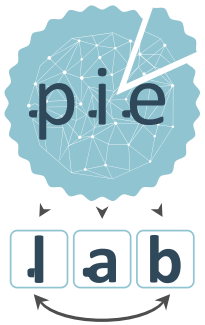
# Evaluating the Validity of Compound Remote Associates Items

Kendall Mather, Sara Weston, and David Condon
University of Oregon






# Compound Remote Associates (CRA) Items

**You are given three words:**

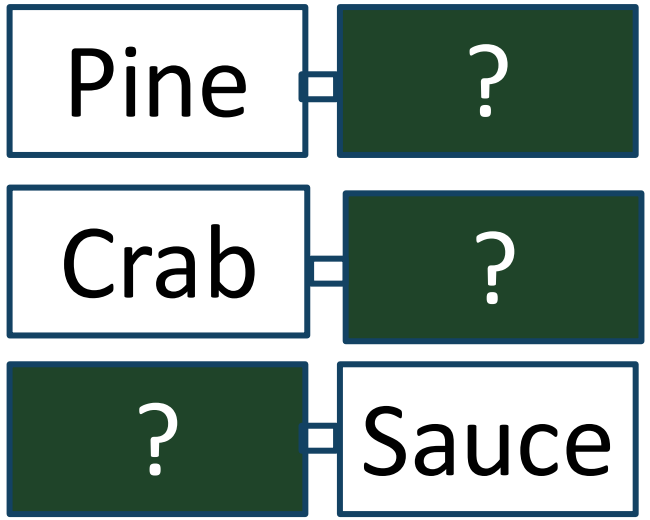
*Pine*, *crab*, *sauce*

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**Your task:** Find a fourth word that can form a compound word with each of the three

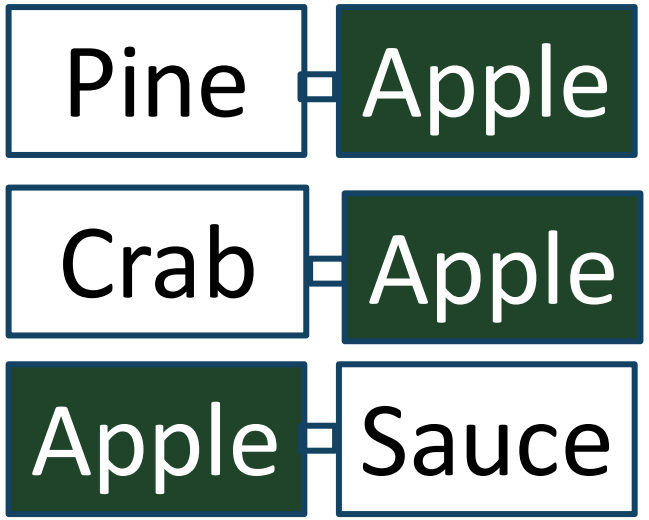


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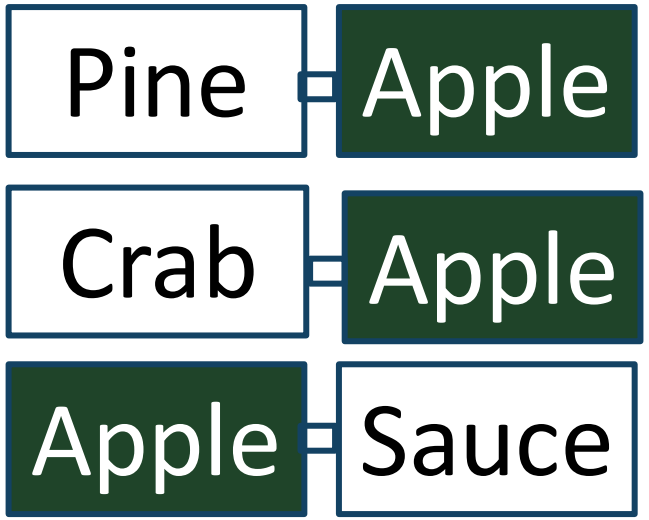


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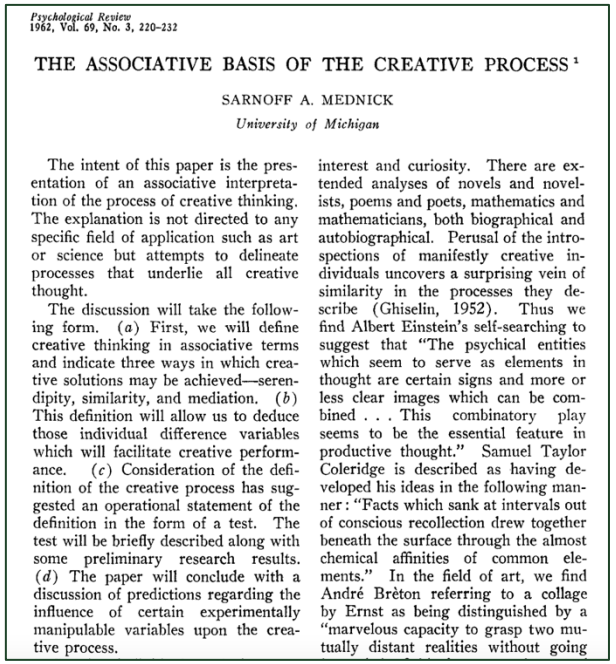

*More examples:*

*Bed*, *sheet*, *wide* (*spread*)

*stalk*, *jelly*, *pole*, (*bean*)

# Theory

- These items are used to assess traits like creativity and insight
- Creativity is fundamentally the ability to make associations across remote ideas and concepts (Mednick, 1962).
- Implicated in the creative process across domains (e.g., art, science; Ghiselin, 1985; Simonton, 2022)
- Implicated in creativity at all levels (Kaufman & Beghetto, 2009; Ghiselin, 1985)



*Psychological Review*
1962, Vol. 69, No. 3, 220–232

THE ASSOCIATIVE BASIS OF THE CREATIVE PROCESS[1]

SARNOFF A. MEDNICK
*University of Michigan*

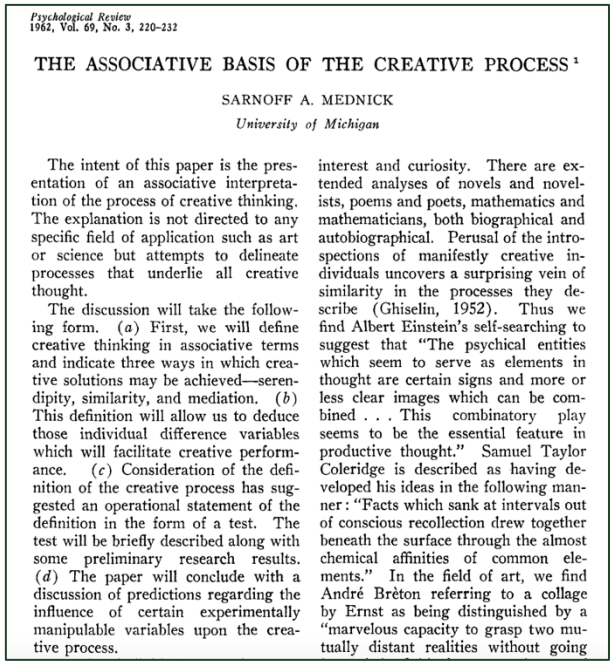
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The discussion will take the following form. (*a*) First, we will define creative thinking in associative terms and indicate three ways in which creative solutions may be achieved—serendipity, similarity, and mediation. (*b*) This definition will allow us to deduce those individual difference variables which will facilitate creative performance. (*c*) Consideration of the definition of the creative process has suggested an operational statement of the definition in the form of a test. The test will be briefly described along with some preliminary research results. (*d*) The paper will conclude with a discussion of predictions regarding the influence of certain experimentally manipulable variables upon the creative process.

interest and curiosity. There are extended analyses of novels and novelists, poems and poets, mathematics and mathematicians, both biographical and autobiographical. Perusal of the introspections of manifestly creative individuals uncovers a surprising vein of similarity in the processes they describe (Ghiselin, 1952). Thus we find Albert Einstein's self-searching to suggest that "The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be combined . . . This combinatory play seems to be the essential feature in productive thought." Samuel Taylor Coleridge is described as having developed his ideas in the following manner: "Facts which sank at intervals out of conscious recollection drew together beneath the surface through the almost chemical affinities of common elements." In the field of art, we find André Brèton referring to a collage by Ernst as being distinguished by a "marvelous capacity to grasp two mutually distant realities without going

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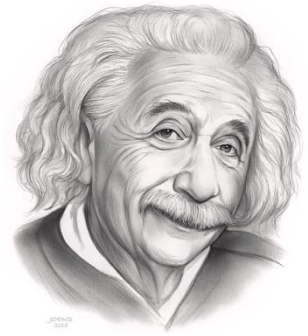
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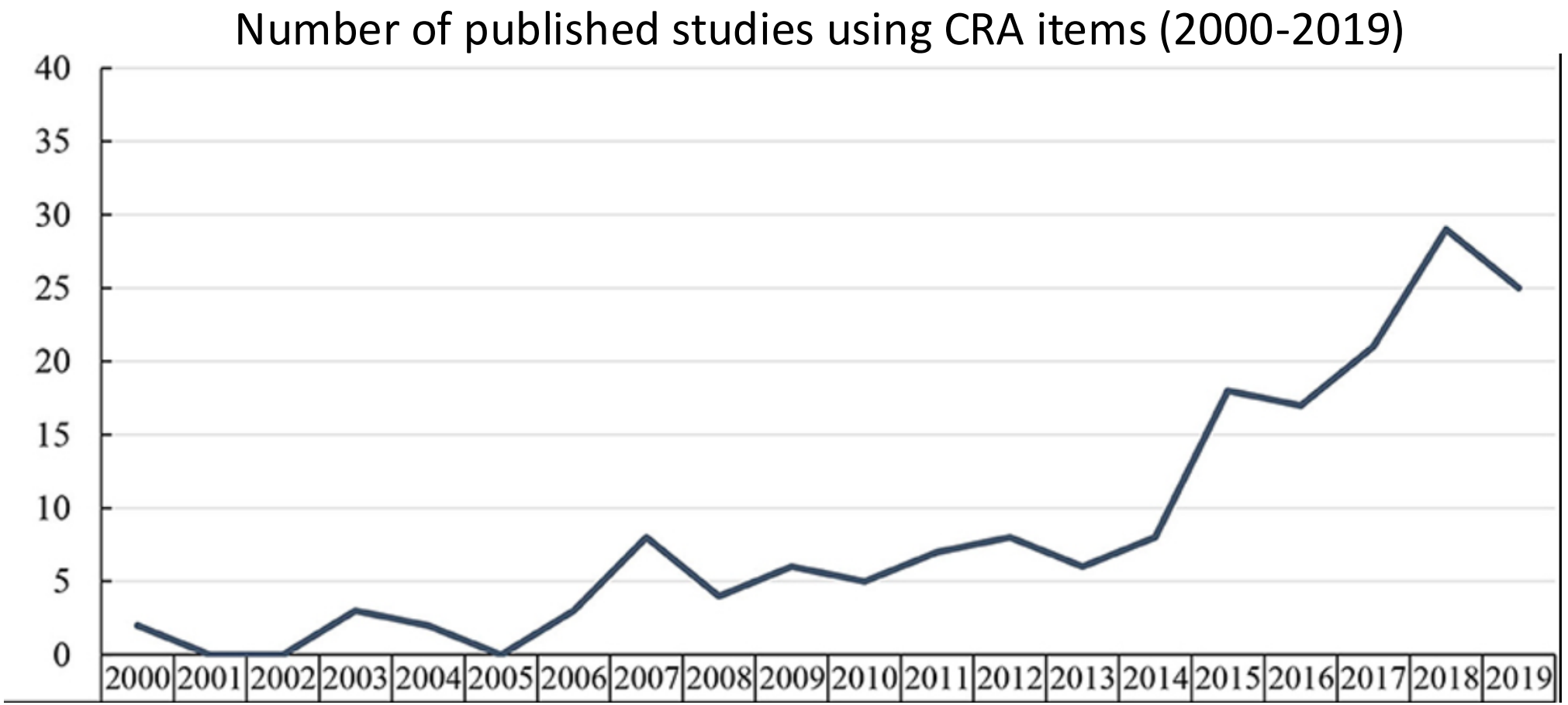
"To create consists of making new combinations of associative elements"
-Poincaré

"...combinatory play seems to be the essential feature in productive thought"
-Einstein



# Open Questions

- Despite frequent use of the problems, their validity remains unclear




Wu, Huang, Chen, & Chen (2020)

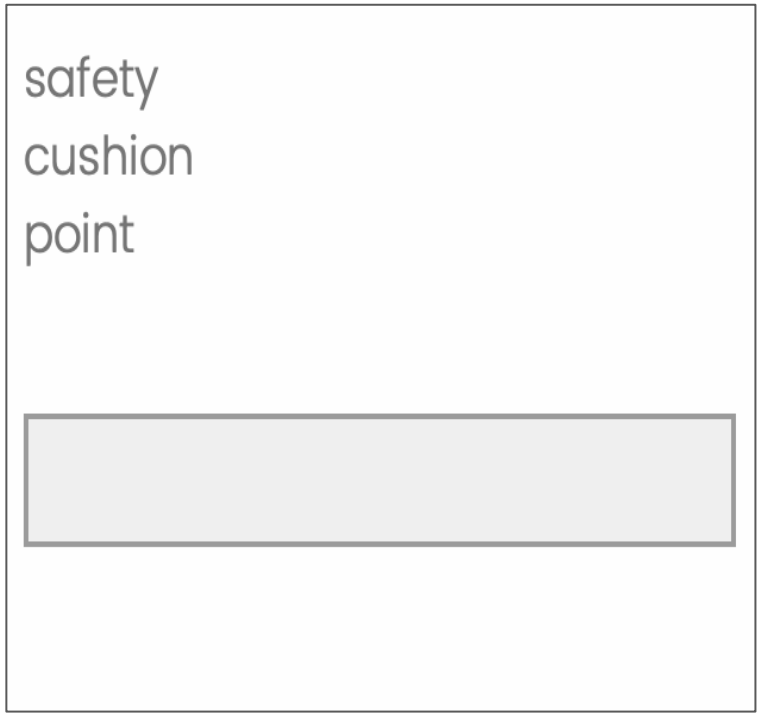
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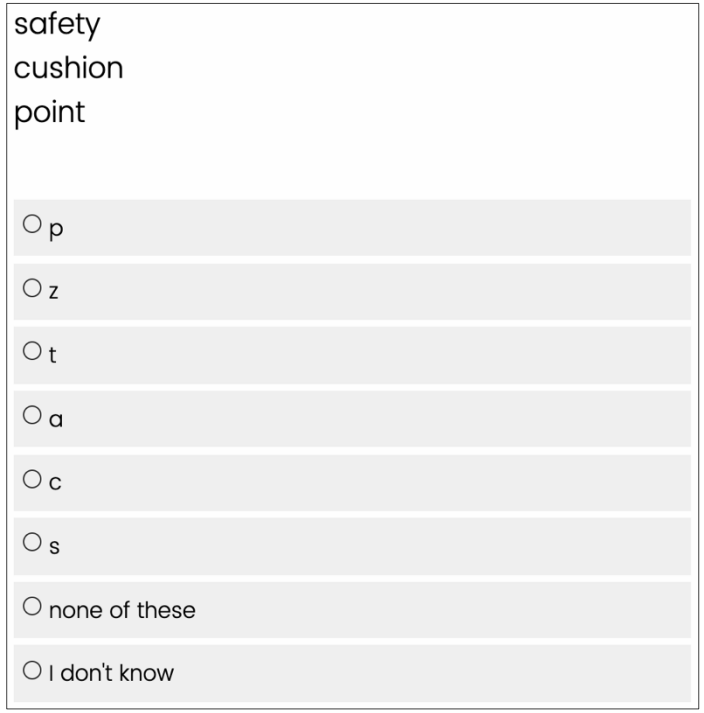
# Open Questions

- Despite frequent use of the problems, their validity remains unclear
- The validity of a multiple-choice response mode

**Open-ended**




**Multiple-choice**



# Goals of this project

Across three studies...

**1. Evaluate the validity of CRA items**

**2. Validate multiple-choice method**

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Across three studies...

## 1. Evaluate the validity of CRA items

## 2. Validate multiple-choice method

**Two pools of items:**

- Existing items: 30 Compound Remote Associates Task ("CRAT") items developed by Bowden & Jung-Beeman (2003)

- New items: 67 representative items from a large pool of algorithmically generated items developed recently

# Goals of this project

Across three studies...

**1. Evaluate the validity of CRA items**

- Reliability
- Unidimensionality
- Item-level psychometric properties (item difficulty and discrimination)
- Examine relationships with temperament, ability, interests

**2. Validate multiple-choice method**

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safety
cushion
point

- ○ p
- ○ z
- ○ t
- ○ a
- ○ c
- ○ s
- ○ none of these
- ○ I don't know

# Three Studies

**Study 1**

SAPA Sample

- N = 1,323,398
- average pairwise: n = 395
- Minimum pairwise: n = 215

**Study 2**

Undergraduate Sample

- N = 688

**Study 3**

Prolific Sample

- N = 300

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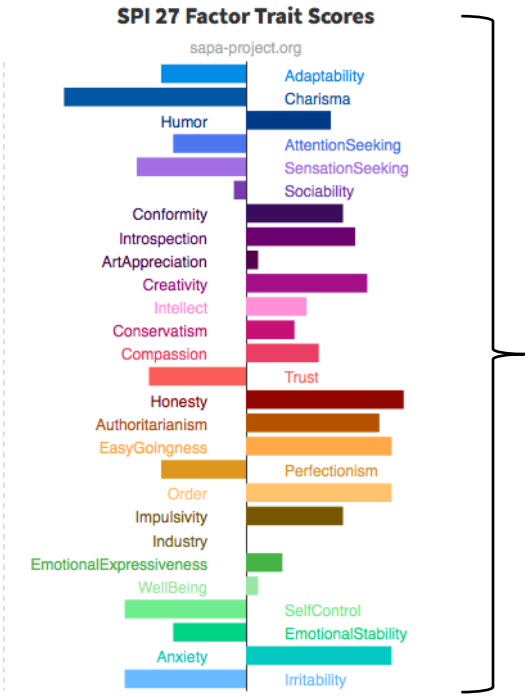
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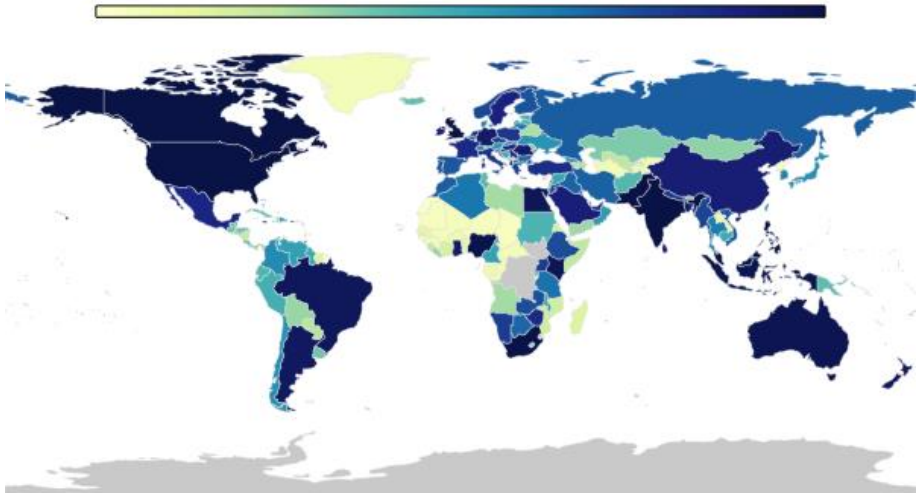
## About the SAPA Project

- Online data collection tool for assessing individual differences that uses a planned missingness design.
- Data collected from 2017-2022




Participants receive information on their personalities in exchange for participation

Heatmap of participants by country



# Three Studies

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## Purpose of study 1:

- Evaluate structure, unidimensionality, and item-level psychometric properties

Examine relationships with…

- Temperament (e.g., Big Five, SPI-27)
- Cognitive abilities (e.g., verbal ability)
- Occupation and Major choice

# Three Studies

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**Purpose of study 2:**

Evaluate the effects of….

1. Response format

(multiple-choice vs. open-ended)

2. Problem set

(New CRA items vs. CRAT items)

# Three Studies

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Undergraduate Sample

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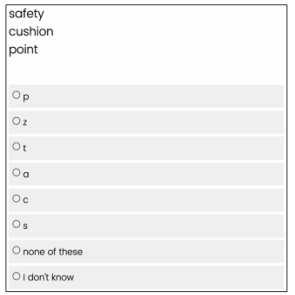
**New items**

Total item pool: 67 items

30 random open-ended items




25 random MC items



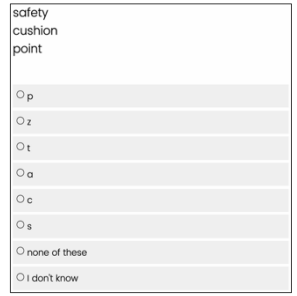

**CRAT items**

Total item pool: 30 items

10 random open-ended items




5 random MC items



# Three Studies

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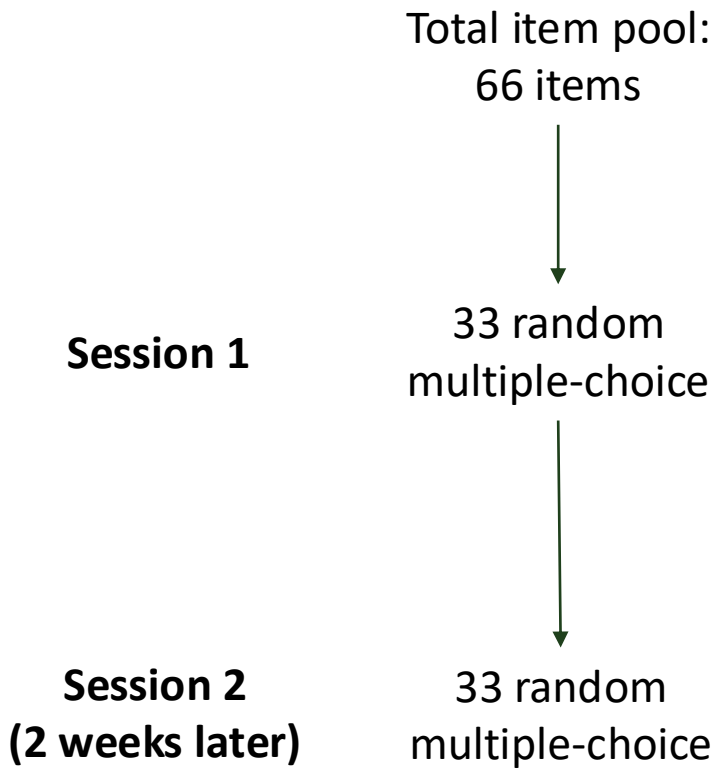
**Study 3**

Prolific Sample

- N = 300

## Purpose of study 3:

Assess test-retest reliability of the new items administered using multiple-choice format



# Three Studies

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**Study 2**

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**Study 3**

Prolific Sample

- N = 300

**(Sample)** ⇦

## Purpose of study 3:

Assess test-retest reliability of the new items administered using multiple-choice format

Total item pool:
66 items

↓

**Session 1** — 33 random multiple-choice

↓

**Session 2 (2 weeks later)** — 33 random multiple-choice

# Results: Structure and Reliability

Do the CRA items show unidimensionality?

**General factor saturation:** How much of the variance in scale scores is accounted for by a general factor?

$\omega_h = .87$

(SAPA Sample)

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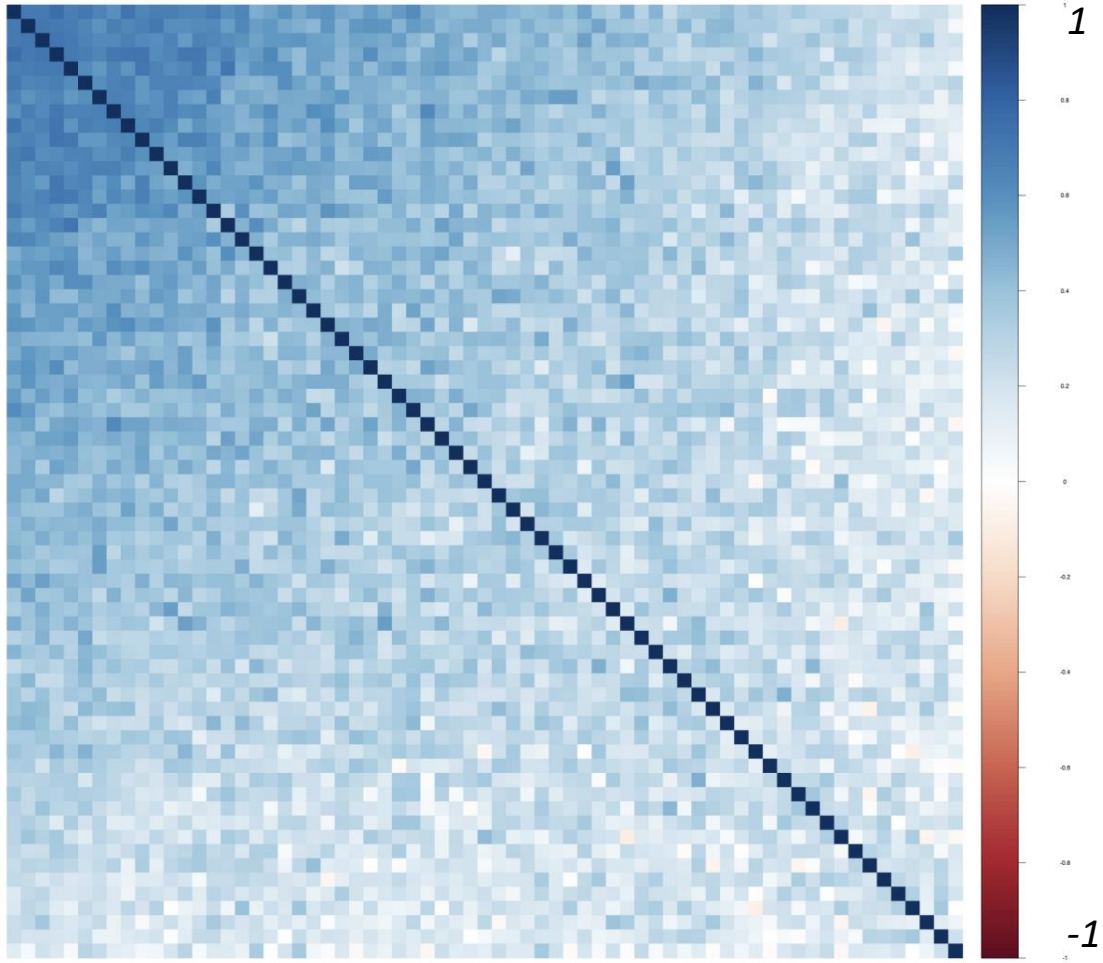
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**Internal consistency:**

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(SAPA Sample)

Inter item correlations for the 67 new items

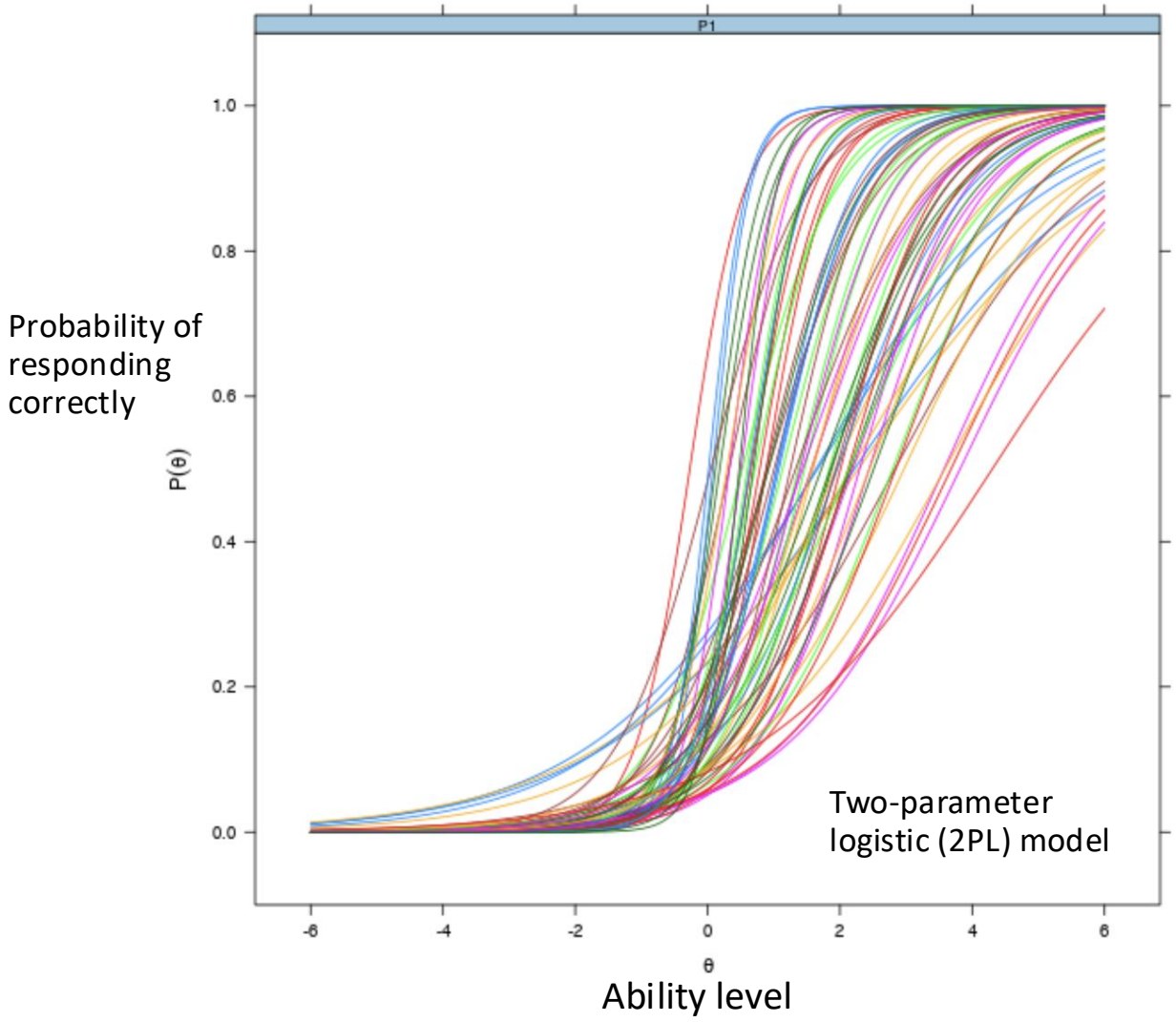



Average $r = 0.326$

# Results: Structure and Reliability

Do CRA items have adequate item-level psychometric properties?

*Item probability functions for the newly developed items*




(SAPA Sample)

# Results: Structure and Reliability

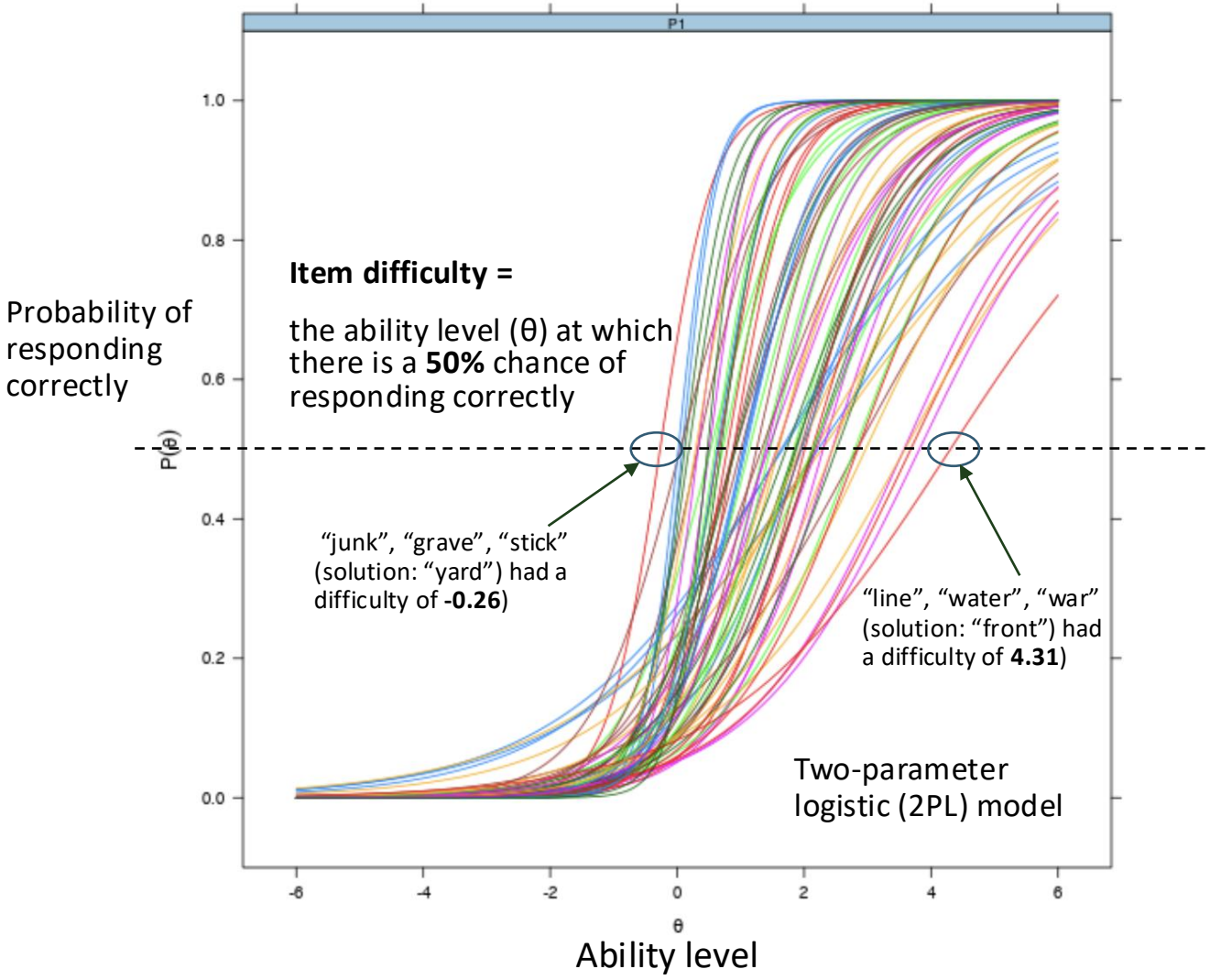
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### Item response theory parameters

- Range of difficulty suggests that CRA items are challenging
  - Most item difficulties > 0
  - Ranged from -0.27 to 4.30 (M = 1.61)

(SAPA Sample)

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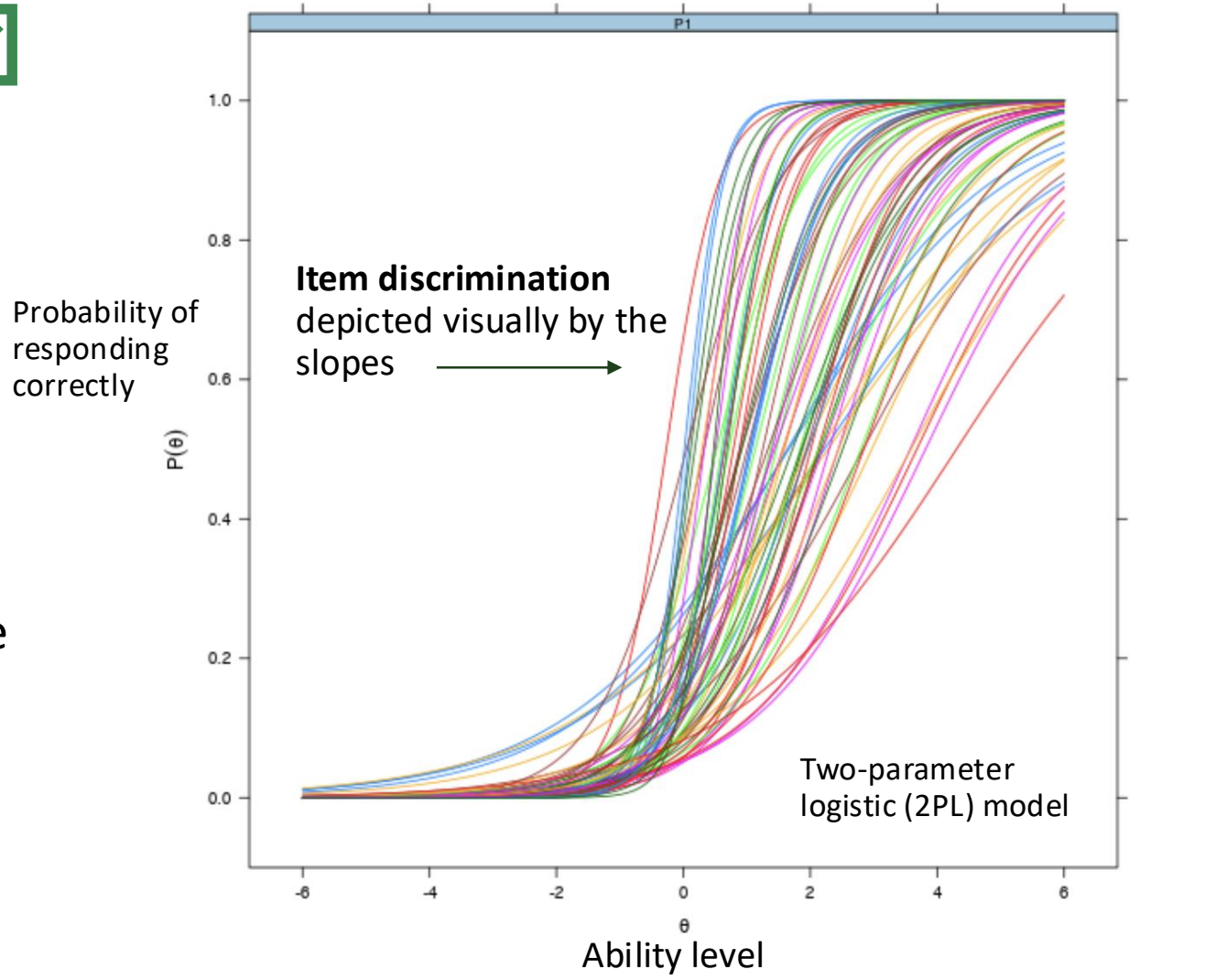
## Do CRA items have adequate item-level psychometric properties? ☑

### Item response theory parameters

- Range of difficulty suggests that CRA items are challenging
  - Most item difficulties > 0
  - Ranged from -0.27 to 4.30 (M = 1.61)
- CRA items differ in their ability to discriminate among participants of similar ability levels
  - Range from 0.52 to 3.64 (M = 1.46)

(SAPA Sample)

*Item probability functions for the newly developed items*



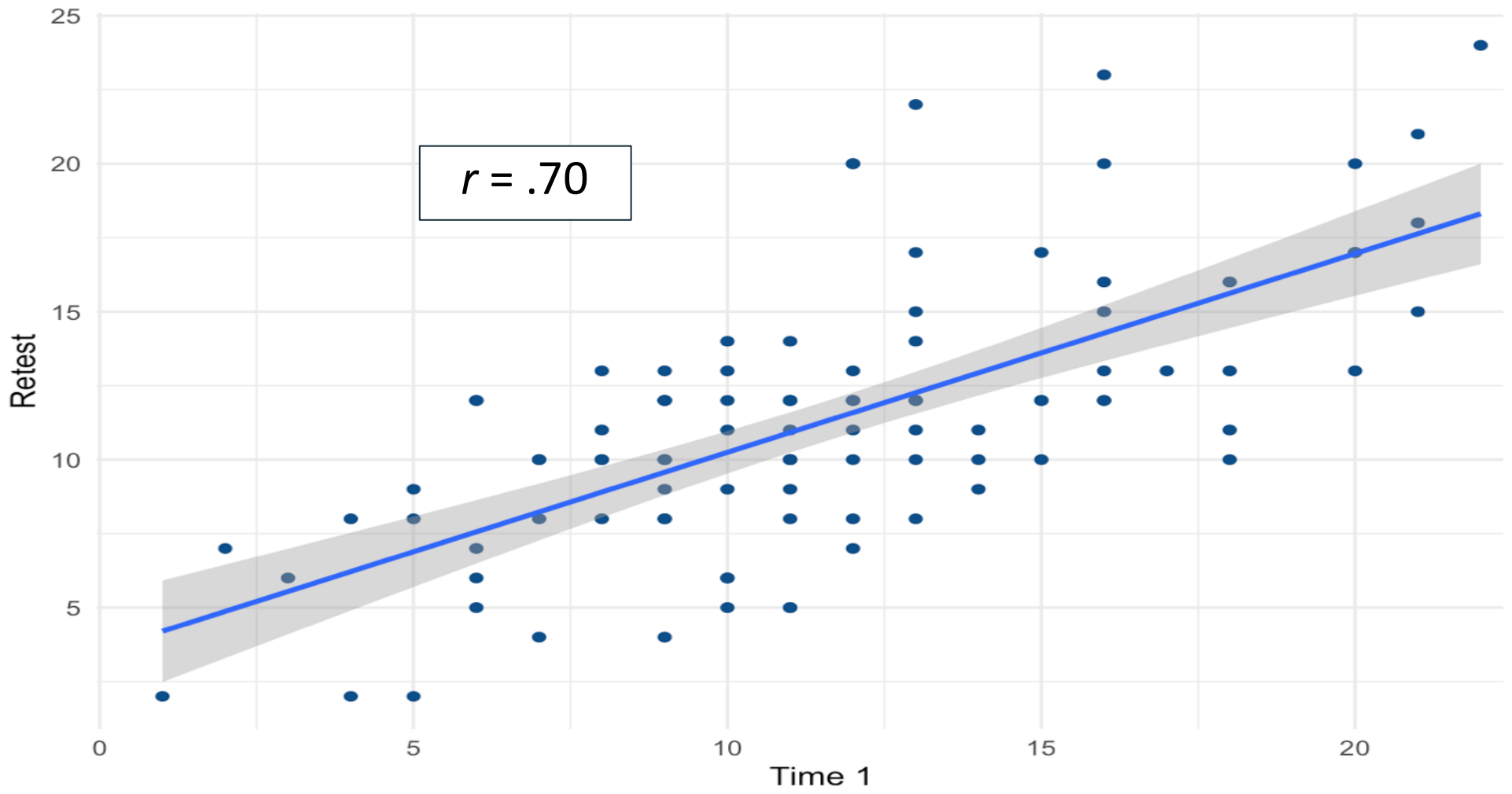
# Results: Structure and Reliability

Are CRA items reliable?

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Are CRA items reliable? ☑

Two-week test-retest reliability




(Prolific Sample)

# Results: The effect of response mode

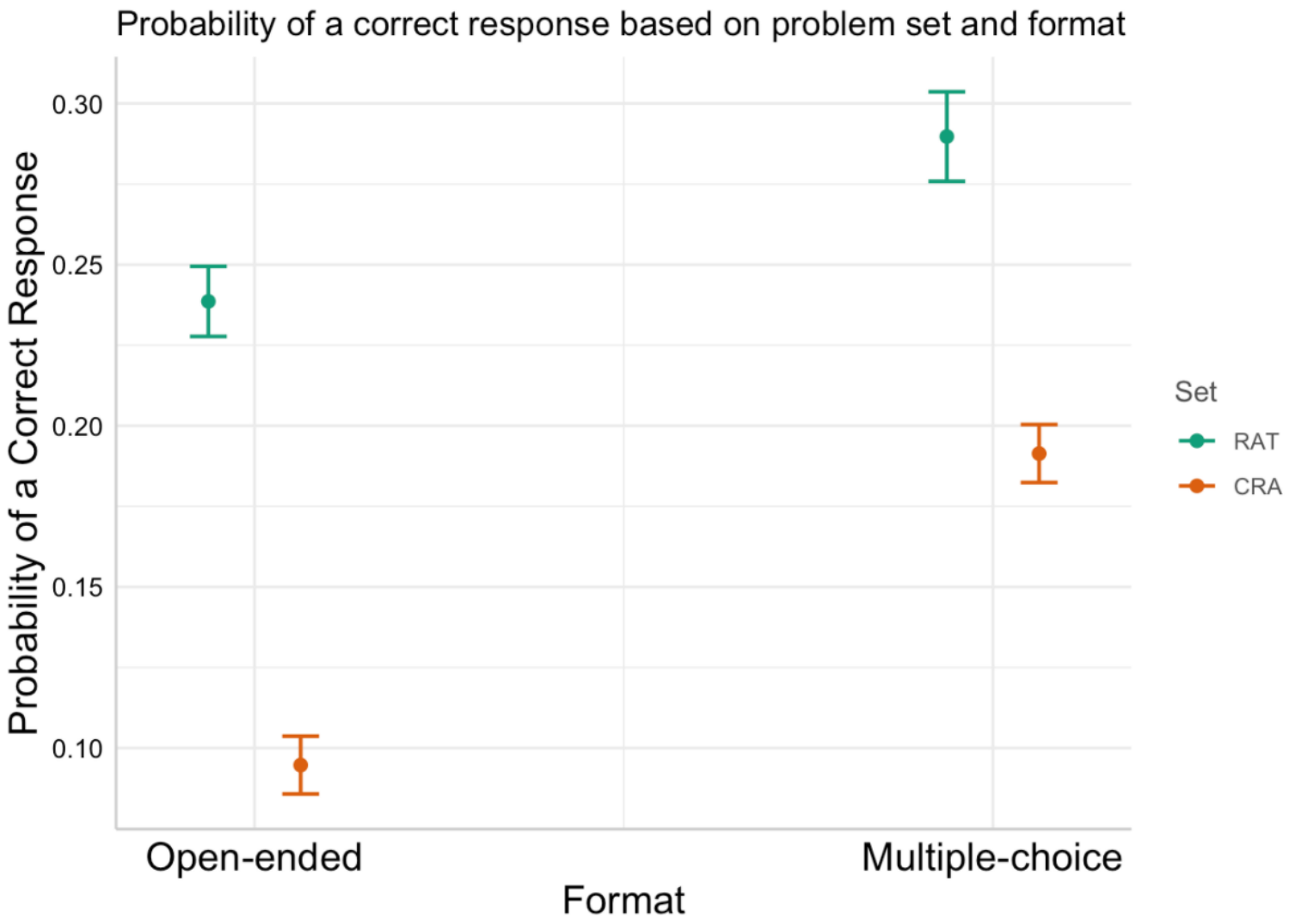
## Does response mode matter?

Fixed effects:

- Response mode
- Problem set

Random effect: Participant

(Undergraduate Sample)



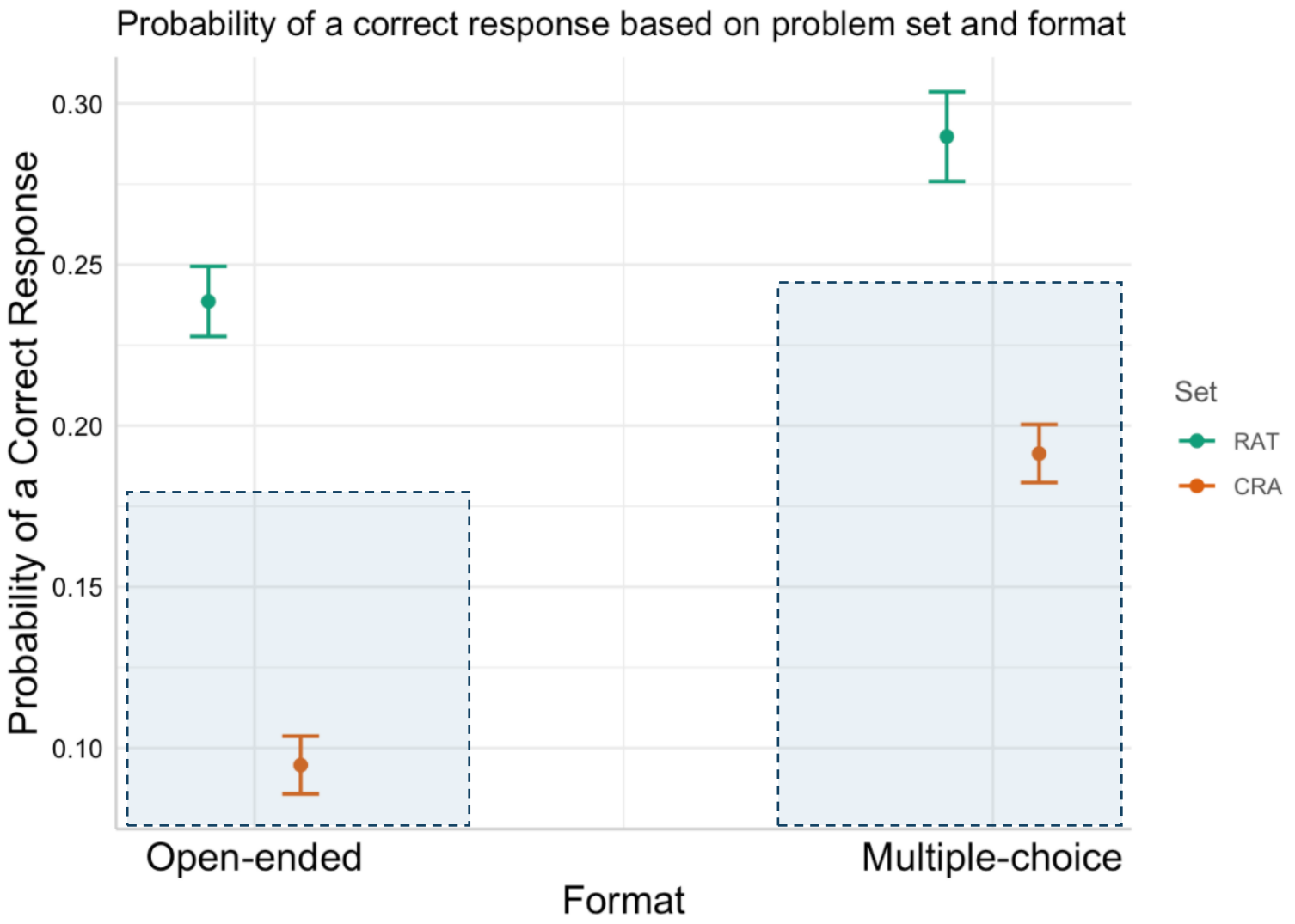
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OR 1.08, 95% CI [1.08, 1.09].

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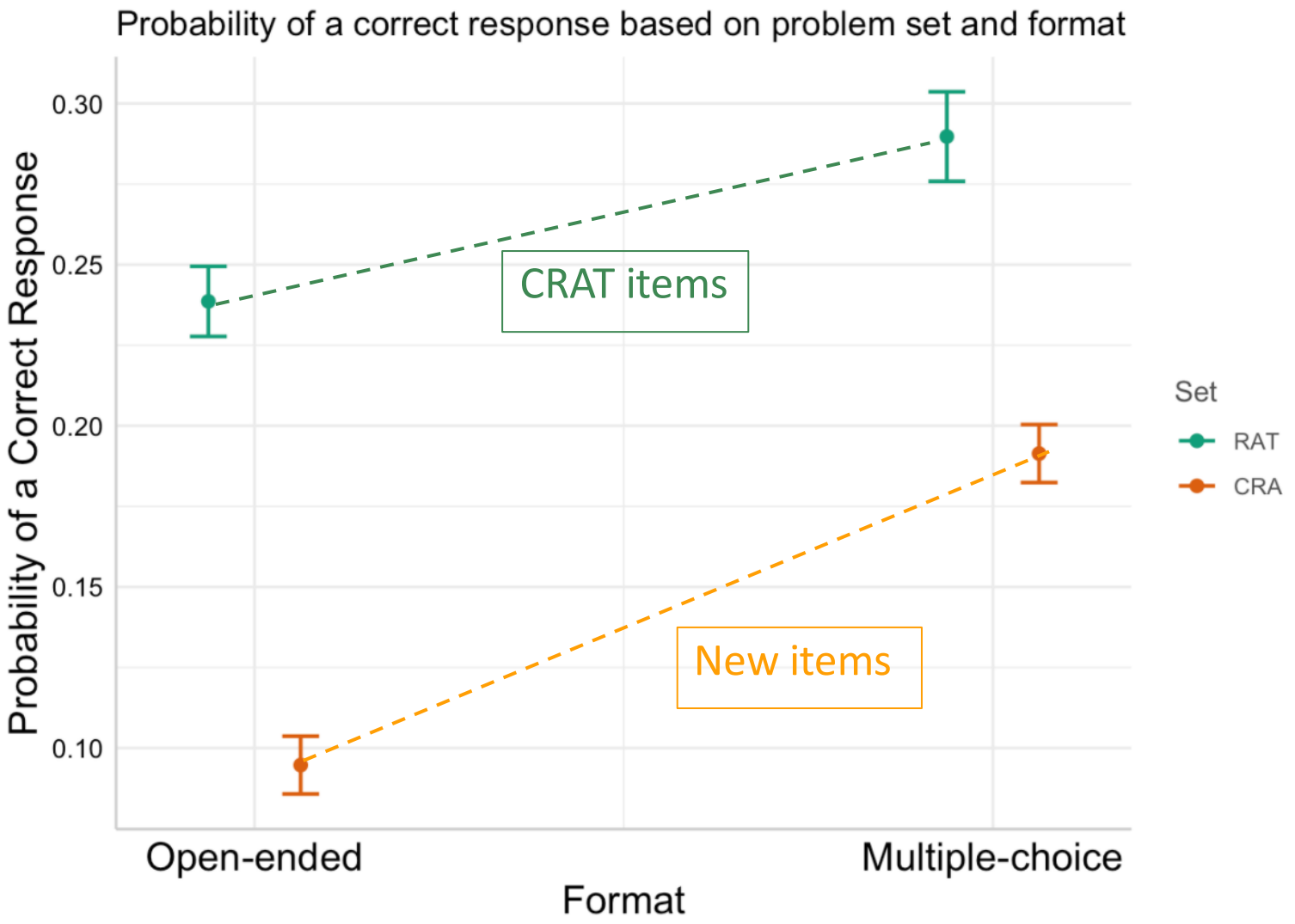
- Multiple-choice items are easier to solve

OR 1.08, 95% CI [1.08, 1.09].

- Older (CRAT) items are easier to solve

OR 1.13, 95% CI [1.12, 1.14].

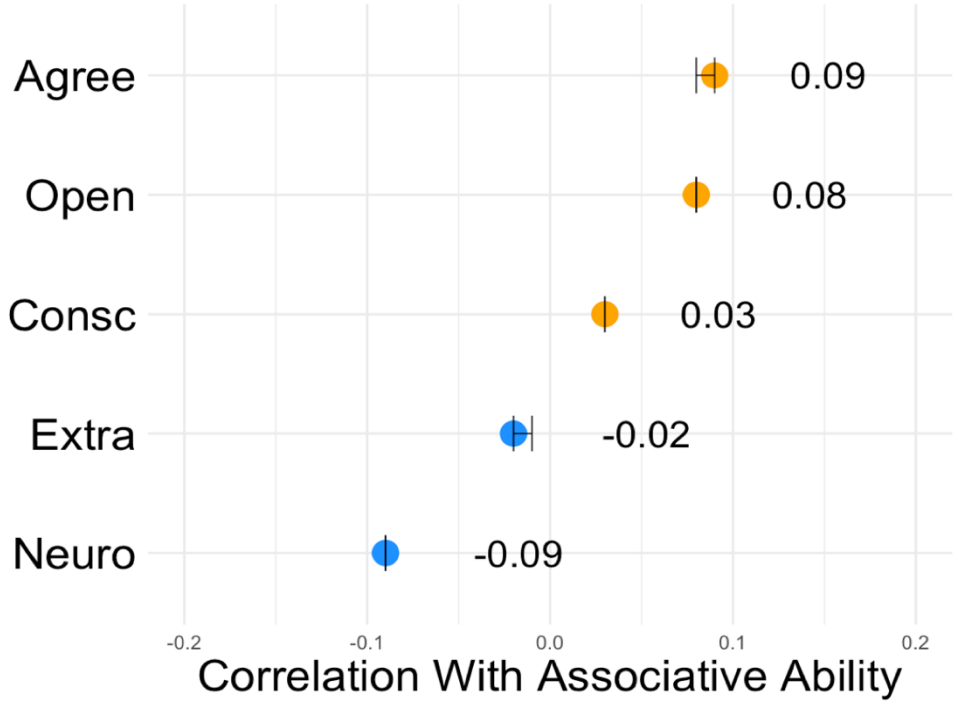
(Undergraduate Sample)



# Results: convergent and discriminant validity

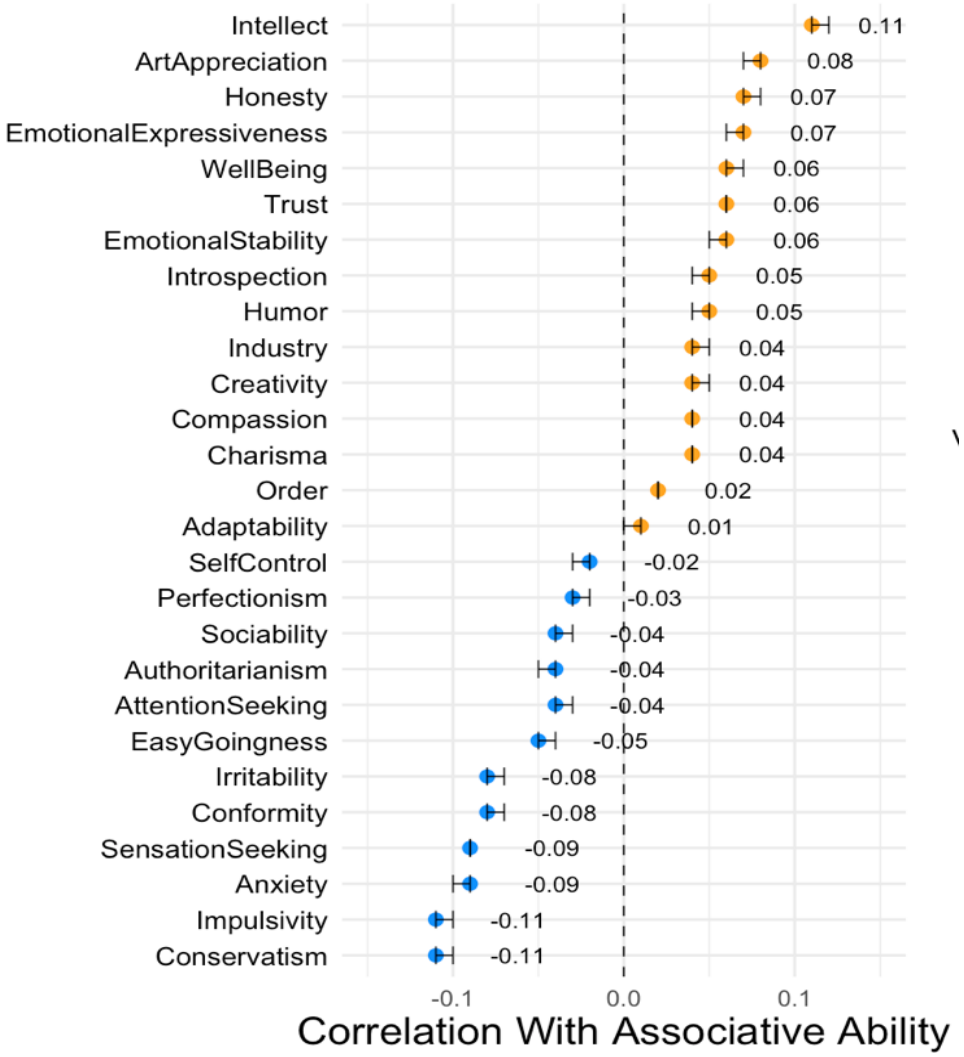
## Temperament

**Big Five**




(SAPA sample)

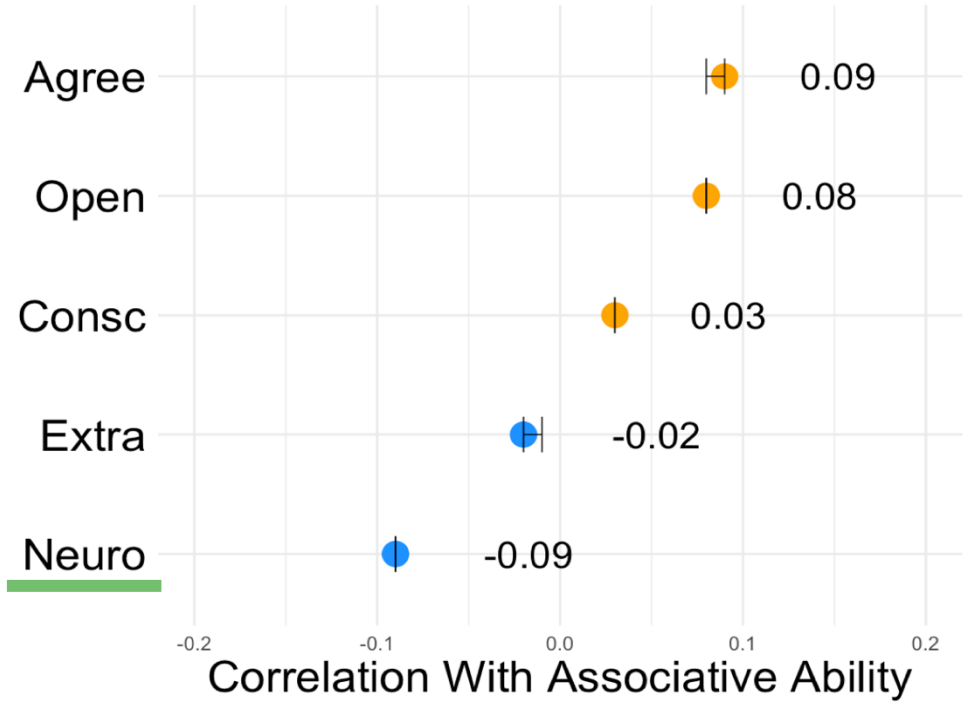
**SAPA Personality Inventory**



# Results: convergent and discriminant validity

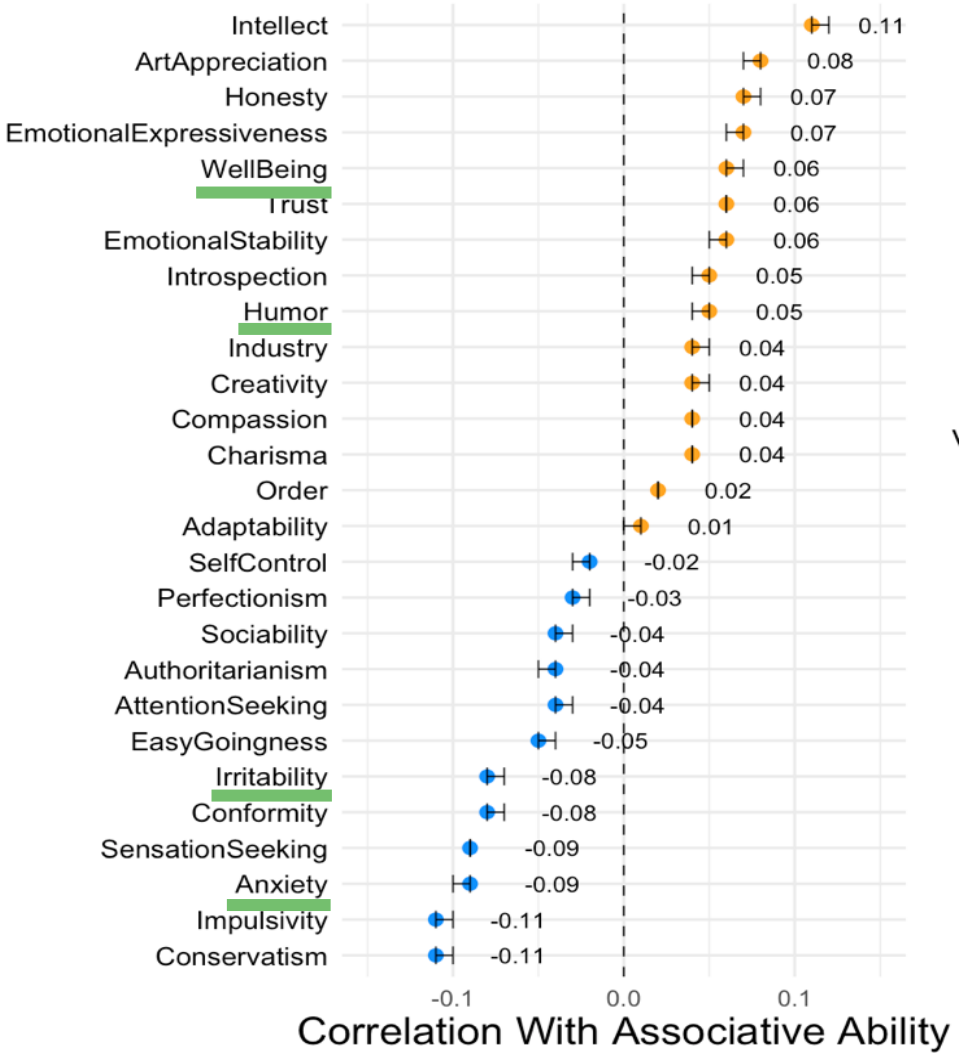
## Temperament

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(SAPA sample)

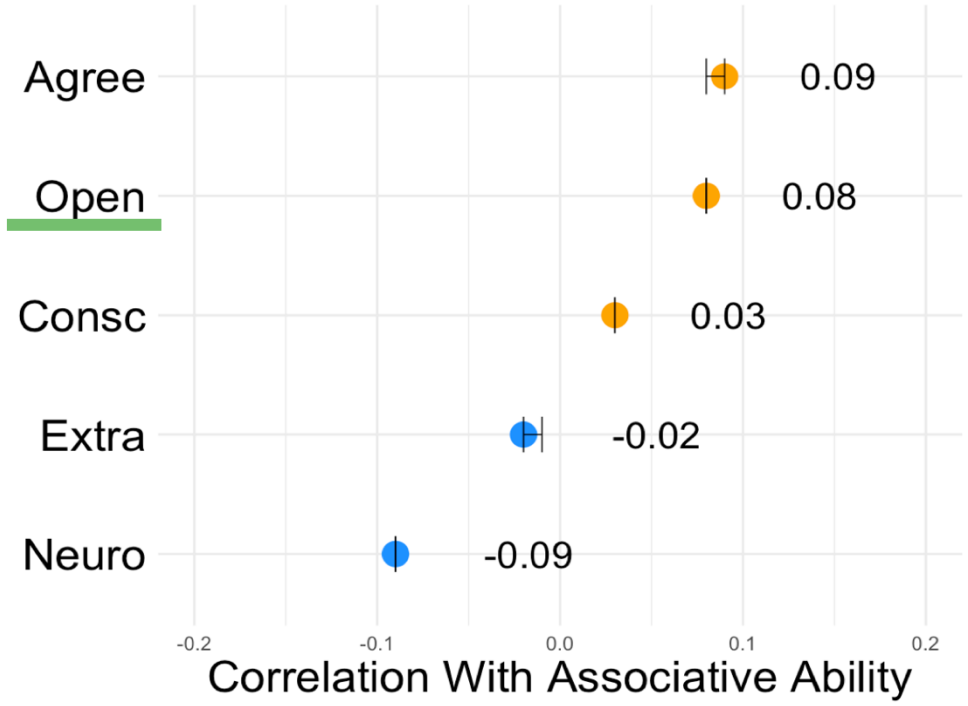
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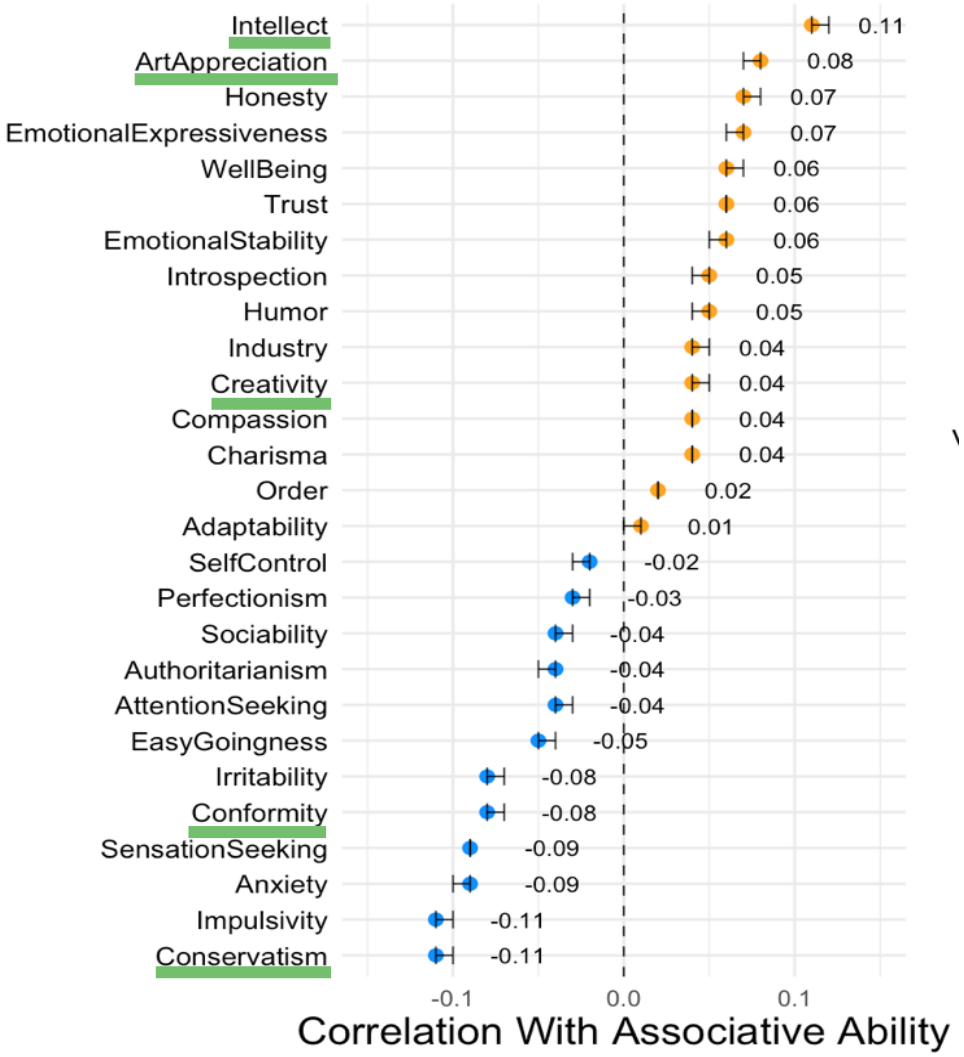
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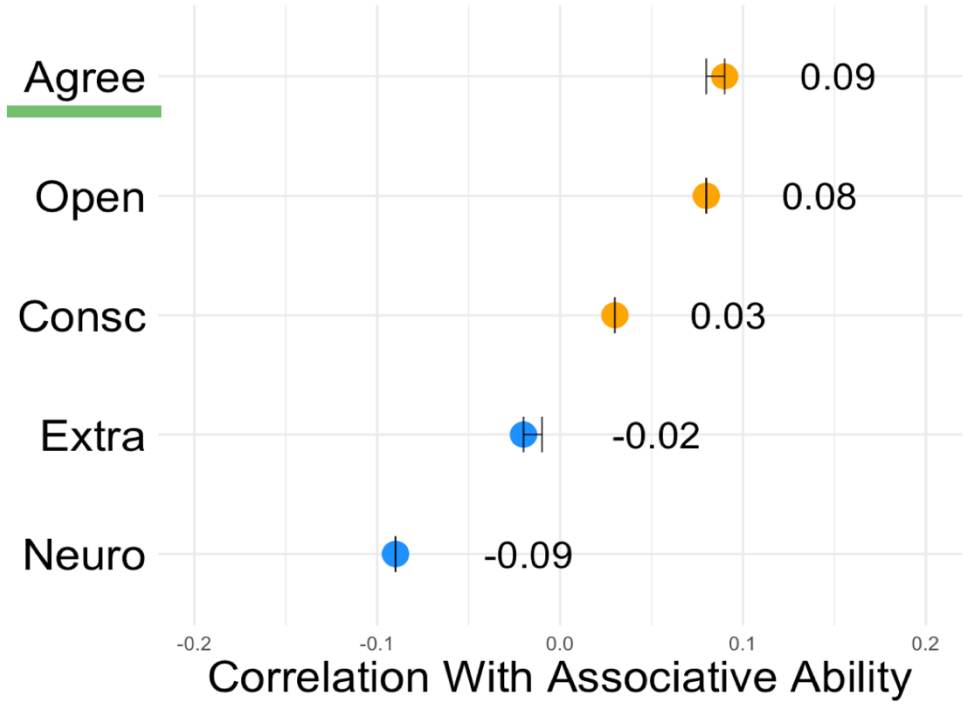
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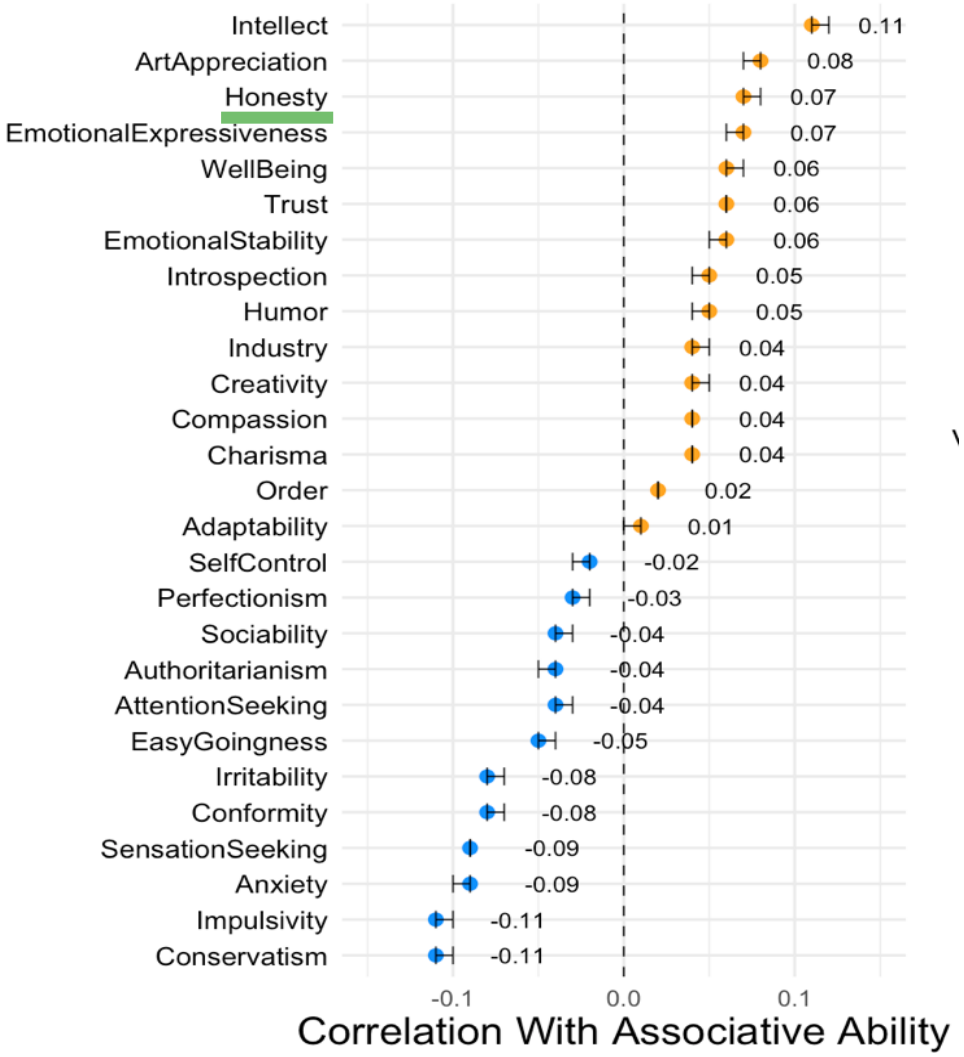
## Temperament

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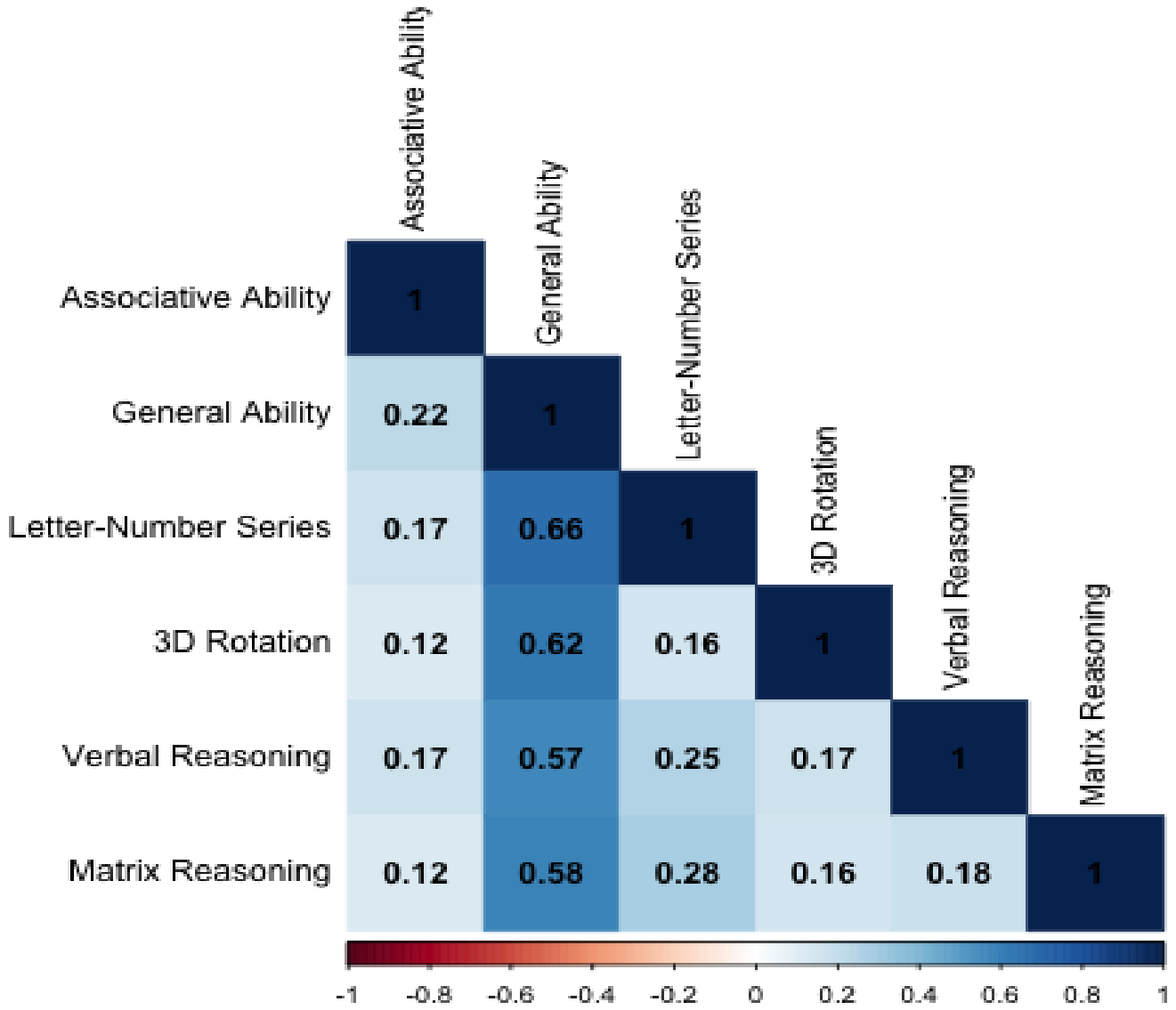
**SAPA Personality Inventory**



# Results: convergent and discriminant validity

## Cognitive Abilities

Assessed using the International Cognitive Ability Resource (ICAR)



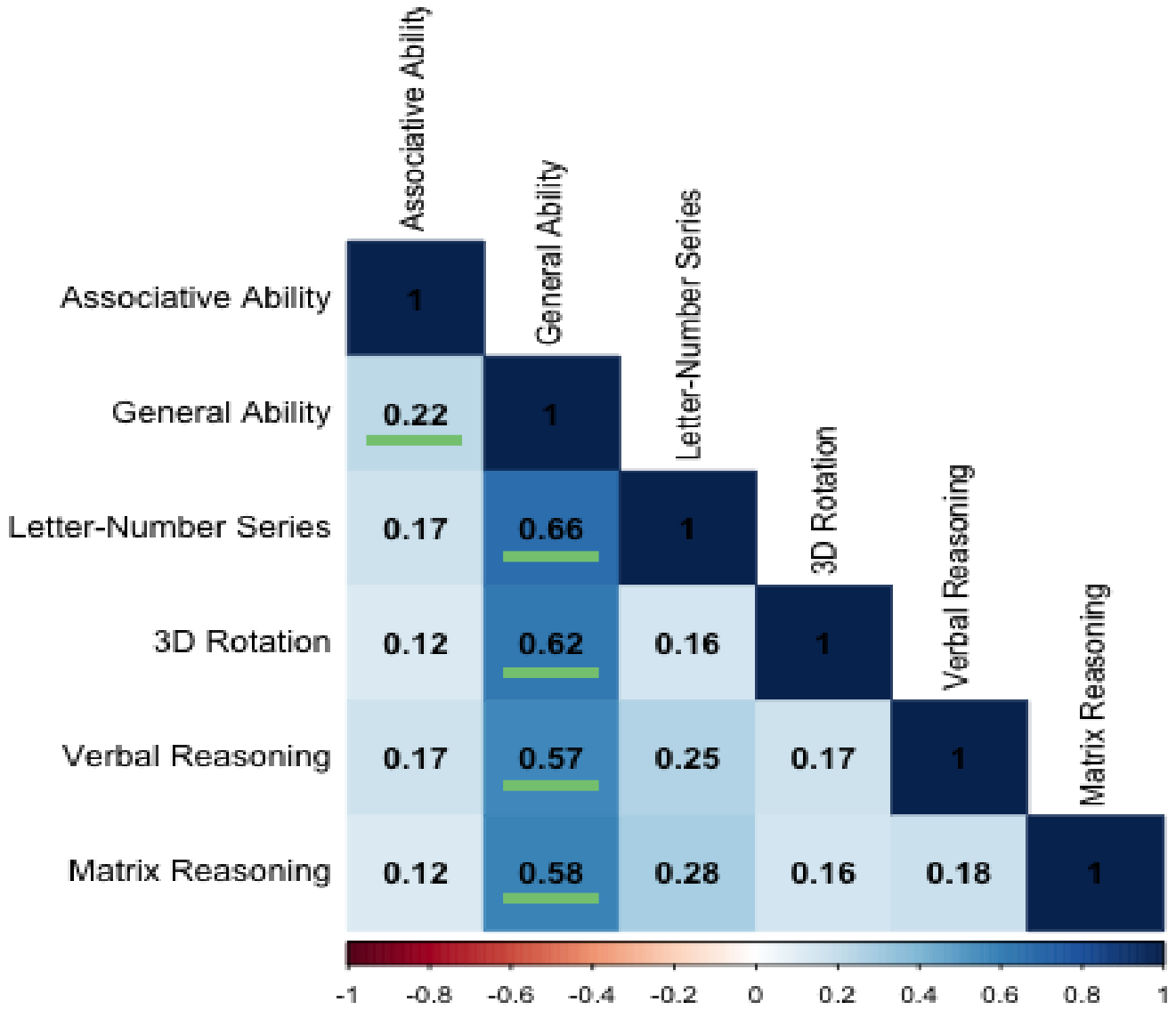

(SAPA sample)

# Results: convergent and discriminant validity

## Cognitive Abilities

Assessed using the International Cognitive Ability Resource (ICAR)

- Most strongly related to general ability and verbal ability
- Not as strongly related to the cognitive abilities as they are to each other




(SAPA sample)

# Results: convergent and discriminant validity

## Majors and Occupations

### Majors (N = 137)

| Major | Ability and Percentile | |
|---|---|---|
| | Associative | General |
| Classical Languages (Latin and Greek) | 0.99 | 0.95 |
| American Studies | 0.97 | 0.71 |
| Spanish | 0.97 | 0.78 |
| Comparative Literature Studies | 0.96 | 0.77 |
| Slavic Languages | 0.95 | 0.79 |
| Fiction Writing | 0.95 | 0.70 |
| Anthropology | 0.94 | 0.86 |
| Neuroscience | 0.93 | 0.99 |
| Performance Studies | 0.92 | 0.61 |
| Government | 0.92 | 0.45 |

### Occupations (N = 317)

| Occupation | Ability and Percentile | |
|---|---|---|
| | Associative | General |
| Writer | 0.94 | 0.71 |
| Physicist | 0.93 | 0.99 |
| Veterinarian | 0.93 | 0.86 |
| Editor | 0.92 | 0.83 |
| Education Administrator - Postsecondary | 0.92 | 0.92 |
| Author | 0.91 | 0.53 |
| Postsecondary Teacher - Mathematical Science | 0.91 | 0.95 |
| Postsecondary Teacher - English Language and/or Literature | 0.90 | 0.51 |
| Clergy | 0.90 | 0.75 |
| Political Scientist | 0.89 | 0.85 |

(SAPA sample)

# Conclusions

The validity of the CRA items is well-supported

- Unidimensionality ☑
- Adequate Item-level psychometric properties ☑
- Reliability ☑
- Convergent/discriminant validity ☑

More work is needed to…

- Examine whether cognitive processes differ across response formats
- Explore the reasons for unexpected findings (e.g., positive relationship with Agreeableness)

# Limitations and Future Directions

## Limitations

- Did not include additional creativity measures
  - e.g., Divergent thinking ("How many uses can you think of for a brick?")
- Only one domain of Associative ability



Olteteanu & Zunjani (2020)

Preregistration

## Future Directions

- Multiple-choice format could be useful in Neuroimaging, and large-scale surveys, especially with multiple time points (ESM)
- IRT results suggest that items vary greatly in difficulty. The item parameters could be used to select CRA items of an appropriate difficulty level in future studies.

# Thank you!

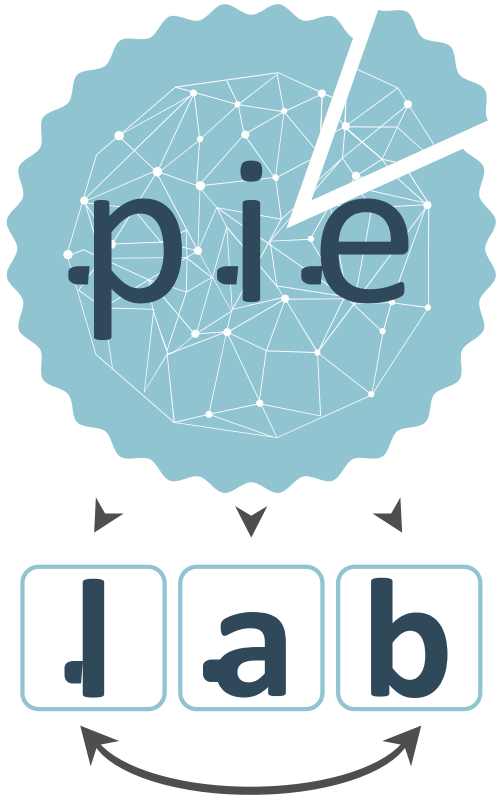
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# Questions?