Sentence-level and Environmental Cues to Lexical Representation of Abstract Predicates

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September 17, 2016
SynLinks Workshop
University of Connecticut
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What are those cues and how do they interact?
Outline

What are sentence-level cues and what are environmental cues?
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- An experimental approach to studying judgments of grammaticality
- Another type of abstract predicate: emotion adjectives
Sentence-level and Environmental Cues

What are “Sentence-level cues” to word meanings?
Sentence-level and Environmental Cues

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- Argument-structure frames
  - [Subject [Verb]]
  - [Subject [Verb [Object]]]
  - [Subject [[Verb [Object]] Indirect Object]]
  - [Subject [Verb [Sentence]]]

sleep, *hit, *give, ?think
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- **NP animacy**
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- Any other cues that come from grammatical restrictions: definite vs. indefinite determiners, morphosyntactic markers or patterns, etc.
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- Observable actions, events and states
- Any other observable or inferable properties of the scene that restrict or relate to how the story plays out
The Usefulness of Sentence-level Cues

Previous work: as predicate meanings become more abstract, sentence-level cues become more reliable and critical for learning those meanings.

The Usefulness of Sentence-level Cues

Frames that are Helpful for Abstract Predicates

- tensed complement (*that*-clause)
  - mental verbs (*think*, *know*, *believe*)
  - verbs of communication (*say*)
Frames that are Helpful for Abstract Predicates

- tensed complement (that-clause)
  - mental verbs (think, know, believe)
  - verbs of communication (say)

- infinitive complement (to-clause)
  - raising verbs (seem, tend)
  - control verbs (want, claim)
  - tough-adjectives (easy, tough)
  - control adjectives (eager, afraid)
Predicates that take an infinitive complement are all fairly abstract (seem, want), but they differ from each other in important ways (seem vs. want)
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→ different representations.

How do children come to distinguish them?
Types of Abstract Predicates

Raising V  Control V  Tough-Adj  Control Adj

seem  want  easy  eager
Types of Abstract Predicates

<table>
<thead>
<tr>
<th>Raising V</th>
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(1) John \_Th seems \_ti to be friendly.] raising verb
(2) John \_Ag/Exp wants \_PROi to be friendly.] control verb
Types of Abstract Predicates

Raising V  Control V  Tough-Adj  Control Adj

seem  want  easy  eager

(1) John_i. Th seems [t_i to be friendly.] raising verb
(2) John_i.Ag/Exp wants [PRO_i to be friendly.] control verb
(3) John_i. Th is easy [PRO_{arb} to please t_i] tough adjective
(4) John_i. Exp is eager [PRO_i to please e] control adjective
Fortunately, a finer-grained Syntactic Bootstrapping approach reveals frame differences among these predicate types.
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(5) It seems/*wants to be cloudy.
   There seems/*wants to be a problem.
   The book seems/*wants to be heavy.

(6) It is easy/*eager to please John.
   The rock is easy/*eager to push.
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    The rock is **easy/**eager to push.

(7) John **wanted/**seemed the prize.

(8) John is **eager/**easy.
Are Speakers Sensitive to these Restrictions?

My older work showed that adults and children generally assume
the following (Becker 2005, 2006, 2009, Becker & Estigarribia 2013):

- It/There < \verbs > to S → raising verb NP
- NP inanimate < \verbs > to S → raising verb
- NP animate < \verbs > to S → control verb

More recent work extended this to adjectives (Becker 2015).
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Teach children novel adjectives by using them 5 times in a story or dialogue
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Manipulate sentence-level cues in dialogue (here: subject animacy).
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Manipulate sentence-level cues in dialogue (here: subject animacy).

In addition to providing a sentence-level cue (animacy), the stories provided some environmental context so the stories were coherent.
If participants are able to develop a lexical representation of the novel word that includes its Theta grid → should have intuitions about other possible/impossible sentence frames.
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Ask children a yes/no question using the novel adjective in one of those possible/impossible frames.
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Should be slower to answer the “impossible” questions
Inanimate, “easy” context

Nurse asks Mrs. Farmer to help her learn to draw. Nurse draws a flower but messes up, suggests drawing a tree. Mrs. Farmer encourages her to draw an apple instead, since “apples are very daxy to draw”
Stimuli: Inanimate Condition

Inanimate, “easy” context

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Animate, “eager” context

Policeman asks for help moving furniture. Nurse refuses to help, but suggests that Mr. Farmer do it since he is “always greppy to help”
Stimuli: Animate Condition

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Nurse asks Mrs. Farmer to pose so she can draw her portrait. Mrs. Farmer refuses but Mr. Farmer agrees. Nurse successfully draws Mr. Farmer’s portrait, since he was “daxy to draw”.

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Prediction:
inanimate subject (An apple is daxy to draw) →
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inanimate subject (An apple is daxy to draw) → tough-adj.
Prediction:
inanimate subject (An apple is daxy to draw) → *tough-adj.*

√ Is it daxy to draw an apple? → faster RT

* Is the tree daxy? → slower RT
Novel Abstract Predicates

Prediction:
inanimate subject (An apple is daxy to draw) $\rightarrow$ tough-adj.
  $\sqrt{}$ Is it daxy to draw an apple? $\rightarrow$ faster RT
  * Is the tree daxy? $\rightarrow$ slower RT

animate subject (Mr. Farmer is greppy to help) $\rightarrow$
Novel Abstract Predicates

Prediction:
inanimate subject (An apple is daxy to draw) → tough-adj.
  √ Is it daxy to draw an apple? → faster RT
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animate subject (Mr. Farmer is greppy to help) → control or ?
Prediction:
inanimate subject (An apple is daxy to draw) $\rightarrow$ tough-adj.
$\checkmark$ Is it daxy to draw an apple? $\rightarrow$ faster RT
* Is the tree daxy? $\rightarrow$ slower RT

animate subject (Mr. Farmer is greppy to help) $\rightarrow$ control or ?
*/? Is it greppy to help the nurse? $\rightarrow$ slower/= RT
$\checkmark$/? Is Mr. Farmer greppy? $\rightarrow$ faster/= RT
Children ages 4–7 years (N = 40; Becker 2015)
As expected, in the **inanimate** condition children generally responded:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Question 1</th>
<th>Question 2</th>
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</thead>
<tbody>
<tr>
<td>faster</td>
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However, when all subjects were **animate** they responded:

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**Control**
Is relative Reaction Time a good measure of grammatical acceptability?
A Side Note about Methodology

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⇒ Children should show surprise → longer RT ← when the question sounds ungrammatical
RT as a Measure of Grammaticality

Does this actually work?
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- Did the farmer play with the car? √
Does this actually work?

- Did the farmer play with the car?  √
- Did the farmer play the car to his friend?  *
RT as a Measure of Grammaticality

Does this actually work?

- Did the farmer play with the car? √
- Did the farmer play the car to his friend? *
- Did the nurse borrow a basket? √
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- Did the nurse borrow? *
RT as a Measure of Grammaticality

Children (N=40; age range=4–7 years, mean=6;0)
RT as a Measure of Grammaticality

- Is the girl petting the cat? √
- Is the boy petting? *
- Is the nurse sleeping? √
- Is the policeman sleeping the nurse? *
Children (N=37; age range=3–4 years, mean=3;8)
RT as a Measure of Grammaticality

Adults (N=13; age range=21–52, mean=30.3)
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⇒ On what basis were they determining adjective category?
Environmental Cues

There were no sentence-level cues to categorize the adjectives.
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Mr. Farmer is daxy to draw
Mr. Farmer is greppy to help  \{ both are compatible with either tough or control adjective \}

Mr. Farmer gets drawn
Mr. Farmer helps out his friend

⇒ Theme
⇒ Agent

Nurse gets hidden under blanket
Teacher is excited about teaching

⇒ Theme
⇒ Agent/Experiencer

(cf. Papafragou, Cassidy & Gleitman 2007)
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What else was going on in the scenario?
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What else was going on in the scenario?

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Environmental Cues

More generally: how do children learn the individual lexical meanings of different *tough*-adjectives, different control adjectives, raising verbs, etc.?
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Sentence-level cues serve to categorize → restrict range of possible meanings but this is only the first step.
Environmental Cues

Refinement of lexical representation must come from other information.

Observable:
- relative agency of participants
- events themselves
- causes and outcomes of actions
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Non-observable:
- desires and intentions (want/try to)
- perceptions (seem to X)
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- other internal states (afraid to)
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Can children infer these internal states?
Emotion adjectives denote internal states. How do children learn their meanings?
Emotion Adjectives

Emotion adjectives denote internal states. How do children learn their meanings?

- Which sentence-level cues help to restrict the set of likely/possible meanings?
Emotion adjectives denote internal states. How do children learn their meanings?

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Emotion adjectives denote internal states. How do children learn their meanings?

- Which sentence-level cues help to restrict the set of likely/possible meanings?
- Which environmental cues (facial expressions, situations) help to refine the lexical meaning?
- How do the sentence-level and environmental cues interact?
Prior work suggests an influence of language on the formation of access to emotion concepts.
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...language plays a role in emotion because it helps acquire, organize, and use the concept knowledge that is an essential element in emotion perceptions ... and perhaps even experiences.

Lindquist et al. 2015, p.100
Emotion Concepts and Language

Prior work suggests an influence of language on the formation of/access to emotion concepts

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Lindquist et al. 2015, p.100

...emotion words help a perceiver understand the meaning of another person’s facial muscle movements. [...] Language plays a constitutive role in emotion perception...

Lindquist & Gendron 2013, p.66
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If learning a word for an emotion facilitates the concept of the emotion, how is the word learned in the first place?
### Sentence-level Cues for Emotion Adjectives

<table>
<thead>
<tr>
<th>Frame</th>
<th>Possible Meanings</th>
</tr>
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<tbody>
<tr>
<td>John is <em>daxy</em></td>
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**tall, red**  
**physical/external properties**
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- tall, red  physical/external properties
- hungry, cold  internal physical (non-emotion) properties
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- tall, red: physical/external properties
- hungry, cold: internal physical (non-emotion) properties
- happy, sad: internal, mental/emotion properties
Widen and Russell (2010) presented children (4–10 years) with stories/faces and asked children to label how the character felt.
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One day, it was Joan’s birthday. All her friends came to her birthday party and gave her presents. Joan jumped up and down and clapped her hands. How does Joan feel?
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One day, it was Joan’s birthday. All her friends came to her birthday party and gave her presents. Joan jumped up and down and clapped her hands. How does Joan feel?

Or:

Here’s a picture of Joan. How does Joan feel?
They found...

- Main effect of age between 3 groups (preschool, K–1, 2–3)
They found...

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- Everyone was 100% correct on happy
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- Main effect of presentation mode: kids were better with stories than pictures (except for surprise)
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- Main effect of age between 3 groups (preschool, K–1, 2–3)
- Everyone was 100% correct on happy
- Main effect of presentation mode: kids were better with stories than pictures (except for surprise)
- Significant interaction between age and presentation mode: children improved earlier in story mode than face mode.
We taught children (age 3–5) novel adjectives in two studies (Becker, Lindquist & Shablack, in prep.).
Teaching Novel Emotion Adjectives

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Study 1 (“Language-Only”): Sentence-level cues but no environmental cues
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- Children heard a novel adjective used 4 times in one of three sentence frames
  - Puppet A: I know an alien who is daxy!
  - Puppet B: Really? You know an alien who is daxy?
  - Puppet A: Yeah! This alien is daxy.
  - Puppet B: Wow! You know an alien who is daxy.
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- I know an alien who **is daxy**
  - feels daxy
  - feels daxy about something
Teaching Novel Emotion Adjectives

Study 2 ("Language + Context"): Environmental cues and (some) sentence-level cues

- Children heard a short story (w/ video) about a character who experiences some emotion.
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- Children heard a short story (w/ video) about a character who experiences some emotion.
- “It was Wazu’s birthday. All his friends came to his birthday party and gave him presents. Wazu jumped up and down.”
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- Point to where Wazu is daxy
  feels daxy
  feels daxy about something
Both studies: children were asked to “point to where NP is daxy/feels daxy/feels daxy about something”
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Point to where Palooza feels blinty.
Predictions

- If sentence-level cues (feels daxy (about)) $\rightarrow$ emotion word, children in the Language-Only study should choose the emotion picture in the feels and feels-about conditions, but not in the is condition.

And should choose state picture in feels condition but not feels about condition.

- If environmental cues $\rightarrow$ emotion word, children in the Language+Context study should choose the emotion picture in all conditions.

- If both types of cues have an additive effect, children in the Language+Context study should choose the emotion picture more in feels and feels-about than in is condition.

$\text{feels-about} \geq \text{feels} > \text{is}$
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feels-about ≥ feels > is
Results: Language-Only

N=129, 64F, mean age = 3.9

2-way (choice x age) $F = 2.99$, $p = 0.020$; 3-way int. (choice x cond. x age) $F = 1.76$, $p = 0.086$
Results: Language-Only

- **Is** condition
  - 3- and 4-year-olds don’t differentiate
  - 5-year-olds **avoid** picking action (running; *is daxy*, not *is daxing*)

- **Feels** condition
  - 3-year-olds don’t differentiate
  - 4- and 5-year-olds prefer **state** pictures (itchy)

- **Feels About** condition
  - 3- and 4-year-olds pick **state** pictures
  - 5-year-olds pick **emotion** pictures (happy)
Results: Language + Context

N=123, 50F, mean age = 4.0

2-way (choice x age) F = 10.19, p = 0.001; 3-way int. (choice x cond. x age) F = 2.85, p = 0.005
Results: Language + Context

- **Is** condition
  - 3- and 4-year-olds don’t differentiate
  - 5-year-olds pick emotion pictures

- **Feels** condition
  - 3-year-olds avoid picking action
  - 4- and 5-year-olds pick emotion (and state) pictures

- **Feels About** condition
  - 3-year-olds don’t differentiate
  - 4- and 5-year-olds pick emotion pictures sig. more than state
With no environmental cues ("language-only")
- 3-year-olds don’t distinguish adjective meanings
- 4- and 5-year-olds tend to prefer state pictures
- 5-year-olds pick emotion pictures only in the Feels About condition
Discussion

- With no environmental cues ("language-only")
  - 3-year-olds don’t distinguish adjective meanings
  - 4- and 5-year-olds tend to prefer state pictures
  - 5-year-olds pick emotion pictures only in the Feels About condition

- With environmental cues ("language + context")
  - 3-year-olds are still unable to distinguish adjective meanings
  - 4-year-olds pick emotion pictures w/ feels and feels about
  - 5-year-olds pick emotion pictures in all conditions
Some Concerns

- In the language-only study there was a general preference for the *state* pictures, including in fillers (which used novel verbs)
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(a) we used analogues of human emotions, and

(b) not clear if drawings depict what we wanted.
Summary: Tough- and Control Adjectives

- For learning predicates with abstract, not-directly-observable meanings, sentence-level cues provide important restrictive information.
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  - Agency
  - Intentions
  - Repercussions and outcomes of actions
Summary: Emotion Adjectives

Previous work (Widen & Russell)

- Story cues provide more information than face cues → stories provide information about agency, intentions, repercussions and outcomes of actions
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Our study

- Without environmental (story) cues, only 5-year-olds drew expected inferences:
  - `is daxy` → state or emotion, *action
  - `feels daxy` → state or emotion, *action
  - `feels daxy about s.th.` → emotion, *state or *action
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- With environmental cues, 5-year-olds chose emotions, 4-year-olds did so with feels and feels about.
Future Directions

Where do we go from here?
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- Redo with human faces, not alien cartoons
Future Directions

Where do we go from here?

- Redo with human faces, not alien cartoons
- Increase range of sentence frames? (NP feels daxy about something, NP feels daxy to do something...)

Languages differ in the exact emotions labeled. Are bilingual children better/worse at face labeling/sorting tasks?
Future Directions

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Thank you!
Acknowledgments

Collaborators...

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<th><strong>Tough-Adjectives</strong></th>
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<tr>
<td>Bruno Estigarribia</td>
<td>Kristen Lindquist</td>
</tr>
<tr>
<td>Duna Gylfadóttir</td>
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And other supporters...

- UNC’s Fostering Interdisciplinary Research Explorations (FIRE) grant
- Museum of Life and Science (Durham, NC)
- National Living Labs (funded by NSF)
- RAs: Laura Belk, Thomas Bulick, Will Carter, Nolan Danley, Iyad Ghanim, Xue He, Anika Khan, Emily Moeng, Jordan Jarrett, Sarah Smith, Shannon Watkins
In addition to children, we tested 72 adults (29F, mean age = 36.6) on the emotion stimuli.
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Novel Raising/Control Verbs

- Small pilot with 5 5-year-olds
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- Verbs with infinitive complements, animate or inanimate subjects
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<th>Subject</th>
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<tr>
<td>The vegetables meb to be tasty</td>
<td>inanimate</td>
</tr>
<tr>
<td>My dog zids to be at the park</td>
<td>animate</td>
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<tr>
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<td>Did there meb to be a banana in the soup?</td>
<td>grammatical</td>
</tr>
<tr>
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<td>ungrammatical</td>
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<tr>
<td>Did there zid to be a dog with the policeman?</td>
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</tr>
<tr>
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