

Reminders:

- **Assignment 1** has been posted; due Mar 23
 - Will be covering related material in upcoming lectures
- **Quiz 3** has been released; due Monday
- **Tutorial material** will be posted to Piazza soon (hopefully over the weekend)

Language II

- Words
- Rules
- Anatomy of language
- *Acknowledgments: Frank Keller, Frank Mollica, Chris Lucas, Mirella Lapata*

Waggle dance!

- <https://www.youtube.com/watch?v=12Q8FfyLLso>

From last time...

- A word is a symbol that stands for something (referent)
 - Sometimes this can be smaller than a word:
“pre-” => premade “-able” => capable
“hexa-” “-gon” => hexagon
 - These units are called “morphemes”
 - Sometimes this can be larger than a word:
idioms: “piece of cake”
 - Also terms like: “artificial intelligence” (kindof?)

Arbitrariness of symbols

- For most words/morphemes, the choice of symbol is arbitrary
 - Exception: Onomatopoeia, e.g. “buzz”, “pop”
 - Exception: The bouba/kiki effect, e.g.,. a bouba is a round blob, but a kiki is a pointy thing
 - We systematically associate certain speech sounds with certain percepts
- These are both examples of sound symbolism, i.e. the link between sound and meaning is not arbitrary

Bouba/kiki effect... but for WHOM????

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2020, VOL. 16, NO. 1, 49–60
<https://doi.org/10.1080/15475441.2019.1685386>

 **Routledge**
Taylor & Francis Group

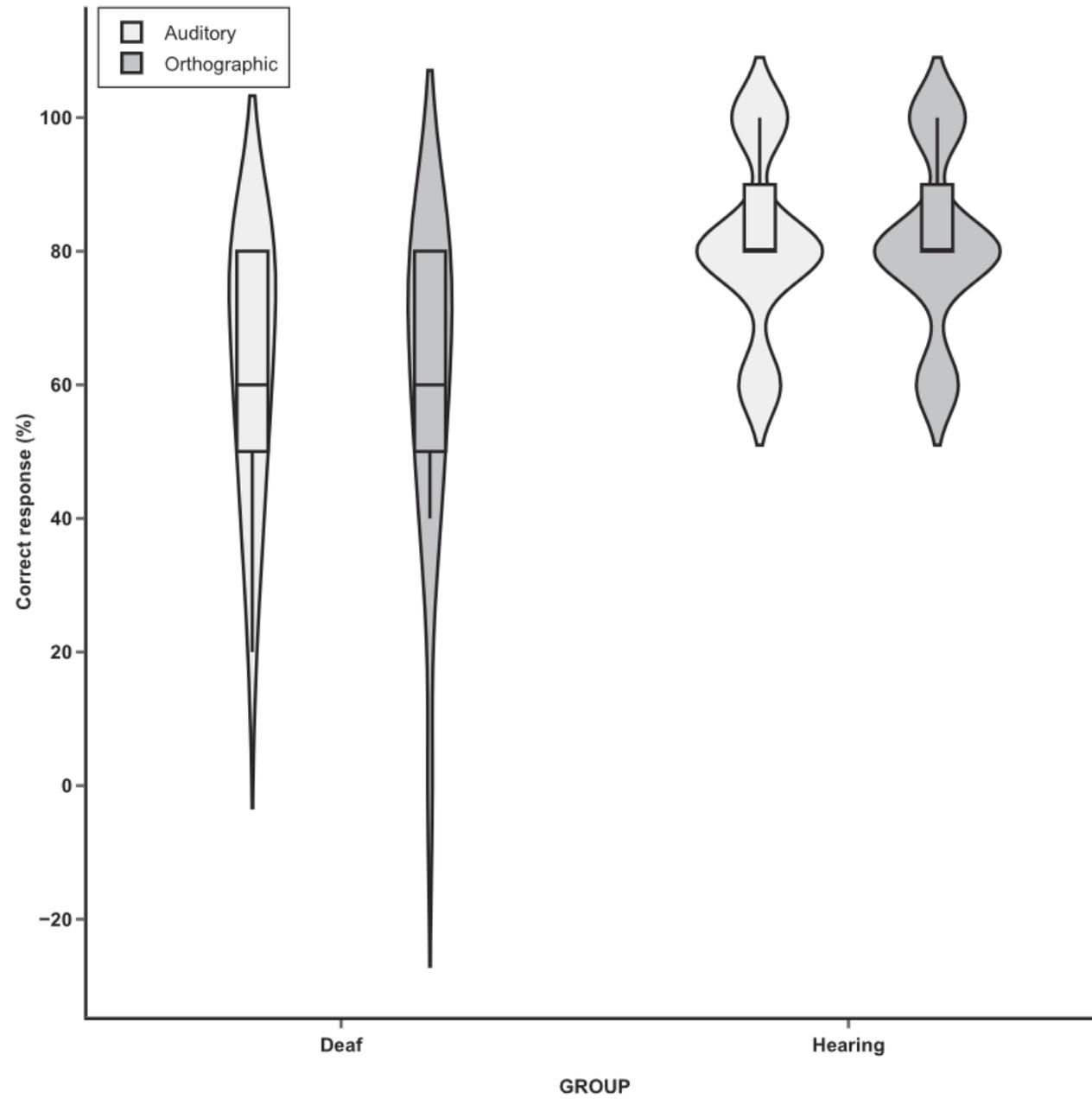


The Bouba–Kiki Effect in Persons with Prelingual Auditory Deprivation

Rinat Gold and Osnat Segal

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- Sixteen participants comprised the group of people with deafness (PD): four men and 12 women with prelingual severe-to-profound hearing loss
- The PD started using their hearing device between seven and 39 months of age
- Stimuli presented auditorily (without mouth being visible) and orthographically (written)



Bouba/kiki effect... but for WHOM????

- Kanzi!
- (October 28, 1980 – March 18, 2025) 😞
- From Wikipedia:
- As an infant, Kanzi accompanied Matata to sessions where Matata was taught language through keyboard lexigrams, but showed little interest in the lessons.
- It was a great surprise to researchers then when one day, while Matata was away, Kanzi began competently using the lexigrams.
- These keyboards had over 300 symbols, and once a symbol on the keyboard was pressed, a computer synthesizer attached to the keyboard would speak the word.
- Within a short time, Kanzi had mastered the ten words that researchers had been struggling to teach his adoptive mother, and eventually learned a further 348, which he could also combine for new meaning.
- When he heard a spoken word (through headphones, to filter out nonverbal clues), he pointed to the correct lexigram.
- Sue Savage Rumbaugh, in 2006, claimed Kanzi understood about 3,000 spoken words.



Bouba/kiki effect... but for WHOM????

PROCEEDINGS B

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Research



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Bo-NO-bouba-kiki: picture-word mapping

in a language

trained bonobo

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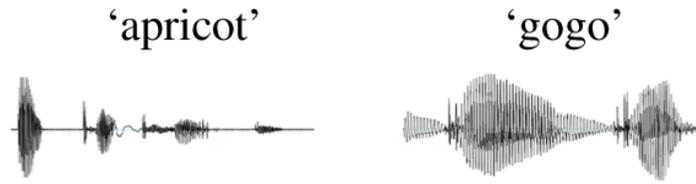
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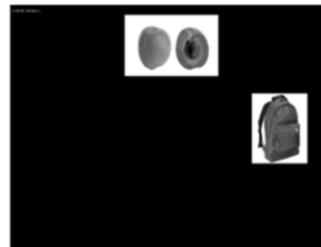
sound sample
(ca. 600 ms)



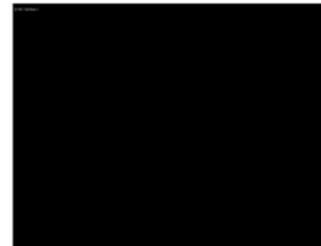
blank screen
(100 ms)



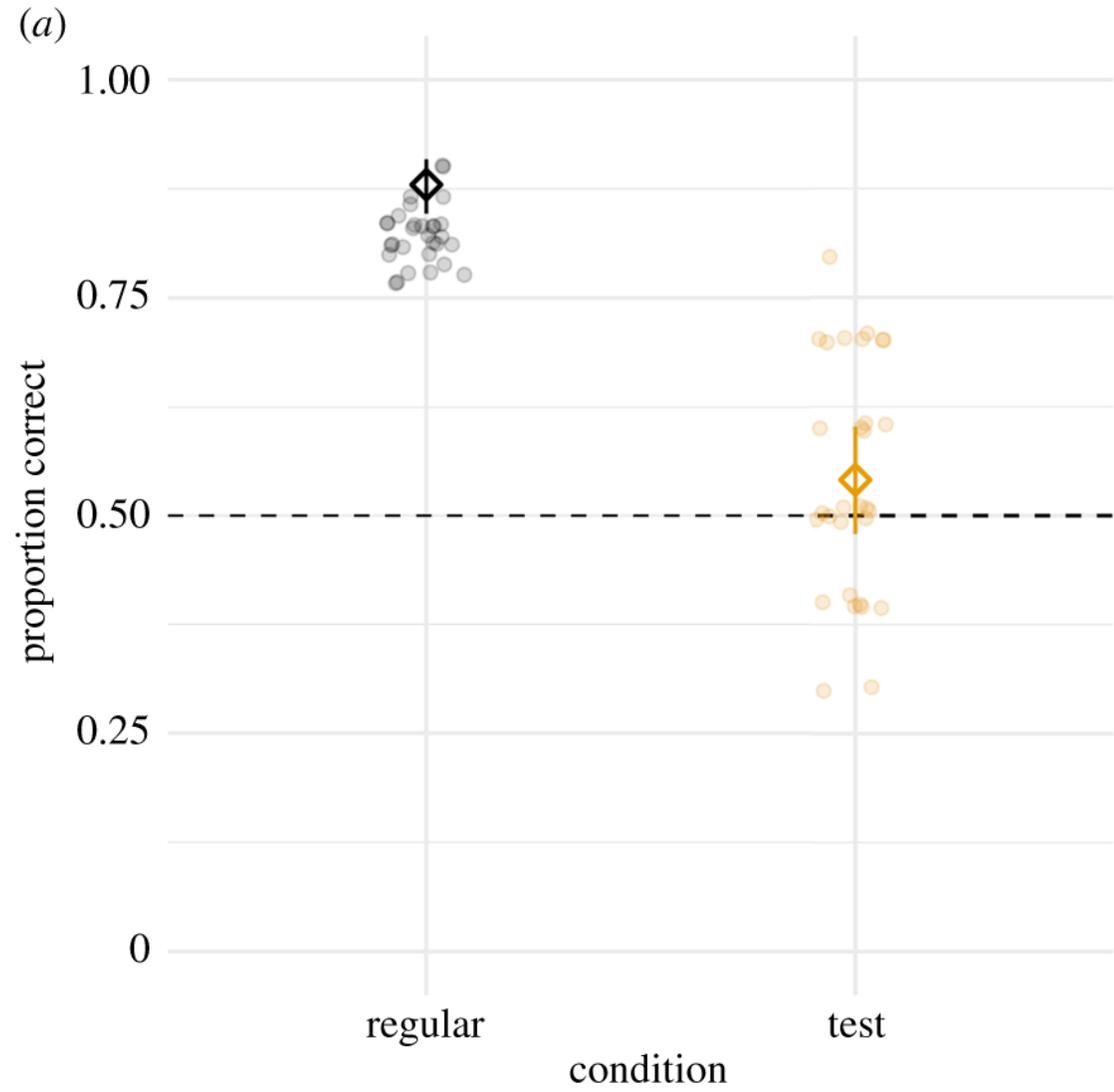
selection



sound feedback
(2000 ms)



- Why?



Rules

- We do not just blurt out isolated words.
- Rather we combine them into phrases and sentences.
- The meaning of the combination can be inferred from the meanings of the words and the way they are arranged.

1. The boy saw the girl with the telescope

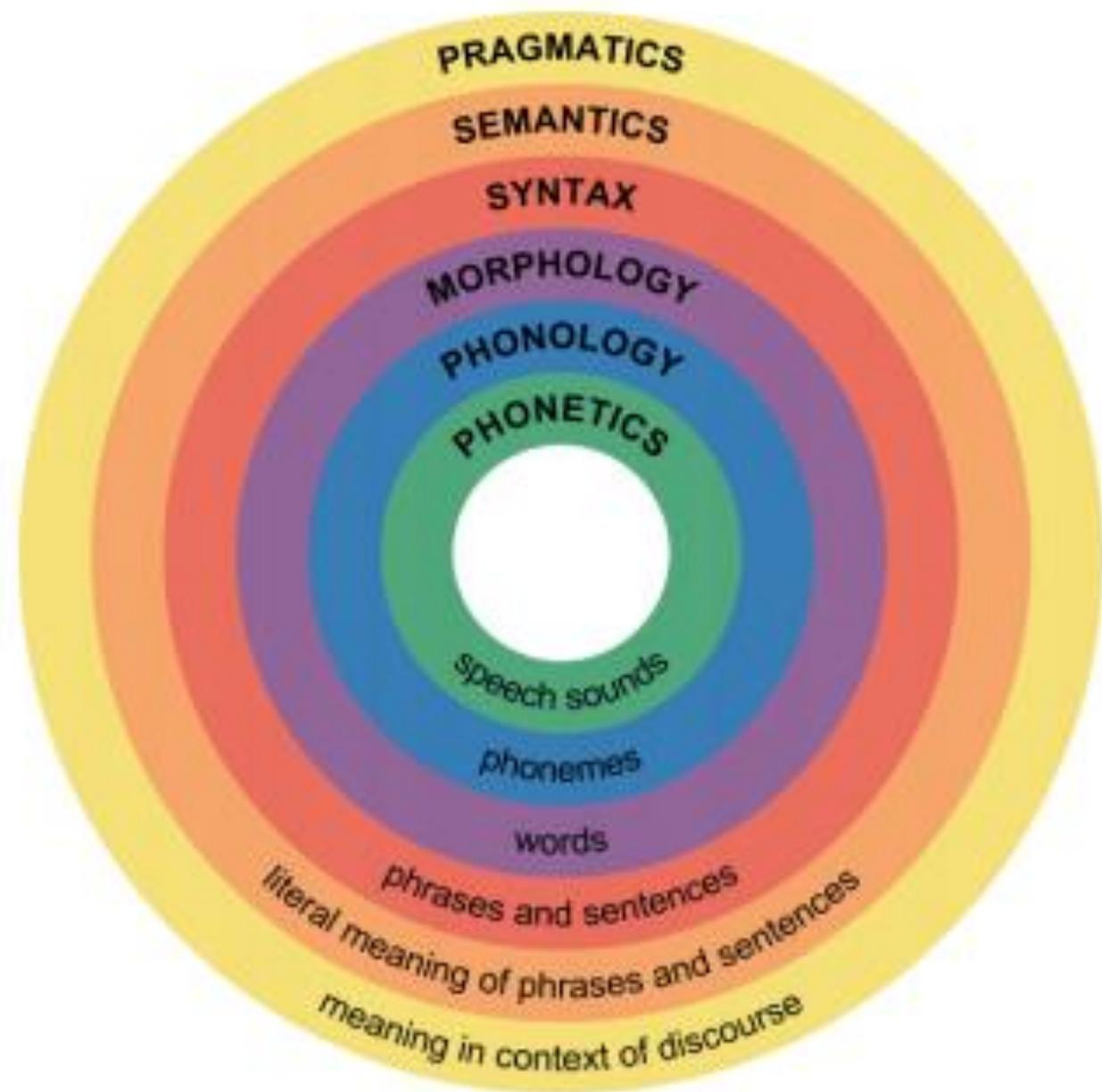
2. The girl saw the telescope with the boy

3. The boy with the telescope saw the girl

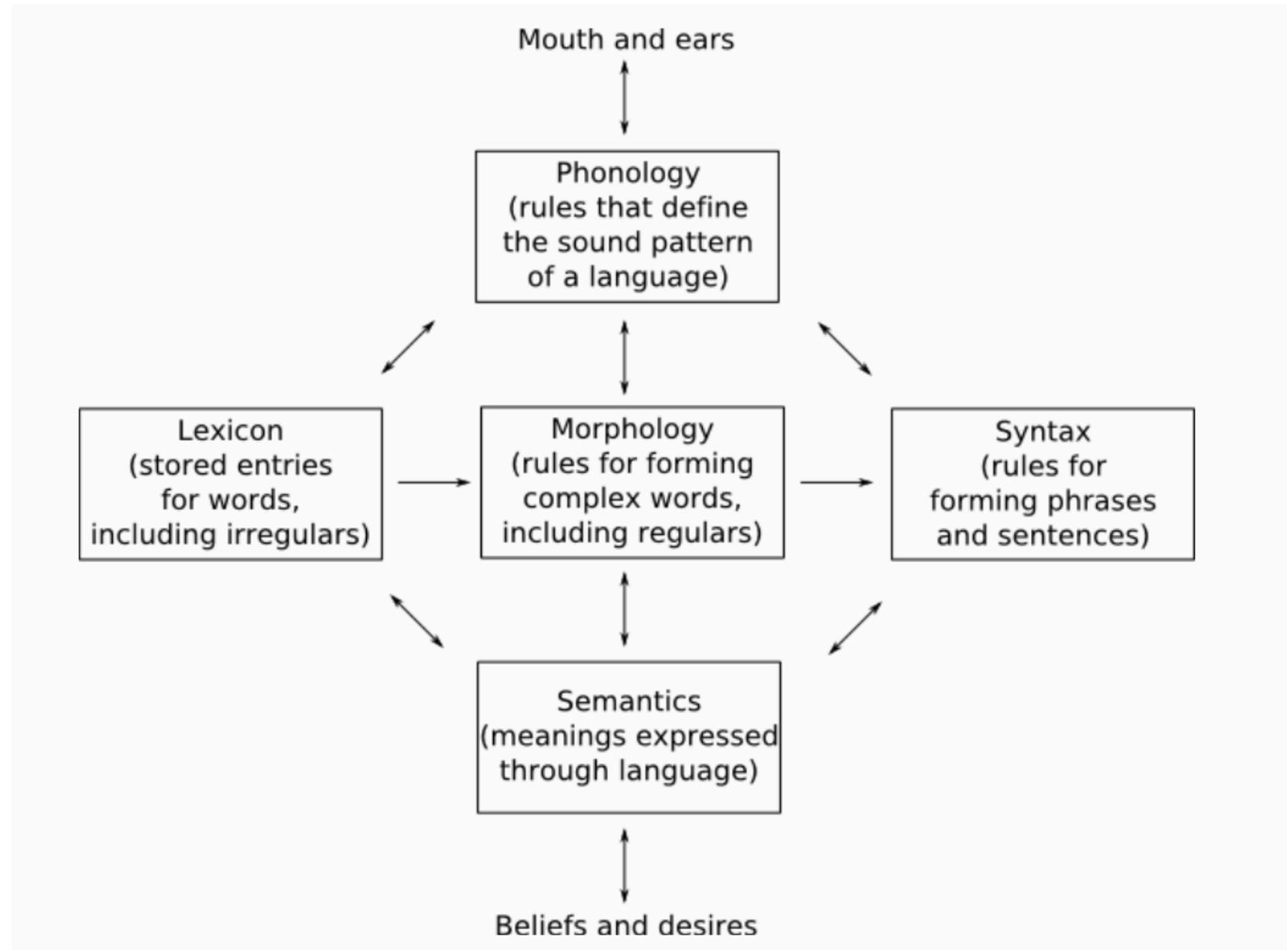
- Example of a rule: Sentence = Noun phrase + Verb + Noun phrase
- Noun phrase = Determiner + Noun phrase
- Noun phrase = Noun phrase + Prepositional phrase

What are the rules?

- There must be a code, a set of rules that specifies how words may be arranged into meaningful combinations: **the grammar**
- **Phonology** – sounds in a language (and parts of sounds)
- **Morphology** – words in a language (and parts of words)
- **Syntax** – sentences (i.e., sequences of words) in a language
- Nasalize vowels that precede a nasal consonant. **phonological rule**
- Mark plurals with the suffix -s. **morphological rule**
- Include a subject before the verb in a sentence. **syntactic rule**



- Where is grounding?



Expressive power of a system of representation

- What can be represented?
- What cannot be represented?
- How efficiently can it be represented?

Expressive power of language rules I

- Rules are **productive**, defined over kinds of words rather than actual words (we assemble new sentences on the fly).
- Symbols contained in the rules are abstract (we can talk about anything we like!)
- Noun phrase --> Verb --> Noun phrase

Expressive power of language rules II

- The rules are also **combinatorial**: a small inventory of elements can be assembled by rules into immense set of distinct objects.
- Noun phrase --> Verb --> Noun phrase
- What if you have 5 nouns and 2 verbs... how many sentences?
- 50 sentences
- 10,000 nouns, 4,000 verbs....
- 400,000,000,000 sentences (400 billion)

Expressive power of language rules III

- The rules are also **recursive**: a small inventory of elements can be assembled by rules into immense set of distinct objects.
- The rules create an entity that can contain an example of itself

the girl with the telescope

- Noun phrase = Noun phrase + Prepositional phrase
- Can make sentences infinitely long!

Summary

- Words / symbolic units
 - Grounded in meanings
- Lexicon
- Grammar

- Language rules are:
 - Productive
 - Combinatorial
 - Recursive

Next time

- Are all languages equally expressive?
- If you can express a meaning in one language, can you express the same meaning in another language?

- How do we learn the rules of a language?