A usage-based account of Second Language Acquisition: A computational perspective

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Computational modeling in language acquisition

Child language acquisition:

- word segmentation (ten Bosch, Van Hamme, Boves, and Moore, 2009);
- learning words and their meanings (Yu and Ballard, 2007; Frank, Goodman, and Tenenbaum, 2009; Fazly, Alishahi, and Stevenson, 2010);
- learning language structure (Elman, 1990);
- etc.

Second language acquisition: ???
First and second language acquisition

The outcomes are different – no need to argue.

But: Are the learning mechanisms different?

Nick Ellis: L2 acquisition is painted in the same colors as the rest of cognition.
The difference

First language:
Input $\Rightarrow$ tabula rasa $\Rightarrow$ Output

Second language:
Input $\Rightarrow$ L1 knowledge $\Rightarrow$ Output
My project

Specific task: Learning argument structure constructions

Goldberg: *Argument structure constructions are a special subclass of constructions that provides the basic means of clausal expression in a language.*
Verbs and their arguments

Verbs:
- Intransitive: *cough*, *sneeze*
- Monotransitive: *slap*
- Ditransitive: *give*

Optional arguments:
- *Frankie ate. / Frankie ate the chicken.*

Syntactic alternation:
- *John gave a plate to Edit. / John gave Edit a plate.*

(examples from Tyler, 2012)
Learning constructions

Bencini and Goldberg (2000):

1. Alice told many stories.
2. Frank told June a very funny story.
3. Frank sang a lovely song.
4. Alice sang Frank a song.
Model of early argument structure acquisition

(Alishahi, 2008)

Utterance–scene pairs ⇒ Learner ⇒ Output

Utterance: *Mom put toys in boxes.*
Scene: \(\text{Put } [\text{cause, move}] (\text{MOM}<\text{agent}>, \text{TOYS}<\text{theme}>, \text{In}[] (\text{BOXES}<\text{destination}>)<\text{destination}> )\)

Frame:

<table>
<thead>
<tr>
<th>Head verb</th>
<th><em>put</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb semantic primitives</td>
<td><em>&lt;cause, move&gt;</em></td>
</tr>
<tr>
<td>Number of arguments</td>
<td>3</td>
</tr>
<tr>
<td>Argument roles</td>
<td><em>&lt;agent, theme, destination&gt;</em></td>
</tr>
<tr>
<td>Syntactic pattern</td>
<td><em>arg1 verb arg2 arg3</em></td>
</tr>
</tbody>
</table>
Model of early argument structure acquisition (cont.)

Constructions are groups of frames.

Learning by incremental Bayesian clustering.

Finding the most probable construction for a given frame:

$$\text{Best construction } (F) = \arg \max_k P(k|F)$$

Evaluating the knowledge based on language use (i.e., prediction).

(Alishahi, 2008)
Model architecture

Learner $\leftrightarrow$ Memory $= \emptyset$
Model architecture

L1 input

\[\downarrow\]

Learner \[\longleftrightarrow\] Memory = \{L1 constructions\}
Model architecture

\[ \text{L1 input} \downarrow \]
\[ \text{Learner} \longleftrightarrow \text{Memory} = \{ \text{L1+L2 constructions} \} \]
\[ \uparrow \]
\[ \text{L2 input} \]
Second Language Data

The Flensburg English classroom corpus (56,000 words).

The only easily available resource.

English teachers’ speech addressed to German children.
First Language Data

CHILDES: 3 German children

10 frequent verbs: *machen*, *kommen*, *gucken*, *gehen*, *sagen*, *sehen*, *weissen*, *geben*, *heissen*, *essen*

Extracting instances of each verbs, classifying the frames.
Difficulties

What belongs to the same construction and what does not?

- Word order: *Das macht sie gut.* / *Sie macht das gut.*
- Questions and imperatives: *Mach das mal!* / *Was machst du?*
- Separable prefixes: *Mach das nicht kaputt!*
- Arguments and adjuncts: *Was machst du hier?* / *Wer kommt hier?*
What’s next?

Provide the model with L1 input.
⇓
Store the L1 knowledge.
⇓
Provide the model with L2 input.
⇓
See how the two types of input interact in learner’s “memory”.
Future work

1. Add other features helping to distinguish between the languages, e.g., phonetical.
2. Enhance the clustering algorithm and/or clusters structure.
3. Experiment with typologically close/distant languages.