PLEASE TURN OFF AND PUT AWAY ALL ELECTRONIC DEVICES.

PHIL/PSYCH 256
INTRODUCTION TO COGNITIVE SCIENCE
Week 3: Rules

Rules
Rule: Mental representation of the form
IF .... THEN ...
Not just a moral instruction.
Simpler than logic.
Examples: What are some rules that describe your knowledge of how to enjoy the weekend?

History of Rules
• Production systems
• Newell & Simon, General Problem Solver, 1950s-1960s
• Expert systems, 1970s-1990s
• SOAR: Newell, Laird, etc.
• ACT, 1983-now, John Anderson, CMU (reading)

Rules: Computational Power
• Problem solving as search
  • planning
  • explanation
• forward chaining: string rules together, matched against working memory of current state
• backward chaining: work back from goal to start

Discussion Question
• How much of your everyday knowledge can be captured by rules, e.g. driving a car?

Rules: Computational Power
• Learning
  • generalize to form new rules
  • specialize to form more specific rules
  • abduction to form explanations
  • IF CAUSE then EFFECT
  • EFFECT
  • So, maybe CAUSE
  • chunking to build rules from old
• Are some rules innate?
Strengths of Rules
- Modular, easy to add to.
- Apply to much problem solving and learning.
- Practical applications, e.g. tutors.

Limitations of Rules
- Inflexible
- Overgeneral
- Difficult to control
- Hard to understand operation
- Knowledge acquisition is difficult: tacit knowledge. Non-verbal representations.

Anderson
- Cognitive skills are realized by production rules.
- Production rules are organized around a set of goals.
- Complex cognitive processes involve a sequence of production rules.
- Productions are matched against working memory.
- Rules are psychologically realistic, because they describe many aspects of skilled behavior, and predict the details of that behavior.

Key Points
- Rule-based representations and procedures have been used to explain many psychological phenomena.
- But they may not capture the full range of human thinking.

Linguistic Rules
- Phonetic, e.g. "finger", "cats"
- ghoti
- Tenses, e.g. "ed". Pinker.
- Syntactic, e.g. forming questions
- Innateness

Discussion Questions
- How much of our knowledge of language is captured by rules?
- How much of our knowledge of rules is innate?
Psychological Plausibility

- Applied to many tasks, e.g. arithmetic, chess. John Anderson reading.
- Models learning, as new rules are constructed and chunked. Quantitative fit: power law of learning.
- Learning in rats.
- Learning of social rules, physical systems.
- Language learning

Neurological Plausibility

- Are there rules in the brain?
- Connectionism as an alternative.

Pinker

- English has both regular past tenses formed by adding "ed" and irregular past tenses, e.g. "sang".
- The rule-rote theory, which says that irregular verbs are just memorized, is implausible, but such verbs fall into families, e.g. "sang" and "rang".
- Associationist theories are implausible, because they produce behavior that differs from human languages.
- Past tenses are computed by a combination of rules and associative memory.
- Some language impairments can be explained on the assumption that people use rules.

Key Points

- Rules have much psychological plausibility, for example in explaining the learning and comprehension of language.
- But other phenomena may require alternative kinds of representations.