Informativeness and processing cost in verb acquisition:
Evidence from typical language development and autism spectrum disorder

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Outline

1. Proof of concept: Beyond joint attention

2. Learning verbs from their linguistic context

3. What kinds of linguistic contexts best support verb learning?

4. What kinds of linguistic contexts do parents use?
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Word learning in ASD

- Difficulty attending to social cues to discover word meanings e.g., Baron-Cohen et al., 1997; Norbury et al., 2010; Parish-Morris et al., 2007; Preissler & Carey, 2005

- Receptive language deficits are extremely common and are an early indicator e.g., Barbaro & Dissanayake, 2012; Charman et al., 2003; Luyster et al., 2008; Ellis Weismer et al., 2010

- But there is tremendous variability in abilities and outcomes e.g., Pickles et al., 2014
Addressed condition

Overheard condition
<table>
<thead>
<tr>
<th></th>
<th>TD</th>
<th>ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Addressed</strong></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Akhtar et al., 2001</td>
<td>Luyster &amp; Lord, 2009</td>
</tr>
<tr>
<td><strong>Overheard</strong></td>
<td>✔</td>
<td>???</td>
</tr>
<tr>
<td></td>
<td>Akhtar et al., 2001</td>
<td></td>
</tr>
</tbody>
</table>
N = 12
ASD diagnosis
3;2-5;9
<table>
<thead>
<tr>
<th></th>
<th>TD</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Addressed</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Overheard</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
Although word learning is most often a social, interactive process… e.g., Baldwin & Moses, 2001; Hirsh-Pasek & Golinkoff, 2008; Tomasello & Farrar, 1986

Children with ASD may be able to acquire nouns through overhearing others’ conversations

Caveat: This is a laboratory situation; there is some debate about whether even TD children make use of this ability in real life
Shneidman et al., 2013; Weisleder & Fernald, 2013
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Verb learning is hard

- Observing the world and hearing a verb provides insufficient information for learners.
- We rarely produce verbs while the events they describe are ongoing.
- Verbs are critical for subsequent language development; early verb vocabulary predicts grammatical scores. Hadley, Rispoli, & Hsu, 2016.
- Children with language delays/impairment struggle particularly with verbs.
Transitive Condition:
The duck is gorping the bunny.

OR

Intransitive Condition:
The duck and the bunny are gorping.

Where’s gorping?

Naigles, 1990
Transitive Condition:
The boy **mooped** the flower, The fireman **mooped** the lady, The girl **mooped** the cat...

Intransitive Condition:
The boy and the flower **mooped**, The fireman and the lady **mooped**, The girl and the cat **mooped**...

Arunachalam, 2013, Cognition
“Look! Wow!”
“Find mooping!”

Arunachalam, 2013, *Cognition*
N = 40
TD children
2;1-2;5

Arunachalam, 2013, Cognition
TD 2-year-olds can infer broad categories of verb meaning from non-social and non-interactive ambient language input.

Arunachalam, 2013, Cognition
Some evidence for syntactic bootstrapping in ASD
Naigles et al., 2011; Shulman & Guberman, 2007

No attention to social cues is required.

Learning is measured by eye gaze.

Auditory and visual information are presented separately.
<table>
<thead>
<tr>
<th>N = 36</th>
<th>Age</th>
<th>MCDI II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>2;1</td>
<td>0</td>
</tr>
<tr>
<td>Max</td>
<td>5;1</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>3;5</td>
<td>56</td>
</tr>
</tbody>
</table>
3-year-olds with ASD can also infer broad categories of verb meaning from non-social and non-interactive ambient language input.

Horvath et al., in prep
What kinds of linguistic contexts are best?

- Telegraphic speech is bad Bredin-Oja & Fey, 2014; van Kleeck et al., 2010; Venker et al., 2015

- Interventions focus on general techniques like responsiveness, imitation, recasting, frequency e.g., Girolametto, Weitzman, McCauley, & Fey, 2006; Roberts & Kaiser, 2015

- But parents can apply more specific guidelines to their speech e.g., Hadley & Walsh, 2014
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see also Imai et al., 2005, 2008
A boy is gonna **pilk** a balloon.  
He is gonna **pilk** it.

Mean age:  
2;0 (2011)  
2;3 (2010)

Arunachalam & Waxman, 2011, *Language Learning and Dev't*;  
see also Imai et al., 2005, 2008
Mean age: 2;3

He is gonna **pilk** it slowly. ✅
He is gonna **pilk** it nicely. ❌
He is gonna **pilk** it right now. ❌

Syrett et al., 2014, *Language Learning & Development*
Je t’aime
I love you

In French, “the grammar is also one of reassurance: with the object positioned second, the beloved isn’t suddenly going to turn out to be someone different.”

--Julian Barnes, A History of the World in 10 1/2 Chapters
**With Arguments (Heavy Context)**
아저씨가 풍선을 필키고 있어
a-jeo-ssi-ga pung-seon-eul pilki-go iss-eo
man-NOM balloon-ACC **pilk**-PROG PRES
'The man is **pilking** a balloon.'

**Arguments Dropped (Light Context)**
필키고 있어
pilk-go iss-eo
**pilk**-PROG PRES
‘Pilking.'

Arunachalam et al., 2013, *Language Acquisition*
N = 80
TD
Mean age: 2;0

Arunachalam et al., 2013, Language Acquisition
low processing

high informativeness

C.F. Almor, 1999
He, Kon, & Arunachalam, under revision
The ball is fezzing!
The round ball is fezzing!
The pretty round ball is fezzing!

0 adjectives
1 adjective
2 adjectives

He, Kon, & Arunachalam, under revision
Where's fezzing?

He, Kon, & Arunachalam, under revision
N = 60
TD
Mean age: 3;2

He, Kon, & Arunachalam, under revision
Modified nouns can hinder verb learning, even at an age when children can parse through modified determiner phrases (Thorpe & Fernald, 2006).

The ball is *fezzing*! ✔
The round ball is *fezzing*! ✗
The pretty round ball is *fezzing*! ✗
low processing

high informativeness
He is *blicking*.  
The boy is *blicking*.  
The nice boy is *blicking*.  
The nice boy with the red hat is *blicking*. 

low processing

high informativeness
He is *blicking.*

The boy is *blicking.*

The nice boy is *blicking.*

The nice boy with the red hat is *blicking.*
Linguistic context is a great cue for supporting verb learning, but it’s fragile – the context must be “just so”

Informativeness and processability of the context both matter

Critically important for children with language delays, children with ASD, SLI, late talkers all are slow language processors e.g., Bavin & Baker, 2016; Fernald & Marchman, 2012; Venker et al., 2013

What kinds of contexts do parents actually use when talking to their children?
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Tobii X2-30, with Windows Surface Pro 2 tablet

parent wears laser goggles that block the wavelengths used for tracking
<table>
<thead>
<tr>
<th>Moon</th>
<th>Umbrella</th>
<th>Flower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dotted Umbrella</td>
<td>Thumbs Up</td>
<td>Tractor</td>
</tr>
</tbody>
</table>

Arunachalam, 2016, *Journal of Memory and Language*
Same condition

Arunachalam, 2016, *Journal of Memory and Language*
Different condition

Arunachalam, 2016, *Journal of Memory and Language*
Parent speech:

- Most parents *over-modify* on at least one trial: e.g., “Where’s the white fluffy bunny on the table?”

- In the **Same** condition, modifiers tended to appear after the noun (79%). In the **Different** condition they appeared either before (52%) or after (48%).

32 TD dyads, 3;2 to 4;11, mean 3;11
1 parent each, 4 dads

Arunachalam, 2016, *Journal of Memory and Language*
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Arunachalam, 2016, *Journal of Memory and Language*
What referential expressions do parents use?

- In the harder condition, prefer postnominal modifiers

How does the parent’s choice of label affect children’s processing?

- postnominal modifiers are easier

Arunachalam, 2016, *Journal of Memory and Language*
parents of TD 2-year-olds (N = 8)

high informativeness

low processing

He is \textit{blicking}. The boy is \textit{blicking}. The nice boy is \textit{blicking}. The nice boy with the red hat is \textit{blicking}. 
parents of TD 3- and 4-year-olds (N = 6)

low processing

high informativeness

He is *blicking.* The boy is *blicking.* The nice boy is *blicking.* The nice boy with the red hat is *blicking.*
parents of 3- and 4-year-olds with ASD (N = 7)

- **low processing**
- **high informativeness**

He is *blicking.*

The boy is *blicking.*

The nice boy is *blicking.*

The nice boy with the red hat is *blicking.*
collapsing across all children

low processing

493 ms

He is *blinking*.

The boy is *blinking*.

The nice boy is *blinking*.

389 ms

high informativeness

The nice boy with the red hat is *blinking*. 
Wrapping up

low processing

high informativeness

He is blicking.
The boy is blicking.
The nice boy is blicking.
The nice boy with the red hat is blicking.
Wrapping up

- Young children with ASD can mine their environment for useful linguistic information.
- Children with ASD and TD children use an unfamiliar verb’s linguistic context to infer its meaning.
- But informativeness and processability of the context matter.
- Parents help by producing language that is tailored to their child’s language level.
Thank you!

Collaborators and Students:
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Angela Xiaoxue He  Kristen Syrett
Sabrina Horvath  Matthew Valleau
Maxwell Kon  Sandra Waxman