Differential Sensitivity of Items in the *n*-back Task: "Lures" Explain Variance in Executive Control That "Non-lures" Don't

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1. INTRODUCTION

The ***n*-back task** is a widely used probe of **working memory**:

- Used in neuroimaging studies
- Recently, become more prominent in behavioral studies.
- Little emphasis on task analysis of the *n*-back task.

Some trials in the *n*-back may be more sensitive to executive control differences:

- Global accuracy measures fail to distinguish different types of items and their underlying processes.
- Comparison of **"lure"** nontargets to **"non-lure"** nontargets may be particularly sensitive to executive control differences.
- **"Lure"** nontargets contain more irrelevant or misleading information than **"non-lure"** nontargets
- For an analysis of other trial types, as well as a different operationalization of "lures", see Conway and Kane (2001).

Active maintenance of context information:

- Biases processing toward task-relevant pathways
- Protects from interference from task-irrelevant pathways
- **"Lure"** performance may be more sensitive to active maintenance of context information, and overall efficiency of executive control

Predictions:

- Subjects will false alarm (FA) more to **lures** than to **non-lures**
- **Lure** FAs will predict variance in executive control stemming from:
  - **Individual differences in fluid intelligence** (Dempster, 1991)
  - **Individual differences in working memory span** (Engle, 2002)
  - **Age-related differences** (Braver et al., 2001)
- These relationships will stand, even after controlling for **non-lure** FAs

2. METHOD

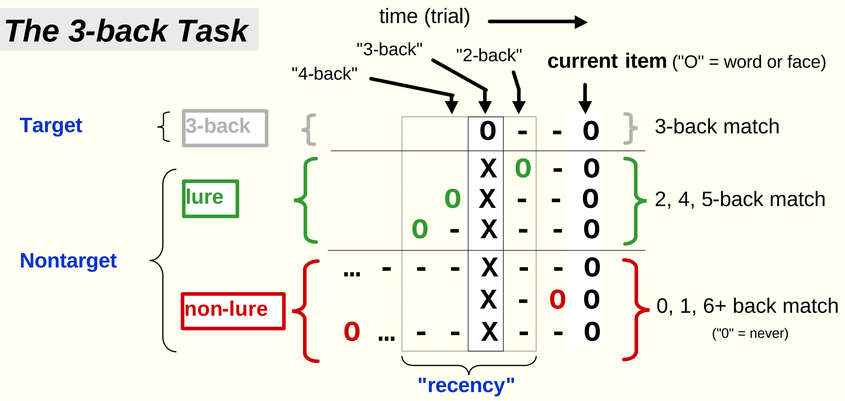
Study 1: Participants, procedure

58 subjects: 6 task blocks (see Gray, Chabris, & Braver, submitted)
3-back task = Verbal (words) or Non-verbal (faces)
Instructions: "Is the current item the same as or different from the one 3 previously?"
64 trials, 30% targets; recorded responses and response time (RT)
Raven's Advanced Progressive Matrices **(fluid intelligence)**
Reading Span (working memory span)
AX-CPT (active maintenance of context information)

Study 2: Participants, procedure

Behavioral study with younger and older adults (see Braver et al., 2001)
256 subjects: 175 younger adult subjects; 81 older adult subjects
3-back task = Verbal (single letters)
instructions: "Is the current letter the same as or different from the one 3 previously?"
64 trials, 33% targets; recorded responses and response time (RT)
Reading Span
AX-CPT

The 3-back Task



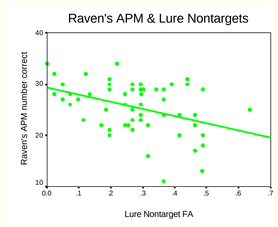
3. RESULTS

Study 1: Correlations of lure false alarms with:

Fluid Intelligence…

as predicted, higher Raven's APM score was associated with:

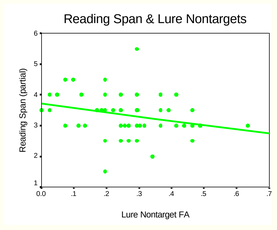
- lower **lure false alarm** rate r = -.39, p = .002
- lower **lure false alarm** rate controlling for **non-lures** pr = -.28, p = .028



Working Memory Span…

as predicted, higher reading span was associated with:

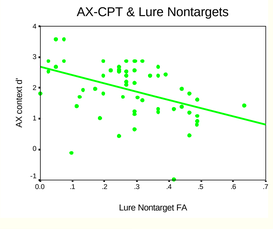
- lower **lure false alarm** rate r = -.29, p = .028
- lower **lure false alarm** rate controlling for **non-lures** pr = -.32, p = .014



Active Maintenance of Context…

as predicted, higher AX-CPT target discrimination was associated with:

- lower **lure false alarm** rate r = -.42, p = .001
- lower **lure false alarm** rate controlling for **non-lures** pr = -.36, p = .006



Correlation Matrix

	Lure FAs	Raven's	Reading Span	AX-CPT d'
Lure FAs	-	-0.394	-0.288	-0.419
Raven's		-	0.270	0.323
Reading Span			-	0.196
AX-CPT d'				-

Study 2:

Correlations with age:

as predicted, age group (old vs. young) was associated with:

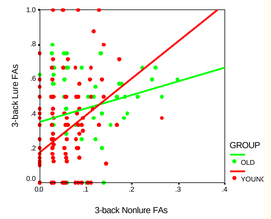
- higher **lure false alarm** rate r = .281, p < .001
- higher **lure false alarm** rate controlling for **non-lures** pr = .17, p = .007

One might argue that false alarms to lures explain more age-related variance than false alarms to non-lures due to increased psychometric sensitivity of lures.

Controlling for baseline FA differences using regression:

as predicted, after controlling for differences in non-lure FA rates, older adults have higher lure FA rates than younger adults:

-Younger adults:
3-back LN = 2.133*non-lures + 0.179
-Older adults:
3-back LN = 0.789*non-lures + 0.351



Predicted old lure FA rate at mean non-lure FA rate (using younger adult regression equation) is significantly lower than measured:

- **Old non-lure mean = .0853**
- **Predicted Old lure FA rate = 2.133 * .0853 + 0.179 = .3609**
- **Measured Old lure FA rate = .4183; *t* (80) = 2.293, p=.024**

4. CONCLUSIONS

Lure nontargets are differentially sensitive to executive control differences
- Fluid Intelligence
- Reading Span
- AX-CPT (Active Maintenance of Context Information)
- Healthy Aging

This differential sensitivity may not be due to psychometric issues
- Even after controlling statistically for baseline FA rates, individuals / groups predicted to have less executive control also have higher lure FA rates

References

Braver, T.S. et al. (2001). *Journal of Experimental Psychology: General, 130*, 746 – 763.
Conway, A.R.A & Kane, M.J. (2001) Talk presented at the Psychonomic Society Annual Meeting
Dempster, F. N. (1991). *Intelligence, 15*, 157-173.
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