Abstract:
Appearance-Reality (AR) errors by 3-year-olds (Figure 1) are thought to stem from conceptual limitations. However, they might instead come from not grasping the pragmatics of successive forced-choice questions. Children completed five tests: AR, Flexible Naming, Forced Choice Question Pairs, Indeterminacy Detection, and Working Memory. Indeterminacy detection predicted errors in AR and other forced-choice questions tasks. Working memory and flexible naming did not relate to AR errors, contrary to a conceptual limitation hypothesis.

General Question: Why do children make Appearance-Reality (ER) Errors?
Conceptual Inflexibility (CI) theory [e.g., Flavell et al., 1983; 1986]
- It is hard for children to switch conceptual representations. [Example: After identifying fake butterfly as MAGNET, cannot switch to think of it as a BUTTERFLY]
- It might be due to a working memory problem, or to a lexical inhibition problem.

Logic of Pragmatics (LOP) theory [Deák, Ray, & Brenneman, 2003]
- Children don’t recognize that successive forced-choice questions may have different answers, even when the options are the same.
- Perhaps they fail to view each question as a new indeterminacy (i.e., recognize multiple possible answers to each question). That is, the pragmatics of standard AR questions are difficult because they require logical awareness of indeterminacy.

Specific Questions:
(1) Are AR errors due to representational limitations?
   Predictions: CI = low performance; LOP = no relation
   Tested By: Flexible Naming (FN) test Working Memory (WM) test
(2) Are AR errors a pragmatic error (perseveration across forced-choice questions)?
   Predictions: CI = no; LOP = yes
   Tested By: FCQP test; FN follow-ups
(3) Does failure to detect indeterminacy predict AR errors?
   Predictions: CI = no relation; LOP = yes
   Tested By: Indeterminacy Detection (ID)

*IF CHILDREN PERSEVERATE IN ANY TASK WITH FORCED-CHOICE QUESTIONS, IT WILL SUPPORT LOP THEORY. IF CHILDREN WHO PERSEVERATE PRODUCE BOTH APPEARANCE AND FUNCTION LABELS IN THE FLEXIBLE NAMING TEST, IT WILL DISCONFIRM THE CI THEORY.
Methods:

Participants

N = 42 English-speaking middle-class children, 3- and 4-year-olds (mean age = 49 months; 26 girls and 16 boys).

Design

All tests in one session, order fixed: Appearance-Reality (AR), Flexible Naming (FN), Working Memory (WM), and Forced-Choice Question Pairs (FCQP).

Six Indeterminacy Detection (ID) trials were randomly interspaced between other tasks.

Procedure

AR Test:

Three deceptive objects (e.g. banana magnet) were shown, one at a time, and their function was demonstrated.

Children were asked 2 questions: “What does it look like…” and “What is it really…,” followed by the same two word choices (see Fig. 1).

FN Test:

Three representational objects (e.g., dinosaur crayon; see Fig. 2) were shown, and the experimenter asked open-ended questions to elicit 2-3 labels/objects.

In follow-ups forced choice questions, children were asked, for each word, they produced, if it was a word for “how you use it” or “what it looks like”

FCQP Test:

Children saw three cards with two pictures each (Fig. 3); two simple questions were asked per pair; each with a different answer.
**ID Test:**

Children hear and see three determinate and three indeterminate scenarios (see Table 1). In *determinate* scenarios there is enough information to answer a single question with certainty. In *indeterminate* scenarios there is clearly not enough information to answer the question with certainty. Thus, the child must judge if an outcome, location, or meaning is certain or uncertain. Each question has different wording and concerns different items, so children cannot perseverate in any simple way. Also, the questions are separated in time, with intervening tasks (see Deák, Ray, & Brenneman, 2003, for an earlier version of this task).

**Table 1**

<table>
<thead>
<tr>
<th>Implication</th>
<th>Color</th>
<th>Location</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Determinate</strong></td>
<td>E will pull ring out of box of identical white rings</td>
<td>E puts penny in hand, closes hand as child watches</td>
<td>“blanket”</td>
</tr>
<tr>
<td></td>
<td>“… know what color… will be, or have to guess?”</td>
<td>“…tell me where… is, or have to look around [for it]?”</td>
<td>“…know what ___ is, or have to ask your teacher?”</td>
</tr>
<tr>
<td><strong>Indeterminate</strong></td>
<td>will pull Lego from box of different-colored Legos</td>
<td>E explains “yesterday I hid a marble in this building”</td>
<td>“conifer”</td>
</tr>
<tr>
<td></td>
<td>“…know for sure [color], or don’t know for sure?”</td>
<td>“…can… get it… right now, or [must] look around first?”</td>
<td>“…know what ___ means, or have to ask your mom?”</td>
</tr>
</tbody>
</table>

**WM Task:**

Children hear four lists of four single-syllable non-words, read at a constant rate, and immediately recall as many words as they can. The recall task is presented as a “Simon Says” game, with two practice trials.

**Variables**

**Perseveration:**

Repeating answer for both questions about an item. This is counted in the AR, FN follow-ups, and FCQP tests.

**Conceptual Flexibility:**

Mean number of words produced per object in the FN test; assuming that at least 1 appearance and 1 function word is produced.

**Verbal Memory Span:**

Mean number of words recalled per list (correct bi-phones given 1/2 credit).
Results:
AR: 48% of children made 2+ perseverative errors.
FN: Produced mean = 2.5 words/object ($SD = 0.8$)
ID: Mean = 67% correct responses (chance = 50%)
FCQP: 31% of children perseverated at least once

Partial correlations (removing age and memory span) are presented in Table 2

Indeterminacy Detection correlated with all tasks with successive forced-choice questions (AR, FN-follow-ups, FCQP)

Step-wise regression: ID was only predictor of:
AR scores: $\beta = .50, R^2 = .23; p < .001$
FCQP scores: $\beta = .42, R^2 = .18; p < .005$

Age predicts ID scores in regression analysis

AGE $\rightarrow$ Detect indeterminacy $\rightarrow$ change answers to successive questions $\rightarrow$ Correct AR responses

Conclusions:
AR errors are just one case of perseverative answer-choices. They occur in many tests with successive forced-choice questions about the same item or topic (Deák, Ray, & Brenneman, 2003)
AR errors are specific to verbal forced choice (Sapp et al, 2000), but unrelated to working memory span.
All children who make AR errors flexibly produce two labels, for an object’s appearance and function, so AR errors are not due to conceptual inflexibility
Indeterminacy detection, not age, was best predictor of perseverative errors. Knowing that each question is indeterminate, even if topic or referent is the same, seems critical. Children with poor ID might view second AR question as a reiteration of the first.

References: