Psych 56L/ Ling 51:
Acquisition of Language

Lecture 9
Lexical Development I

Announcements

Midterm returned, grades also available on EEE

Review questions for lexical development available

HW2 due 2/17/11

Lexical Knowledge in Adults

We know a lot of words

Average English-speaking college student knows ~150,000

Average first grader knows ~14,000 (and has only been alive ~2000 days) - that's 7 new words a day, assuming that the child learns right from the first day s/he is born!

What we know

Mental dictionary of words = lexicon

Each entry for a word contains a lot of information, including what the word sounds like, how to use the word in combination with other words, what the word means, what other words that word is related to…

/ɡɑblɪn/ | goblin | | creature |

the goblin is…, some goblins are…
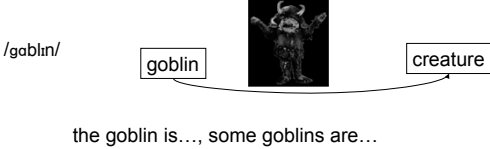
So what exactly is a word, anyway?

A word is an arbitrary symbol that stands for something in the real world (even if it's only a concept in someone else's mind): goblin, silliness, labyrinth

Important: words refer to things (referential). Not enough to simply have associations of sound with something (ex: saying "Eeek!" every time you see a spider)

Some greetings and social routines ("Hi!" "See ya!") might be considered non-referential language.

More about word meaning
(one major part of the lexicon)

Hypothesis 1:
Meaning as reference

- Meaning = Reference
- The meaning of a word (or phrase) is whatever it refers to in the world
  - George Washington = a particular person

  - Fish = a kind of animal

  - Red = property of objects
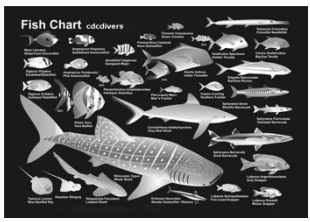
Hypothesis 1:
Meaning as reference

Problems?

- Words can label non-existing real world referents
  - *The Crown Prince of Massachusetts*
  - *unicorn*

- Words can refer to abstract referents
  - *Infinity*
  - *Inevitability*

Hypothesis 1:
Meaning as reference

Problems?

- **Same referent, different meaning**
  - *Morning star* (the last visible star in the eastern sky as dawn breaks)
  - *Evening star* (the first star visible in the western sky as sun sets)

  - *Creatures with a heart*
  - *Creatures with a kidney*
- **Learning: Many non-encountered instances**
  - *Fish*?

Hypothesis 2:
Meaning as definition

The Classical Theory

- Word meanings are a set of properties that are **necessary** and **sufficient** for membership in the category.
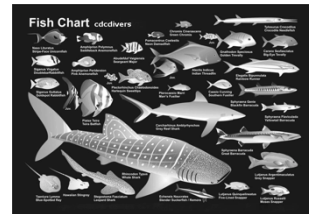
  - Meanings are analyzable into bundles of semantic primitives (features).

  - Triangle: a closed, three sided figure, whose angles add up to 180 degrees.

Hypothesis 2:
Meaning as definition

Word meanings are a set of properties that are necessary and sufficient for membership in the category.

- Fish

[aquatic]
[water-breathing]
[cold-blooded]
[animal]
[chambered heart]

Hypothesis 2:
Meaning as definition

How do we come up with the right set of properties?

- Bachelor
  - # My husband is a bachelor.
    - Bachelor → UNMARRIED
  - # I met a two-year-old bachelor.
    - Bachelor → ADULT
  - # My sister is a bachelor.
    - Bachelor → MALE
  - # My dog Rex is a bachelor.
    - Bachelor → HUMAN

[UNMARRIED]
[ADULT]
[MALE]
[HUMAN]

Hypothesis 2:
Meaning as definition

How do we create new meanings?
Compositional semantics.

NP   *red triangles*
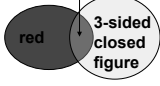
red   *triangle*

[red]   [3-sided]
           [closed]
           [figure]

red   3-sided
       closed
       figure

[red]
[3-sided]
[closed]
[figure]

Hypothesis 2:
Meaning as definition

- Composition doesn't always seem to work, though...

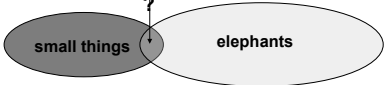*Are small elephants really in the set of small things to begin with?*

NP   small things   elephants   **?**

Modifier   **Head Noun**   **Union of**   **[small?]**
Ex: "small" **Ex: "elephant"** **Features**   **[mammal]**
                                        [has trunk]
[small]   **[mammal]**
               [has trunk]   **Ex: "small elephant"**

Hypothesis 2:
Meaning as definition

Also, necessary and sufficient features aren't always so easy to come up with.

What is a game?
(Wittgenstein, 1953)

Is it always amusing?   Is skill required?

Is it always competition?   Must luck play a role?

Hypothesis 2: Meaning as definition

Also, necessary and sufficient features aren't always so easy to come up with.

Bachelor (revisited)

[UNMARRIED]	Alfred is an unmarried adult male, but he has been living with his girl-friend for the last 23 yrs. Their relationship is happy. Is Alfred a bachelor?
[ADULT]	
[MALE]	
[HUMAN]	

Hypothesis 2: Meaning as definition

Also, necessary and sufficient features aren't always so easy to come up with.

Bachelor (revisited)

[UNMARRIED]	Bernard is an unmarried adult male, and he does not have a partner. Bernard is a monk living in a monastery. Is Bernard a bachelor?
[ADULT]	
[MALE]	
[HUMAN]	

Hypothesis 2: Meaning as definition

Also, necessary and sufficient features aren't always so easy to come up with.

Bachelor (revisited)

|	
[UNMARRIED]	Charles is a married adult male, but he has not seen his wife for many years. Charles is earnestly dating, hoping to find a new partner. Is Charles a bachelor?
[ADULT]	
[MALE]	
[HUMAN]	

Hypothesis 2: Meaning as definition

Also, necessary and sufficient features aren't always so easy to come up with.

Bachelor (revisited)

[UNMARRIED]	Donald is a married adult male, but he lives in a culture that encourages men to take two wives. Donald is earnestly dating, hoping to find a new partner. Is Donald a bachelor?
[ADULT]	
[MALE]	
[HUMAN]	

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category
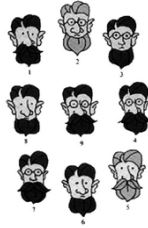
Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Categories have *graded membership*: Some members of a category are reliably rated as "better" members than others

Please rate the following in the category BIRD

Ostrich vs. Robin vs. Bat

1	**2**	**3**	**4**	**5**	**6**	**7**
Good member					**Bad member**	

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Categories have *graded membership*: Some members of a category are reliably rated as "better" members than others

  - Robin: 1.1
  - Eagle: 1.2
  - Wren: 1.4
  - Ostrich: 3.3
  - Chicken: 3.8
  - Bat: 5.8

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Production task

  "I'll give you 30 seconds – name as many fruits as you can"

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Production task: people generate prototypical exemplars of a category earlier than less prototypical members

Example response: apple, orange, banana, peach, grapefruit, apricot, grapes, blueberries, honeydew, …

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Verification task

- Determine whether each sentence is true or false
  E.g.
    – A robin is a bird.
    – A chicken is a bird.
    – An apple is a fruit.
    – A fig is a fruit.

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Verification task
  Finding: Prototypical items are categorized faster, even when frequency is controlled for.

	High Freq	Low Freq
+Proto	(orange-fruit) Fast	(peach-fruit) Moderate
	v	v
-Proto	(fig-fruit) Moderate	(coconut-fruit) Slow

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Feature naming

- Task: List all of the features for category members

- E.g., FRUIT: apple vs. lemon vs. fig

Slide 1

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Feature naming

Findings:

1. Necessary and sufficient features DO NOT emerge
2. However, prototypical exemplars share more features with other exemplars.

| apple	lemon	fig
fruit	fruit	fruit
red	yellow	brown
juicy	sour	wrinkled
round	round	tropical
sweet	juicy	sweet

Slide 2

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

- Current Recap

- Concepts are made of:
  – Features
  – often perceptually grounded

- How are features combined:
  – family resemblance: no single feature necessary
  – more shared features = better category member

Slide 3

Hypothesis 3: **Prototype Theory**
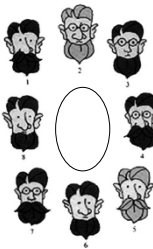Meaning as graded membership to a category

Family Resemblance Structure
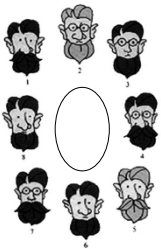
- Smith Family

- Degree of Category Membership ("Smithness") depends on
  – the number of features and
  – how central they are to "Smithness"

Slide 4

Hypothesis 3: **Prototype Theory**
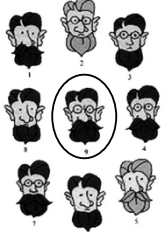Meaning as graded membership to a category

Family Resemblance Structure

- Smith Family

- Smith Features
  – Beard   8/8 = 1
  – Brown hair   6/8 = .75
  – Big nose   6/8 = .75
  – Big ears   6/8 = .75
  – Mustache   4/8 = .5

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

Family Resemblance Structure
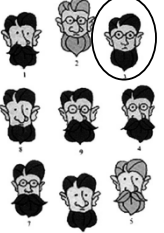
- Smith Family

- Middle Smith has all features
  - beard 1 * 1.0
  - brown hair 1 *.75
  - big nose 1 * .75
  - big ears 1 * .75
  - mustache 1* .5

  - Total 3.75

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

Family Resemblance Structure

- Smith Family

- Smith #3 a few features
  - beard 1* 1.0
  - brown hair 1* .75
  - big nose 0 * .75
  - big ears 1 * .75
  - mustache 0 * .5

  - Total 2.5
  - poorer instance than middle Smith

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

Family Resemblance Structure

- Item with too few features is not a member of the category
  - beard 0* 1
  - brown hair 0 * .75
  - big nose 1 * .75
  - big ears 0 * .75
  - mustache 0 * .5

  - Total .75
  - not a Smith

Hypothesis 3: **Prototype Theory**
Meaning as graded membership to a category

Family Resemblance Structure: One Formalization

- Features have associated probability

- These probabilities may be thought of as weights on the features for membership/identification purposes

- Category membership is based on a weighted sum of the features.

Recap: Children's Lexical Development

Children must figure out the lexicon of their language, including the correspondence between sounds and meaning.

Referential meaning isn't necessarily so easy to define. A current theory that shows promise is a probabilistic implementation of prototype theory.

Presumably, children would learn probabilistic associations between features and category membership when they are learning what things should be called what.

Questions?

You should be able to do up through question 3 on HW2 and up through question 7 on the lexicon review questions.