Natural language

But first: Bagof/3

- Probably not necessary for this course – but handy!
- Collects the results of DFS/unification in a list.

Example:

- allmembers(L, L2) :-
-   bagof(A, ismember(A, L), L2).

Speech acts

- Query: “Where is Leia?”
- Inform: “Leia’s outside.”
- Request: “Would you get her, please?”
- Acknowledge: “OK.”
- Promise: “While you’re doing that, I’ll fix her dinner.”

Note that “speech” refers to all forms of language.

Levels of analysis

- Prosody: the ‘tune’ of the language.
- Phonology: the sound of the language.
- Morphology: parts of words, and how they fit together.
- Syntax/grammar: how meaningful strings of language are constructed.
- Semantics: the meaning of each valid string.
- Pragmatics: meaning in conversational context.
- Dialogue: understanding an entire exchange.

Stages of analysis

ANALYSIS	PRODUCT
Speech analysis	Text, annotated text…
Syntactic analysis	Parse tree…
Semantic analysis	Predicate logic, semantic network…
Pragmatic/dialogue analysis	Database query language, specialized translation representation…

Ambiguity

Ambiguity is when two or more interpretations are produced at some stage of processing.

e.g. syntactic ambiguity:

- I watched Mary with a telescope.

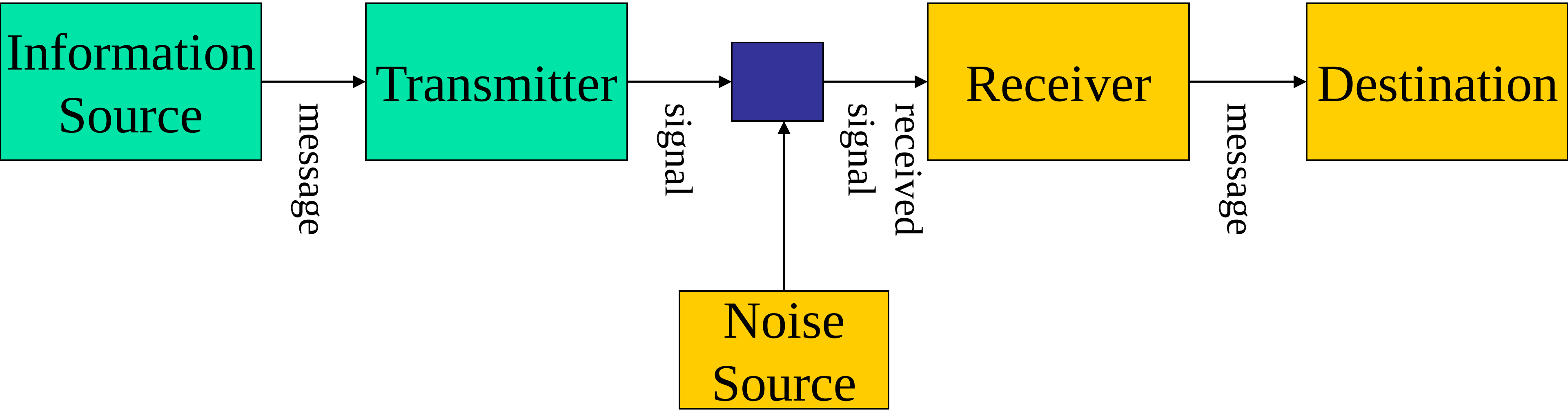
e.g. pragmatic ambiguity:

- Do you have the time?

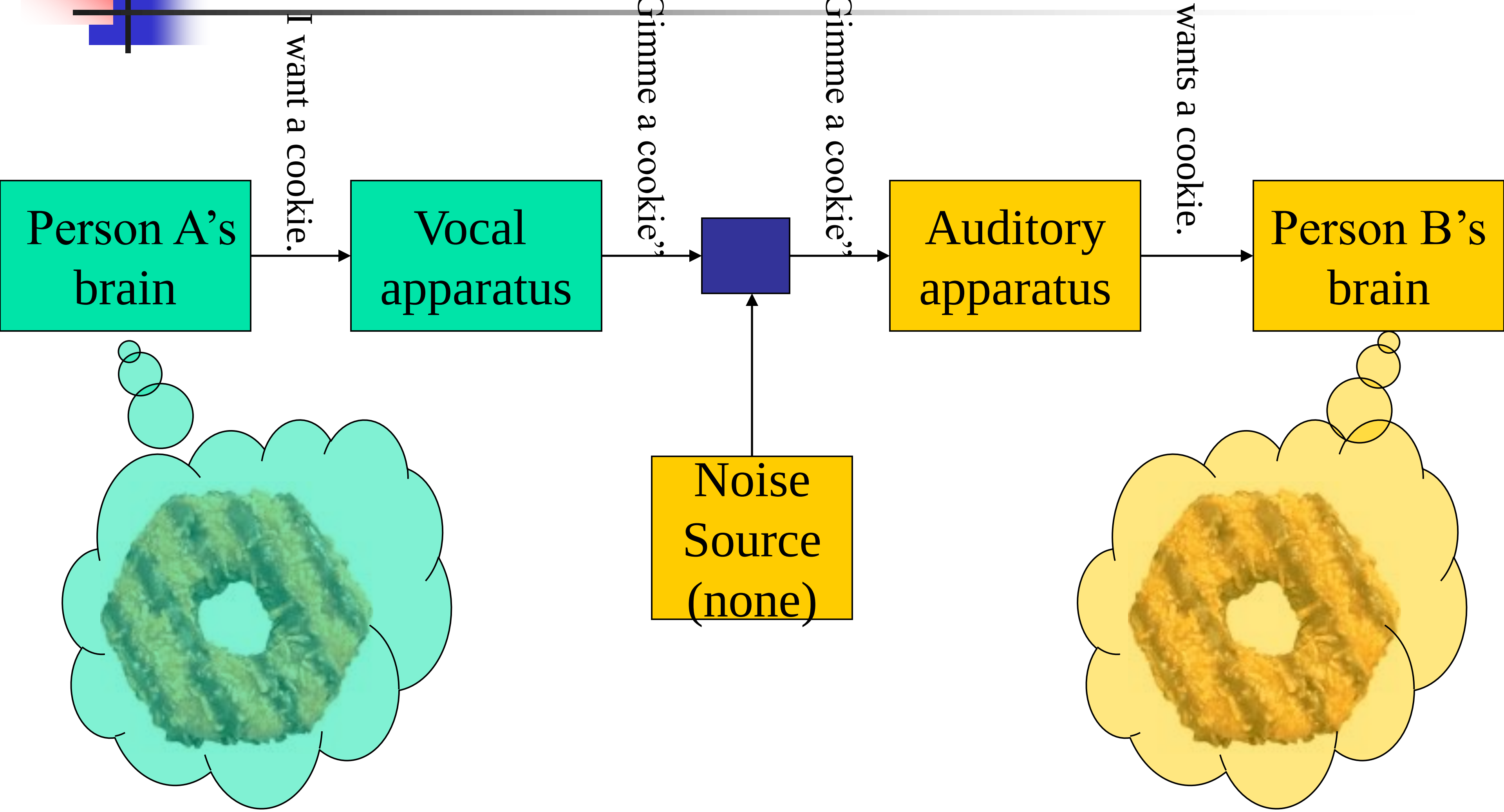
e.g. phonological ambiguity:

- Bear/bare
- Etc.

A general communication system



Example



Person A’s brain

I want a cookie.

Vocal apparatus

“Gimme a cookie”

Noise Source (none)

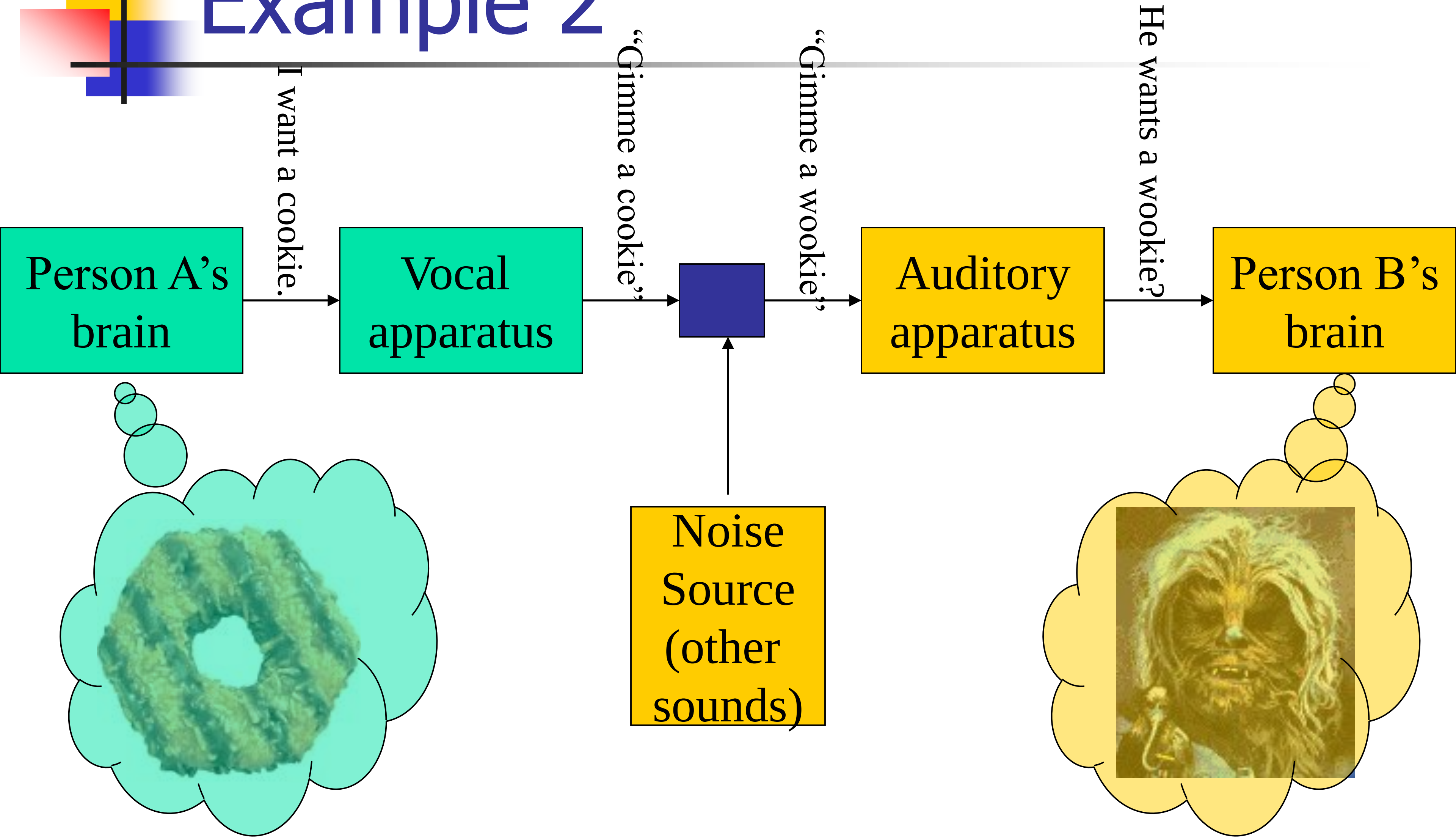
“Gimme a cookie”

Auditory apparatus

He wants a cookie.

Person B’s brain

Example 2



Person A’s brain

I want a cookie.

Vocal apparatus

“Gimme a cookie”

“Gimme a wookie”

Auditory apparatus

He wants a wookie?

Person B’s brain

Noise Source (other sounds)

Components of communication

- Intention: A decides to communicate P to B.
- Generation: A turns P into utterance U.
- Synthesis: A generates a physical realization W of U (speech, text, etc.)
- Perception: B perceives W (perhaps with errors).
- Analysis: B infers zero or more meanings $M_{1..n}$ for W.
- Disambiguation: B decides which M was intended.
- Incorporation: B decides to what extent to incorporate M into beliefs.

Parsing

Formal grammar

from Wikipedia

A formal grammar consists of:

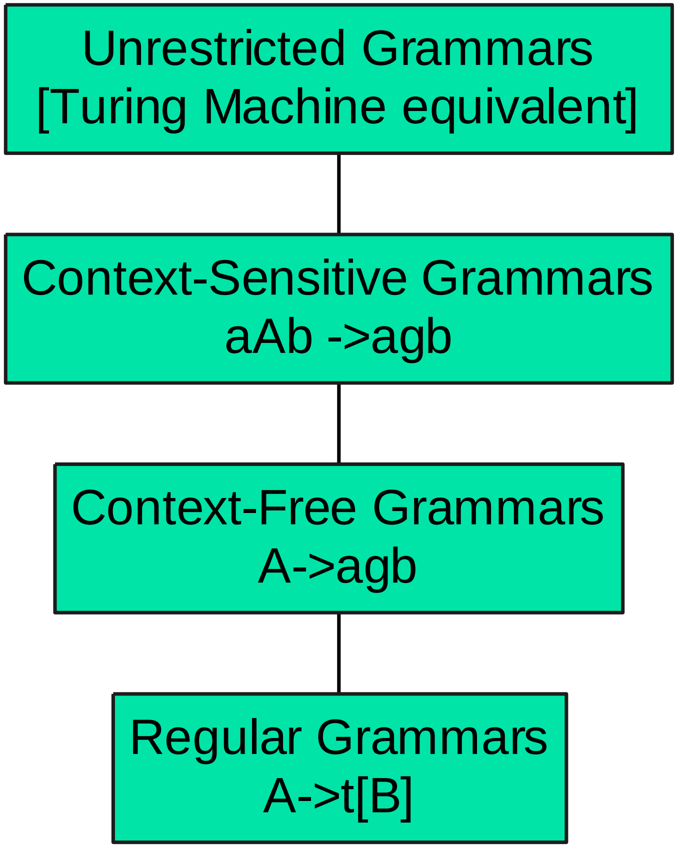
- a finite set of *terminal symbols* (e.g. words),
- a finite set of *nonterminal symbols* (i.e. phrase structure labels, e.g. NP),
- a set of *production rules* with a left- and a right-hand side consisting of a string of these symbols, and
- a *start symbol*.

Such a grammar defines the formal language of all strings consisting solely of terminal symbols that can be reached by a derivation from the start symbol.

Chomsky Hierarchy of formal grammars

- A,B – non-terminals
- a,g,b – strings consisting of terminals and non-terminals
- t – terminal

The higher, the more expressive – the lower, the more efficient the parsing algorithms!



Unrestricted Grammars
[Turing Machine equivalent]

Context-Sensitive Grammars
aAb ->agb

Context-Free Grammars
A->agb

Regular Grammars
A->t[B]

Definite clause grammar (DCG) notation

Look at grammar.pl.

- An extension of context-free grammars, in Prolog notation. (i.e. context sensitive, but only a bit)
- Extensions include:
  - Symbols may be prolog terms
  - Extra conditions may be added on the RHS in {}.
  - Can add terminals to the right of the non-terminal on the LHS.

Grammar:

S → NP VP

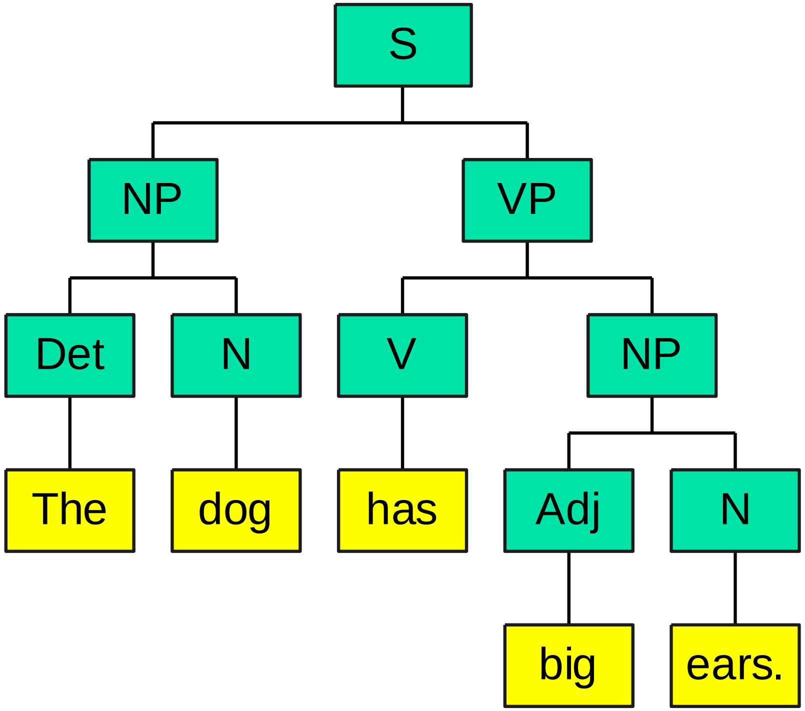
NP → Det N

NP → Adj N

VP → V NP

Lexicon:
"the" Det
"dog" N
"ears" N
"has" V
"big" Adj

Parse tree



In-class exercise: Lost in Translation (post on Laulima)

Go to Google Translate. Think of a sentence (S) and:

- Translate it to Language 1 (L1), and back to English, resulting in S1.
- Translate S1 to L2 and back, giving S2.
- Repeat 4 or 5 times. What do you notice? What does this say about the challenges of language translation?

Post your results on Laulima.

Exercise
(will post answer, so no need to put your version on Laulima)

Build a grammar that can give ***both*** parse trees for:

“Jill watched Mike with the telescope.”