Psych 156A/ Ling 150: Acquisition of Language II

Lecture 14

Poverty of the Stimulus III

Announcements

Pick up HW2 if you haven't already

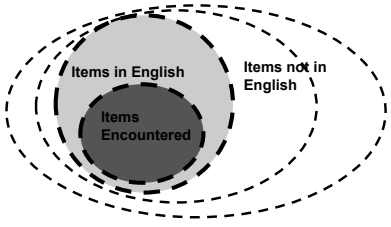
Be working on HW3 (due: 5/29/12)

Next time: Look over Ch.1 and Ch.2 from Baker (2001)

Correction to Poverty of the Stimulus II lecture notes from last time (please download them again to make sure you have the most up-to-date version)

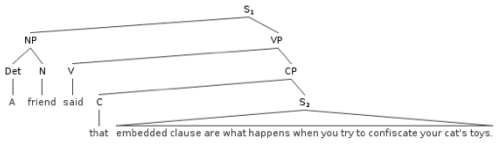
Poverty of the Stimulus

The data encountered are compatible with both the correct hypothesis and other, incorrect hypotheses about the rules and patterns of the language.



Reasonable questions

- What are some examples of linguistic knowledge that seem to present a poverty of the stimulus situation?
  - Structure-dependent rules



English Yes/No Questions

Crain & Nakayama (1987) showed that children as young as 3 years old know how to form complex yes/no questions. They use a structure-dependent rule.

Rule: Move main clause auxiliary

Is the girl who can solve the labyrinth happy?

English Yes/No Questions

The problem is that simple yes/no questions are compatible with a lot of different rules, both structure-independent and structure-dependent.

Jareth can alter time.
Can Jareth alter time?

Rule: Move first auxiliary?

Rule: Move last auxiliary?

Rule: Move main clause auxiliary?

Rule: Move auxiliary in even-numbered position in sentence?

Rule: Move auxiliary closest to a noun?

English Yes/No Questions

The correct rule is a structure-dependent rule (it requires the child to know that sentences can be divided into main and embedded clauses).

Jareth can alter time.
Can Jareth alter time?

~~Rule: Move first auxiliary?~~

~~Rule: Move last auxiliary?~~

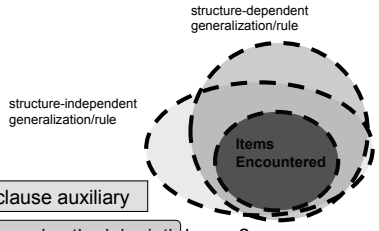
Rule: Move main clause auxiliary

~~Rule: Move auxiliary in even-numbered position in sentence?~~

~~Rule: Move auxiliary closest to a noun?~~

English Yes/No Questions

How do children choose the right rule from all the possible rules that are compatible? That is, how do they generalize the right way from the subset of the data they encounter?



Rule: Move main clause auxiliary

Is the girl who can solve the labyrinth happy?

Reasonable questions

- What are some examples of linguistic knowledge that seem to present a poverty of the stimulus situation?
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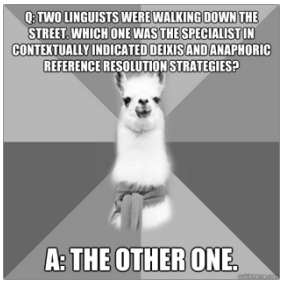


Anaphoric *One*

Look - a red bottle!

Do you see another *one*?

Anaphoric *One*

Look - a red bottle!

red bottle

Do you see another *one*?

Process: First determine the linguistic antecedent of *one* (what words *one* is referring to). "red bottle"

Anaphoric *One*

Look - a red bottle!

red bottle

Do you see another *one*?

Process: Because the antecedent ("red bottle") includes the modifier "red", the property RED is important for the referent of *one* to have.
referent of *one* = RED BOTTLE

Anaphoric *One*

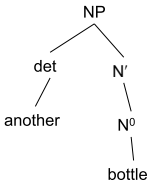
Look - a red bottle!

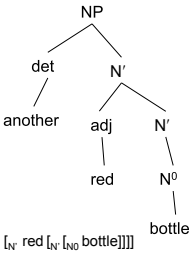
Do you see another *one*?

Two steps:
(1)Identify syntactic antecedent (based on syntactic category of *one*)
(2)Identify semantic referent (based on syntactic antecedent)

Anaphoric *One*: Syntactic Category

Standard linguistic theory says that *one* in these kind of utterances is a syntactic category smaller than an entire noun phrase, but larger than just a noun (N^0). This category is sometimes called N′. This category includes sequences like “bottle” and “red bottle”.





[NP another [N′ [N0 bottle]]] [NP another [N′ red [N′ [N0 bottle]]]]

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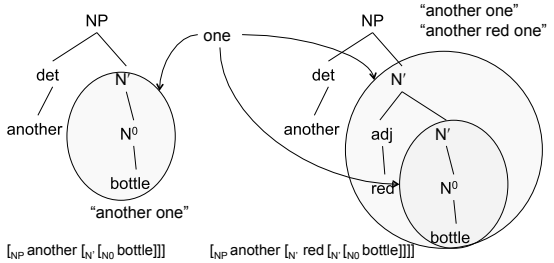
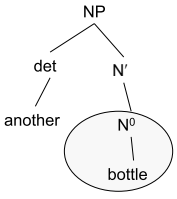
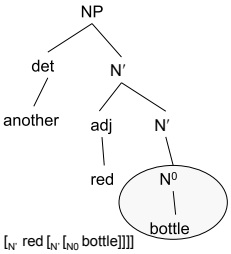


[NP another [N′ [N0 bottle]]] [NP another [N′ red [N′ [N0 bottle]]]]

Anaphoric *One*: Syntactic Category

Importantly, *one* is not N^0. If it was, it could only have strings like “bottle” as its antecedent, and could never have strings like “red bottle” as its antecedent.





[NP another [N′ [N0 bottle]]] [NP another [N′ red [N′ [N0 bottle]]]]

Anaphoric *One*: Interpretations based on Syntactic Category

If *one* was N^0, we would have a different interpretation of

"Look – a red bottle!  Do you see another one?" 

Because *one*'s antecedent could only be "bottle", we would have to interpret the second part as "Do you see another *bottle*?" and the purple bottle would be a fine referent for *one*.

Since *one*'s antecedent is "red bottle", and "red bottle" cannot be N^0, *one* must not be N^0.

Anaphoric *One*: Children's Knowledge

Lidz, Waxman, & Freedman (2003) found that 18-month-olds have a preference for the red bottle in the same situation.

"Look – a red bottle! Do you see another one?"

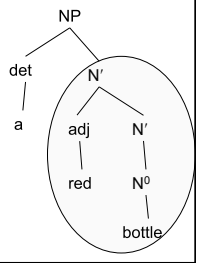
Lidz et al. interpretation & conclusion:

Preference for the RED BOTTLE means the preferred syntactic antecedent is "red bottle".

Lidz et al. conclude that 18-month-old knowledge =

syntactic category of *one* = N′

when modifier (like "red") is present, syntactic antecedent includes modifier (e.g., red) = referent must have modifier property



Anaphoric *One*: The induction problem

Acquisition: Children must learn the right syntactic category for *one*, and the right interpretation preference for *one* in situations with more than one option.

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Problem: Most data children encounter are ambiguous.

Syntactically (SYN) ambiguous data:

"Look – a bottle! Oh, look – another one."

 

one's referent = BOTTLE

one's antecedent = $[_{N'}[_{N0}$ bottle]] or $[_{N0}$ bottle]?

Anaphoric *One*: The induction problem

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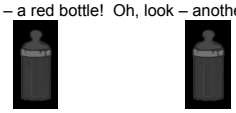
Problem: Most data children encounter are ambiguous.

Semantically and syntactically (SEM-SYN) ambiguous:

"Look – a red bottle! Oh, look – another one."



one's referent = RED BOTTLE or BOTTLE?
one's antecedent = $[_{N'}$ red$[_{N'}[_{N0}$ bottle$]]]$ or $[_{N'}[_{N0}$ bottle$]]$ or $[_{N0}$ bottle$]$?

Anaphoric *One*: The induction problem

Acquisition: Children must learn the right syntactic category for *one*, and the right interpretation preference for *one* in situations with more than one option.

Problem: Unambiguous data are extremely rare

Unambiguous (UNAMB) data:

"Look – a red bottle! Hmmm - there doesn't seem to be another one here, though."

one's referent = BOTTLE? If so, *one*'s antecedent = "bottle".
But it's strange to claim there's not another *bottle* here.
So, *one*'s referent must be RED BOTTLE, and *one*'s antecedent = $[_{N'}$ red$[_{N'}[_{N0}$ bottle$]]]$.

Anaphoric *One*: The induction problem

Acquisition: Children must learn the right syntactic category for *one*, and the right interpretation preference for *one* in situations with more than one option.

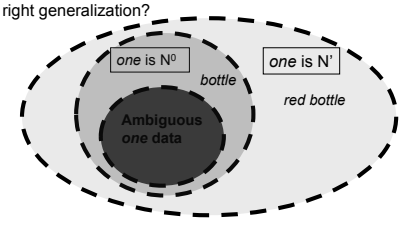
Problem: Unambiguous data are extremely rare

Pearl & Mis (2011) looked at 36,500 child-directed speech utterances (from CHILDES), and discovered that *none* of them were unambiguous for anaphoric *one*.

Anaphoric *One*: The induction problem

Acquisition: Children must learn the right syntactic category for *one*, so they end up with the right interpretation for *one*.

Problem: If children don't encounter unambiguous data often enough to notice them, they are left with data that are compatible with both hypotheses – that *one* is N^0 and that *one* is N'. How do children know which is the right generalization?



Reasonable questions

- What are some examples of linguistic knowledge that seem to present a poverty of the stimulus situation?
  - Structure-dependent rules
  - Anaphoric *one* in English
  - Syntactic islands

Syntactic Islands

Dependencies between a wh-word and where it's understood (its gap) can exist when these two items are not adjacent, and these dependencies do not appear to be constrained by length (Chomsky 1965, Ross 1967).

What does Jack think __?
What does Jack think that Lily said __?
What does Jack think that Lily said that Sarah heard __?
What does Jack think that Lily said that Sarah heard that Jareth stole __?

Syntactic Islands

However, if the gap position appears inside certain structures (called "syntactic islands" by Ross (1967)), the dependency seems to be ungrammatical.

*What did you make [the claim that Jack bought __]?
*What do you think [the joke about __] offended Jack?
*What do you wonder [whether Jack bought __]?
*What do you worry [if Jack buys __]?
*What did you meet [the scientist who invented __]?
*What did [that Jack wrote __] offend the editor?
*What did Jack buy [a book and __]?
*Which did Jack borrow [__ book]?

The input: Induction problems

Data from four corpora of child-directed speech (Brown-Adam, Brown-Eve, Valian, Suppes) from CHILDES (MacWhinney 2000): speech to 24 children between the ages of one and four years old.

Total utterances: 101,838
Utterances containing a *wh*-word and a verb: 20,923

Pearl & Sprouse (2011, submitted) discovered that more complex dependencies were fairly rare in general (<0.01% of the input).

The input: Induction problems

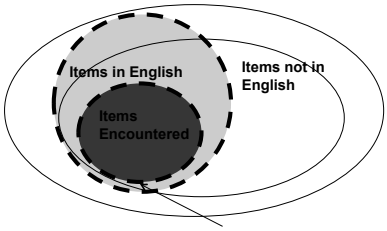
What does the input look like?

76.7%	*What did you see __?*
12.8%	*What __ happened?*
5.6%	*What did she want to do __?*
2.5%	*What did she read from __?*
1.1%	*What did she think he said __?*
…	

The input: Induction problems

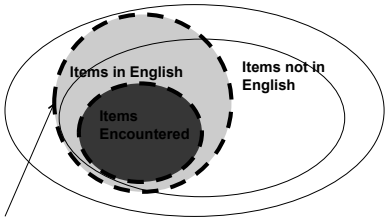
Important: Some grammatical utterances never appeared at all. This means that only a subset of grammatical utterances appeared, and the child has to generalize appropriately from this subset.

Syntactic Islands: Induction Problem



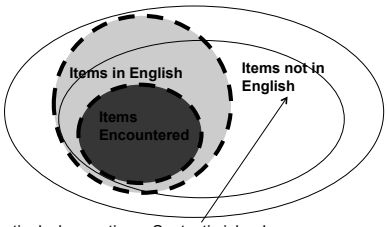
Wh-questions in input (usually fairly simple)
- What did you see?
- What happened?
- …

Syntactic Islands: Induction Problem



Grammatical wh-questions
- What did you see?
- What happened?
- Who did Jack think that Lily saw?
- What did Jack think happened?

Syntactic Islands: Induction Problem



Ungrammatical wh-questions: Syntactic islands

*What did you make [the claim that Jack bought __]?
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Reasonable questions

- When there is a poverty of the stimulus situation, what kind of "knowledge" do children need in order to end up with the right answer?
  - Knowledge kinds (at least three dimensions to consider):

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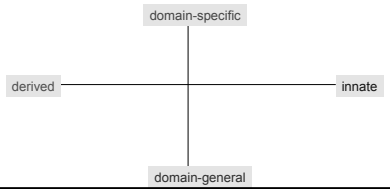
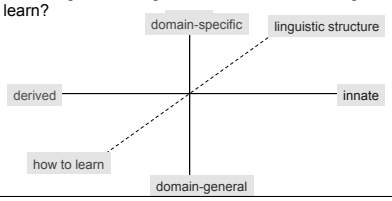


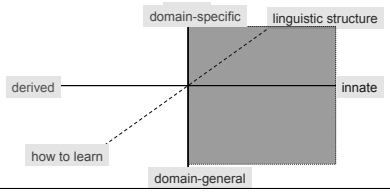
Reasonable questions

- When there is a poverty of the stimulus situation, what kind of "knowledge" do children need in order to end up with the right answer?
  - Knowledge kinds (at least three dimensions to consider):
    - Domain-general or domain-specific?
    - Innate or derived from prior linguistic experience?
    - Knowledge about linguistic structure or knowledge about how to learn?



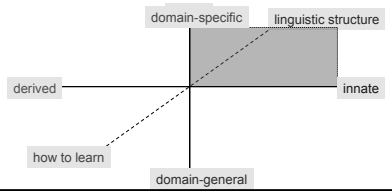
Reasonable questions

- Nativists believe that the necessary knowledge is innate, but may be either domain-specific or domain-general.



Reasonable questions

- Linguistic nativists believe that the necessary knowledge is both innate and domain-specific. This is sometimes called the Universal Grammar (UG) hypothesis. Linguistics nativists believe that because children have Universal Grammar, they can solve these poverty of the stimulus problems.



Reasonable questions

- How can we test different ideas about what the necessary knowledge might be?
  - Computational modeling studies can help us identify the necessary knowledge

We can construct a model where we have precise control over these:

- The hypotheses the child is considering at any given point [hypothesis space]
- How the child represents the data & which data the child uses [data intake]
- How the child changes belief based on those data [update procedure]

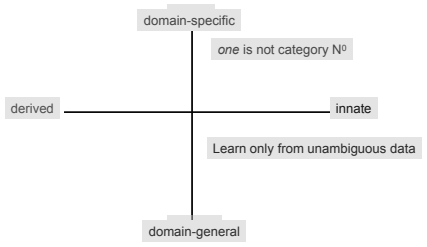
Computational modeling studies

Several recent computational models have attempted to address poverty of the stimulus questions, and rely on probabilistic learning (often Bayesian inference) as the main method of learning. By modeling the acquisition process for these linguistic phenomena, these models hope to pinpoint the kind of knowledge required for language acquisition.

- Anaphoric *one*: Regier & Gahl (2004), Foraker et al. (2009), Pearl & Lidz (2009), Pearl & Mis (2011, submitted)
- Syntactic islands: Pearl & Sprouse (2011, submitted)

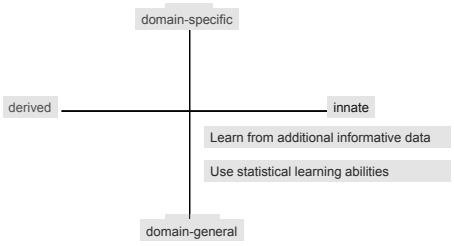
English anaphoric *one*

Baker (1978) assumed only unambiguous data are informative, and these data are rare. So, he proposed that children needed to know that *one* could not be syntactic category N^0.



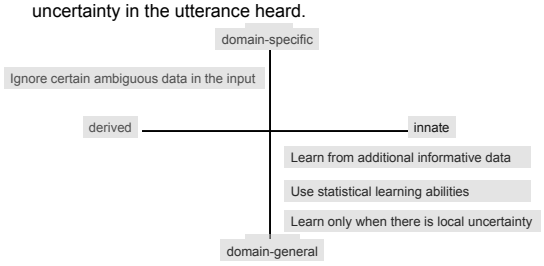
English anaphoric *one*

Regier & Gahl (2004) used a Bayesian learner computational model to show that children could learn *one* is category N′ if they learned from some of the available ambiguous data and used their statistical learning abilities to track suspicious coincidences in the input.



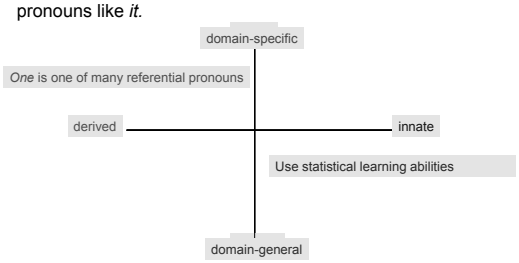
English anaphoric *one*

Pearl & Lidz (2009) discovered that a Bayesian learner must ignore certain ambiguous data (even if they're informative) in order to learn that *one* is category N′. This can be derived from an innate, domain-general preference for learning when there is uncertainty in the utterance heard.



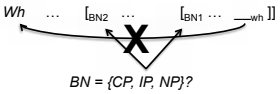
English anaphoric *one*

Pearl & Mis (2011, submitted) discovered that a Bayesian learner can learn from all ambiguous *one* data and still learn to interpret *one* appropriately in experiments like Lidz, Waxman, & Freedman (2003), if the learner also learns from data containing other pronouns like *it*.



Syntactic islands

Chomsky (1973), Huang (1982), and Lasnik & Saito (1984) proposed that children must know that dependencies cannot cross 2 or more bounding nodes (a domain-specific representation).



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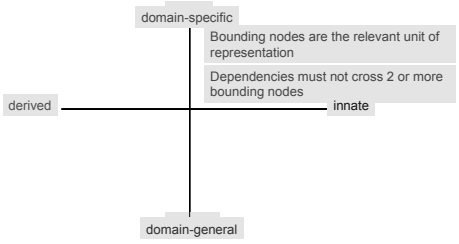


Syntactic islands

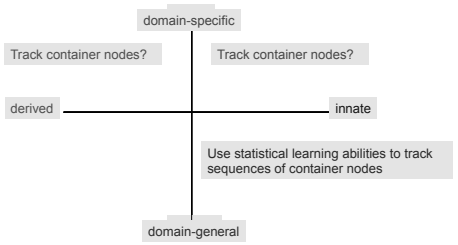
Pearl & Sprouse (2011, submitted) discovered that a probabilistic learner that tracks sequences of container nodes (a linguistic representation) can learn some of the syntactic islands.

[CP Who did [IP she [VP like ___who]]]?
IP VP ← Container nodes

Container node sequence characterizing this dependency: IP-VP

Syntactic islands

Pearl & Sprouse (2011, submitted) discovered that a probabilistic learner that tracks sequences of container nodes (a linguistic representation) can learn some of the syntactic islands. It's unclear whether knowledge of container nodes is innate or derived.



Recap

- There are several examples of poverty of the stimulus problems in language learning, such as the representation of English anaphoric *one*, and the existence of syntactic islands.
- Children require some knowledge to help them solve these problems, but there are different kinds of knowledge they could have.
- Nativists believe at least some of the knowledge is innate. Linguistic nativists believe that at least some of the knowledge is both innate and domain-specific.
- Computational modeling studies can help us determine what knowledge is necessary for successful acquisition to occur.

Questions?

You should be able to do all the questions on HW3 and the review questions for poverty of the stimulus. Use the rest of the time to work on these and ask us questions about them.