# Transitive Inference: Comparative Studies

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# Overview

1. Description of TI and comparative distribution
2. Method for standard laboratory investigation of TI
3. An associative model of TI: Value Transfer Theory
4. Experimental test of VTT
5. Backprop neural network model
6. A more complicated TI task
7. 2 more models: production system & hippocampus
8. Summary table
9. Outstanding issues

# Transitive Inference

- Example: A > B, B > C ∴ A > C
- Piaget 1937/1954: TI not before 7 yrs age; requires mental "seriation" -- a type of "Concrete Operational Thought"
- 4+ yr olds -- Bryant & Trabasso 1971
- monkeys -- McGonigle & Chalmers 1977
- pigeons -- Fersen et al. 1991

# Basic Transitive Inference

- Basic Experiment: Train on A+B- and B+C- using standard operant procedures; Test on AC
- Basic experiment has simple associationist explanation
- 5-element experiment: Train to criterion on A+B-, B+C-, C+D-, D+E-; Test on BD
- Eliminates simple associationist explanation

# TP ≠ TI because VTT?

- Value Transfer Theory (Fersen et al. 1991): In any simultaneous discrimination task, some of the value associated with the S+ is transferred to the accompanying S-.

- B gains more from A+B- than D gains from C+D- because A has higher value than C

- Zentall's (1994) test of Positive VTT: Train to criterion on $A_{100}B_0$ , $C_{50}D_0$; Test BD

- Pigeons may only have "Transitive Performance"

# Test of VTT?

- 7-element task: Train with pairs from ABCDEFG; Test with CE
- Not tried with pigeons (too slow?); done by Bond et al. (2003) with 5 pinyon jays and 5 scrub jays (corvids smarter than pigeons?)
- Pinyon jays faster to reach criterion, but required 3-stage training process and hundreds of exposures to the training set
- Pinyon jays more social than scrub jays

# Backprop: Computational Associative Model

- DeLillo et al. (2001): BD generalization is modeled in an artificial neural network using backward error propagation

- "a simple error-correcting rule can generate transitive behavior similar to the choice pattern of children and animals in the binary form of the five-term series task without requiring high-order logical or paralogical abilities."

# Do monkeys reason?

- McGonigle & Chalmers (1977) pointed to Symbolic Distance Effect, End Anchoring, and other cognitive effects

- But ... these effects are replicated in the backprop model

- But, but ... backprop doesn't simultaneously handle standard and triple-discrimination task: Train AAB, ABB, BBC, BCC, CCD, CDD, DDE, DEE; Test BCD

# Other models

- Production Rule Systems: Harris & McGonigle 1994; Wood, Leong & Bryson 2004
- Hippocampus
  - rat-cutting model: Dusek & Eichenbaum 1997
  - hippocampus-like artificial neural network model: Wu & Levy 1998

# Summary

| Tasks<br>Models | 3 element AC task | 5 element BD task | end-anchor, SDE | 7 element CE task | triadic BCD task (+ errors) |
|---|---|---|---|---|---|
| Simple Associationist | + | | | | |
| Value Transfer Theory | + | + | | | |
| Backprop | + | + | + | ? | |
| Production Rule | + | + | ? | + | + |
| Explicit seriation | + | + | + | + | ? |

# Some Remaining Issues

- Which models account for:
  - Neurological separation of pair associations from serial knowledge (Dusek & Eichenbaum 1997)
  - Ethological observations: of fast learning (e.g. chickens, Beaugrand et al. 1997) and large domains (e.g. Seyfarth & Cheney 2002)