Higher mental processes: language; thinking

Higher mental processes

<table>
<thead>
<tr>
<th>Rule based: Nativist(?)</th>
<th>Example based: Empiricist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language: &quot;built in&quot;</td>
<td>learned</td>
</tr>
<tr>
<td>Reasoning: deductive</td>
<td>inductive</td>
</tr>
<tr>
<td>Concepts: formal</td>
<td>&quot;fuzzy&quot;</td>
</tr>
<tr>
<td>Thinking: algorithms</td>
<td>heuristics</td>
</tr>
</tbody>
</table>

Human Language:
- flexible rule-governed (?) system
- arbitrary symbols
  - Phonemes (speech sounds), letters
    - combined to make words
  - express indefinite # of meanings
  - put together small # of units using rules?

Communication is a social behavior
Given-new contract: speaker takes into account what listener knows
- context, stress, syntax
- description of new objects

Levels of language:
- physical stimulus: complex time-varying pattern of sounds
- phoneme: smallest unit of speech that can affect meaning
- syllable: group of phonemes that "go together"
- word: One or more syllables that stand for something
- syntactic ("grammatical") structure: set of rules that define acceptable combinations of words.

Rules at all levels.
Phonetic rules: certain speech sounds go together
srok - srock bmag - blag bsole - brole gkuse - gluse
- Infants learn word boundaries from rare letter combinations

Word grammar level rules

Meaning depends on:
- words
- grammar = set of syntactical rules (?) for arranging words
- pragmatics:
  - prosody: tone of voice, emphasis, etc.
  - metaphor: "drowning in money"

Grammar independent of word meaning
"Colorless green ideas sleep furiously."
- grammatical, but semantically anomalous, sentence

Syntactic ("grammatical") cues give meaning
- word order
  - The dog bites the man.
  - The man bites the dog.
- inflection ("endings")
  - Der hund beisst den man
  - Den hund beisst der man
- word class (noun, adverb, etc.)

content (open class) words:
- nouns, verbs, adjectives, adverbs
  - have referents

function (closed class) words
- prepositions, articles, "linking"
  - show relation among words

differences between content & function words show up in many ways:
- brain damage effects
  - Broca's: grammar defect: lose function words
  - Wernicke's: vocabulary defect: lose content words
- word association learning

People remember meaning: deep structure
not form: surface structure

Grammatical structure is psychologically real:
- affects other mental functions:
  - perception: clicks moved to grammatical boundaries
  - memory: recall of complex sentences fails at grammatical boundaries
  - thinking?

Simulate grammatical structure with neural nets?

Reading
- phonetic decoding
- whole word recognition

eye movements during reading

good readers:
- short fixations, few direction reversals
- whole word recognition for most words
- fixate more on content words, important words
- efficient use of short term memory

Reading problems:
- limited vocabulary
- inefficient use of phonological working memory

Dyslexia: reading problem, normal intelligence
- perception?
- auditory-visual symbol matching?
- deficit in phoneme perception? Voice Onset Time (VOT)

Language development
- "shape" of language

- phonemes: newborn perceive (all?) phonemes
- 6-8 mo.: babbling like speech sounds
- add sounds in fixed order: easy first
- lose unused phonemes
- find syllable boundaries; identify words: statistical regularities
  - some sounds often go together in words; other rarely go together
- words
  - 1 year: first words: consonant + soft vowel (/da/)
    - under-, over-extend meaning
  - ~18 months: word learning explosion
- grammar: discovered
  a. two words + context + gesture: not adult grammar
  b. easiest rules; most important rules
- overextension of rules from regular to irregular

Learning the specific vocabulary & grammar of your language:
- modeling adult speech
  - good model?
  - child-directed talk:

Rule-based grammar build into the brain?
- language universals = innate rules?
- learn fast from poor[?] models
- no conscious effort or availability
- too complicated to learn [is a rule-based grammar what they learn?]
- develop it in same order [only very early stages]
- new languages develop fast

Alternative ideas about grammar:
- map on realities of world
- part of “lexicon” (~mental “dictionary”)
- grammar not formal (rule-based) but statistical
  - speech sound parsing
  - adults unconsciously “learn” simple artificial “grammars”
  - adults do help toddlers learn language
  - neural network

Critical periods?
- effects of language deprivation

Thinking

Reasoning:
- inductive: example based
- deductive: formal = rule based

Example: metals
- Inductive: all metals I have put in fire don’t burn: ➔ metals don’t burn
- Deductive: if you find a metal that burns, then the rule is wrong.

Deductive reasoning: general principles ➔ specific instances
- syllogisms

Inductive reasoning: specific instances ➔ general conclusion
- never know whether there are exceptions to rule

Concepts: category, membership rules
- Concept formation:
  - formal concepts: rule-based
    - test hypotheses (rules)
Problem: are most concepts formal, rule based?
- concepts develop unconsciously: Hull, Reber
- many everyday concepts are “fuzzy”
- systematic, logical analysis is not “natural” way of thinking
- many things are not “computable”

Heuristics: “Natural” (everyday) concepts:
- boundaries often fuzzy
- exemplar-based
- often very efficient, but can make mistakes

Problem solving and decision making: Formal or heuristic?

Formal:
- algorithm: set of rules for best decision
  - if properly developed
  - if applied to appropriate problem.

Problem: Many things cannot be “computed”

Heuristic: mental short cuts
- “rule of thumb”
- efficient: can be as good or better than full use of all information
- apply to any kind of problem

Problem: heuristics often(?) makes errors

Some heuristics and their problems:

Availability: use what’s easily available
- recall last few cases → bias

Gambler’s fallacy:

Regression fallacy: extreme events are noticeable, but unusual
- “hot hands”, “hot bat” are statistical flukes

Overestimation, illusory correlation

Representativeness

Confirmatory bias:
- All cards have triangle on one side & circle on other.
- Which cards must be turned over to test whether cards with red triangles have green circles on the other side?

Does this logic apply in the real world?
- crashing noise from kitchen.

Base rate fallacy
- Suppose
  - 1 person in 1,000 has AIDS
  - a test for AIDS is 95% accurate (5% false alarms)
    Ron tests positive. What is probability that Ron has aids?
    95%?  85%?  50%?  15%?  2%?
Language and thought:
- Whorf: linguistic determinism
- language structure shapes perception & thinking
- languages have very different words, grammars

Tests of linguistic determinism
- do differences in vocabulary affect perception?
- words for snow & ice
- words for color
- Language related to color memory

Different vocabularies, grammars impose different mental loads
- words with several meanings
- word order vs. inflections
  - English sentences more likely to be ambiguous out of context

Weak version of linguistic determinism may have support:
- different grammars put different loads on working memory