Flexible Induction of Meanings and Means: Development of Adaptive Verbal and Causal Inference

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The problem of flexible cognition: How minds adapt to the world
...for instance...

“...is a tulla”

“...has a framm”

“...is made of snorb”
What is Flexible cognition?

Definition (Deák, in press):

- Choosing response options in uncertain situations...
  - by encoding: (a) patterned information in stimulus array
  - (b) cues/signals that specify task demands;
- ...then re-selecting responses as a function of...
  - changing task demands
  - new events or stimuli (not predictable)
Questions about the development of flexible cognition

- Qualitative improvement from 3 to 4 years?
  - Only shown in a few, narrow experimental paradigms
- Broaden the range of tests of flexibility:
  - Both linguistic and non-linguistic tests of flexibility?
- If so, what causes the improvement?
Evidence for a general developmental shift in flexibility: Verbal and non-verbal tasks

I. Verbal: Development of inductive flexibility in inferences about word meanings
   - *FIM-Objects test*
   - *FIM-Animates test*

II. Non-verbal: Development of inductive flexibility in inferences about “means” (i.e., object functions)
   - *FIF test*
Flexible Induction Paradigm

- Several problems about each of 5-6 stimulus sets
- Each set: several possible bases of generalization
- Task cues change from problem to problem
  - Flexibility: Shifting responses based on task cues
I. Using predicates to flexibly infer word meanings: The FIM-Ob test (Deák, 2000)

- Rationale: *Predicate cues* provide critical information about word meanings:
  - most informative linguistic cue,
  - *but* inherently variable and unpredictable…
  \[ \therefore \textit{need flexibility!} \]

- Test: Infer meanings of 3 words per set
  - Each set: “Standard” object, same-shape, same-material, same-part, and dissimilar “foil” object
FIM-Ob test paradigm (example):

- **set #1**
  - cue (e.g., “looks like a...”)
  - cue ("has a...")
  - cue ("is made of...")

- **set #6**
Results
(3.5-, 4.5-, & 6-year-olds, $N = 90$)
FIM-An test: Inferring meanings of words for animate referents

- Validation of results from FIM-Ob
- 3.5- and 4.5-year-olds ($N = 36$)
- for each of 5 sets of pictures of creatures:
  - 3 words after different predicate cues
    - “is a…” [implies species]
    - “lives [in/on] a…” [implies environment]
    - “holds a…” [implies possession]

- example…
sample FIM-An test item...

"This is a gumby. Find another..."

"This lives in a balen. Find another..."

"This holds a wibble. Find another..."
Results: FIM-AN
\((N = 36)\)
Relation of FIM-An to FIM-Ob performance ($N = 48$)

$r = .53$

* Age & pretest performance partialed out
II. A non-verbal test: Flexible Induction of Function (FIF)

- 3.5-, 4.5-, & 5.5-year-olds, current $N = 43$
- 5 sets of objects:
  - Standard (3 functional parts)
  - 3 comparison objects, each w/ a same-function part & other parts
  - 1 distractor
- each Standard causes 3 changes…
  …to sand, paper, and clay (e.g., imprint pattern on sheet of clay)
  - exact cause of change is hidden from children
- Children must infer…
  ...which of Standard’s parts produced effect, and...
  ...generalize inference to object with similar part.
example of FIF set...

- roll pattern in clay
- sift rocks from sand
- stamp swirl on paper
FIF Results:
Confirm general developmental trend in flexibility
Summary: Discontinuity in flexibility from 3 to 5 years?

- Yes: 3- to 4-year shift, 10-15% cross-over
  - 5 response patterns
- Relation to other skills? FIM-Ob is…
  - Unrelated to inhibition of primed lexical or semantic associations
  - Related to awareness that conflict problems are indeterminate
    - knowing that similar problems might have different answers
- Implications:
  - Adapting to changing tasks improves prior to formal school
  - Not strictly verbal comprehension
  - Not strictly inhibitory capacity (Deak & Narasimham, unpublished)
    - 3-year-olds can resist repeating prior, primed responses
A 3-to-4 shift in flexibility…

**FIM-Ob**

**FIM-An**

**3DCCS**

**FIF**
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