization in production: if children produce a new noun with an unattested vowel/determiner, they are likely produce a form correctly marked for gender.