Acquisition of Complements
What is complementation?

- A special case of a complex sentence -
  - A complex sentence has two verbs expressing two propositions
  - Complementation -
    - One proposition is nested within another
    - One proposition is an argument of another proposition

- Sentential Complements
  - I THINK I can put him in a house

- Wh-complements (with null argument)
  - LOOK AT what the little bear’s eating
Propositions (Kintsch)

Proposition = a "meaning unit", "idea unit"

Every sentence can be represented by 1 or more propositions

The stupid man bought the wrong car.

Proposition 1: BOUGHT (MAN, CAR)
Proposition 2: STUPID (MAN)
Proposition 3: WRONG (CAR)

BOUGHT, STUPID, WRONG = Predicates
- Action, state, relationship, ...

MAN, CAR = Arguments
- Entities participating in the action, ...

The same propositions are found in other ways of saying (roughly) the same thing

The guy was so dumb he bought the wrong car.
Why is complementation important?

- Evidence for recursion in language!
  - S --> NP VP
  - VP --> V  S
  - “I know Jim said Bill thought Fred said Sara knew…”
  - I know [Jim said [Bill thought [ Fred said [Sara knew…]]]]

- Complement-taking verbs refer to abstract mental states

Both reasons indicative of increasing complexity in linguistic and conceptual development
Methods

Four children studied longitudinally
- Observed in their homes during routine activities and playing
- Sessions lasted ~8 hours, at 6-week intervals
- Data grouped into 2 time points based on MLU

<table>
<thead>
<tr>
<th>Times</th>
<th>Number of sessions</th>
<th>Age Range</th>
<th>Age Mean</th>
<th>MLU Range</th>
<th>MLU Mean</th>
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<td>2.30–3.07</td>
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<td>3.05–3.58</td>
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* Times 1 and 2 are the result of grouping data, with Time 1 = MLU < 3.5, and Time 2 = MLU > 3.5.
Frequency of Complementation

- Perception Verbs
  - See (14%); look (10%)
  - Eric: Doggie is looking up
  - Kathryn: And nobody can see him
  - Gia: Look what my mommy got me
  - Kathryn: I’ll see where it is

- Epistemic (i.e., cognitive) Verbs
  - know (44%); think (83%)
  - Eric: I don’t know that part
  - Kathryn: I think up on this bed
  - Peter: Know what the other ones do?
  - Gia: I think the children go to bed

<table>
<thead>
<tr>
<th>Table 15.3</th>
<th>Frequencies of complement and non-complement sentences</th>
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<tbody>
<tr>
<td>Time 1</td>
<td>Perception</td>
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<tr>
<td></td>
<td>see</td>
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<tr>
<td>+COMP</td>
<td>15</td>
</tr>
<tr>
<td>-COMP</td>
<td>349</td>
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<tr>
<td>Time 2</td>
<td>+COMP</td>
</tr>
<tr>
<td></td>
<td>-COMP</td>
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<tr>
<td>Time 1</td>
<td>Perception</td>
</tr>
<tr>
<td></td>
<td>see</td>
</tr>
<tr>
<td>+COMP</td>
<td>1</td>
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<tr>
<td>-COMP</td>
<td>115</td>
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<tr>
<td>Time 2</td>
<td>+COMP</td>
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<tr>
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<td>-COMP</td>
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<tr>
<td>Time 1</td>
<td>Perception</td>
</tr>
<tr>
<td></td>
<td>know</td>
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<tr>
<td>+COMP</td>
<td>23</td>
</tr>
<tr>
<td>-COMP</td>
<td>174</td>
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<tr>
<td>Time 2</td>
<td>+COMP</td>
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<tr>
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<td>know</td>
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<td>+COMP</td>
<td>17</td>
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<td>-COMP</td>
<td>165</td>
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<tr>
<td>Time 2</td>
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<tr>
<td></td>
<td>-COMP</td>
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<tr>
<td>Totals</td>
<td>+COMP</td>
</tr>
<tr>
<td></td>
<td>-COMP</td>
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</table>
Sentential complements
Sentential (S) Complements

- Kathryn: I see Mommy washing her hands
- Gia: I think that he wanna eat this

- Add a simple sentence frame after a verb
- What about the complementizer: *that*?
  - Usually optional in adult speech
    - I know that you’re doing well
    - I know you’re doing well
  - Very rare in the speech of these children
    - For think, 3 of 179 S-complements used that (1.7%)

- Why?
Maybe they don’t know the word?

The children used ‘that’:

- Kathryn: I thought *that* was a snacktime (demonstrative)
- Peter: *That’s* how get them out (deictic)
- Kathryn: I think *that* girl is going to dust *that* *that* paper away (determiner)
- They clearly know the word

Use of ‘that’ with other functions inhibits its acquisition as a complementizer

- An item with several different functions may be more difficult to acquire
- Prior acquisition of other functions of ‘that’ may inhibit its acquisition as a complementizer

Input frequency?

- Maybe they never heard ‘that’-complements?
- ‘that’-less complements are frequent with think, know, see (in adult language)
Wh- complements
Wh- complements

- Kathryn: Let’s go see where Mommy is.
- Gia: You know what’s in this bag?

- A question is embedded after the matrix verb
  - Wh- complements were not used with think
  - Wh- words may not be terribly salient because they occur in the middle of the sentence
  - Acquisition may depend on prior learning of wh-words as questions – where they are sentence initial
Wh-Movement: Filler-Gap Dependencies

a. Did Calvin bring pizza?

b. Calvin brought what?

c. What did Calvin bring ___ ?  
   FILLER   GAP  \[ thematic (agent, patient) and functional (subject object) ambiguity \]

d. *What did Calvin bring pizza?
   FILLER

e. *Did Calvin bring ___ ?
   GAP
* : ungrammatical
Wh-Movement: Filler-Gap Dependencies

Bi-Clausal Sentences

a. Without filler-gap dependency:
   Did Hobbes say [that Calvin brought pizza]?

b. With filler-gap dependency:
   Did Hobbes say [what Calvin brought ___ ]?
   FILLER      GAP

   FILLER      GAP

   What did Hobbes say [that Calvin brought ___ ]?
Emergence of wh- words

- **Questions**
  - *what, where, who* emerge first
  - *how, why* later

- **Complementizer**
  - Emerge after questions
  - Use of word as complementizer is later than use of that same word as a question
  - Except for *how* (and maybe *why*)

- Use of different connectives was verb specific
  - see: *what, if, how, where*
  - know: *what, where, how*
  - look (at): *what*

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**Table 15.4** Average age of emergence for Wh-question words and Wh-complement words

<table>
<thead>
<tr>
<th>Wh-Q(^a) words</th>
<th>Average age</th>
<th>Number of children(^b)</th>
<th>Wh-COMP words</th>
<th>Average age</th>
<th>Number of children(^c)</th>
</tr>
</thead>
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<td>what</td>
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<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>where</td>
<td>2; 2</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>who</td>
<td>2; 4</td>
<td>7</td>
<td>-</td>
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<td>4</td>
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<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>where</td>
<td>2; 7.2</td>
<td>3</td>
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<tr>
<td>how</td>
<td>2; 9</td>
<td>7</td>
<td>how</td>
<td>2; 9.2</td>
<td>3</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(if)</td>
<td>2; 10</td>
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<td>why</td>
<td>2; 11</td>
<td>7</td>
<td>who</td>
<td>2; 11</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^a\) The results for Wh-question words are from Bloom et al. (1982).

\(^b\) \(n = 7\).

\(^c\) \(n = 4\).
Other aspects of Complementation
Frequency of Complement Types

- S-complements are simpler than wh-complements
  - Should they emerge earlier?
  - Do they?

- *think* has no wh-complements

- *know* has (almost) no S-complements
  - Complementation was more frequent in time 2 than time 1
  - (except for *look*)
  - For *see*, S-complements frequent early; wh-complements frequent late

**Figure 15.2** Mean frequency of complement types. ♦, Wh-comp; □, S-comp.
Textual Contingency

- Did an adult use the matrix verb or (part of) the complement within 5 speaker turns?
- Do verbs differ with respect to how they continue a discourse?

- *look (at)* may introduce a new topic;
- *think* may continue an old one.

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Adult: let’s see *how this one works*
Kathryn: You know *how it works*

Adult: I *think* that lamb is *cold*
Eric: he is very *cold* / I *think* I can put him in a house
Restrictions on Subjects

- Expect main clause subjects to be animate
  - see, look, think, know
- More restricted than expected:
  - look – all null second person (imperative)
    - Eric: *(null)* Look at that donkey carrying baskets
  - think – 3 children only I; 1 child also used you
    - Kathryn: *I think we can put it side of him*
    - Peter: *You think it don’t belongs to me*
  - know, see – more variety
    - Either first or second person subjects used first
    - Only Eric used 3rd person subjects with these verbs
    - Eric: Oh *the bunny rabbit* doesn’t know what to do
Lots of variety in subordinate subjects

Pronominal subjects with copula (to be)

Kathryn: I think *it’s* big enough

Eric: Know *what’s* in here?

Gia: I’m going to see if *there’s* any more.

*know* (48%); *think* (35%); *see* (31%); *look* (8%)

Otherwise lots of variety (1st, 2nd, 3rd person)

Eric: Look at *that donkey* carrying baskets

Kathryn: I think *we* can put it side of him
Co-reference

- 2 verbs – 2 subjects
- Do they co-refer?
  - Compare complements like:
    - I want to go home – I want (I) to go home
    - I’m going to go home – I’m going (I) to go home
    - Acquired slightly earlier than S- and wh- complements
- When there was a matrix subject (332)
  - 46 (14%) were co-referential with an expressed subordinate subject
  - Kathryn: I think I’ll pull the other side
  - Of these, 61% (think); 28% (see); 11% (know); 0% (look)
- But what about:
  - Eric: Oh the bunny rabbit doesn’t know what (BR) to do
Morphological Marking

- The subordinate verbs –
  - Were inflected or had modal more than 50% of the time
  - Modals used most often with think
    - 65% of modals used after think
    - Eric: I think we should put this in a house
  - 29% after see (64% were with can, and used if)
  - Kathryn: See if it can make some sound

- Syntax of complementation is verb specific
What do these verbs mean?

- **Think vs know (activity vs experience)**
  - Used to quantify degree of uncertainty
  - **Think = uncertain**
    - Contingent on prior discourse; children express new information from prior discourse
    - Use of modals to express lack of definiteness in complement
    - “that” indicative of certainty – virtually absent
    - “used parenthetically” = ‘perhaps’ or ‘maybe’
  - **Know = certain**
    - Less contingent on prior discourse; children had something in mind to introduce to the discourse
    - Occurred with copula in complement – suggesting talk about attributions and generic events (greater certainty for more general claims)
- **Look vs see (activity vs experience)**
  - Also used to quantify degree of uncertainty
  - See = uncertain
    - Second to *think* in repetitions from prior discourse
    - Second to *think* in use of modals in complement; only verb to itself be used with modals
    - See occurred with conditional *if* but never definite *that*
  - Look = certain
    - Used as an imperative
    - Least contingent upon prior discourse

- **Two-year olds don’t rely on activity vs experience dimension**

- **Certainty: know (experience); look (activity)**

- **Uncertainty: think (activity); see (experience)**
Conclusions

- Acquisition of syntax of complementation requires child to hold two propositions in mind:
  - One is expressed in a simple sentence frame (complement)
  - The other is a mental attitude directed towards that proposition (main clause)

- Acquisition of complementation was verb specific:
  - The verb determined if a complementizer was used, and if so, which one
  - This was learned for each verb separately
Theories of Language Development
Cognitive Approaches to Language Learning

- **Piaget** –
  - General theory of cognitive development
- **Processing approaches** –
  - Operating principles approach
  - The Competition Model
- **Construction based approaches** –
  - Grammar is constructed, not discovered
Piaget

- Acquisition of basic grammatical structures is dependent on child’s level of cognitive development
- There is nothing special about learning language
- No innate linguistic knowledge!
- No difference between language, memory, motor control, drawing, etc.
Piaget: Cognitive Stages

- **Sensorimotor stage (up to 18 months)**
  - Understanding of world based on effect of own actions on world
  - Cannot encode concepts with arbitrary symbols
  - Can’t learn mapping between sound and meaning

- **Symbolic stage (18 months – 4 or 5 years)**
  - Child forms internal representations of world
  - Onset of language (can think about objects no longer present)

- **Concrete operational stage (5 - 11 years)**
  - Child can reason about tangible objects and relations

- **Formal operational stage (12 – 16 years)**
  - Child can reason about hypothetical situations and abstract concepts

- Grammar is like Russian dolls
  - Both have nested structure
Problems for Piaget

- How do children segment speech stream into words?
- What about all the data showing sensitivity to lexical/grammatical information prior to 18 months?
  - Children produce first word at 12 months
  - 17 month olds comprehending word order
  - etc.
Processing Approaches

- Operating principles approach (Slobin)
  - What are “operating principles” children use to acquire grammar
  - Based on production data
  - Language specific differences will influence which operating principles are more important in that language
  - Lots of principles have been proposed
  - Are not based on adult grammar!
  - Grammar is built up through childhood – child grammar is very different from adult grammar
More on Operating Principles

- Perceptual and Storage filters
  - Pay attention to the ends of words, stress, beginnings of words
    - Pay attention to salient aspects of speech
  - Track the frequency of every pattern that is stored
    - Helps discover reliability of cues to grammar

- Pattern makers
  - Segment similar sounding portions of utterances
    - The dog walked
    - The dog barked
    - -ed is common to both verbs; yields – walk, bark, -ed
The Competition Model

- Language is probabilistic rather than deterministic
  - Tries to account for individual variation
  - Rich statistical co-occurrences in language input to child
- Even adult grammar is not fixed – can change to accommodate new utterances
- Accounts for language specific differences in grammar (Italian vs English word order…)
Word order in English is fairly rigid (SVO)

Italian
- (OSV) La pastaciutta Franco la prende sempre qui (Pasta, Franco it orders always here)
- (VSO) Allora, mangio anche io la pastachiutta (Well then, am eating I also pasta)
- (SOV) Allora, io gli spaghetti prendo (In that case, I the spaghetti am having)

Why is word order more flexible in Italian?
- Order is a more reliable (and necessary) cue to meaning in English

Multiple cues to meaning exist (stress, word order, morphological marking, etc.) – cues interact dynamically and compete
- Importance of different cues varies cross-linguistically
Construction Based Approaches

- Child language built up over time based on concrete examples
  - Language production reflects knowledge of specific lexical items and grammatical structures
  - Does not reflect abstract categories
- Children do not learn to combine word categories (noun, verb), etc
  - Rather, learn whole syntactic patterns – “constructions”
  - “dog biting bone” is not “dog + biting + bone”
  - “dog biting bone” is based on “cat chasing mouse”, “daddy washing car” etc.
- Generalization is very limited
  - This is based on analogy! Why doesn’t it fail? (or does it?)
  - Analogies are less abstract, more limited
Announcements

- New experiments have been added, and some have had restrictions relaxed.

- If you are still having trouble finding enough experiments to participate in, contact Laura Kertz (kertz@ling.ucsd.edu)

- Next week we’ll start with the brain
  - Tuesday 5/20: neuroanatomy
  - Thursday 5/22: LDER chapters 18,19
  - Tuesday 5/27: pragmatics/autism