

Theoretical Background

Cattell-Horn-Carroll (CHC) Model

Schneider & McGrew, 2018

In this model of cognitive abilities, general intelligence (G) is divided into several **broad cognitive abilities**, including fluid reasoning (Gf).

Gf: "the use of deliberate and controlled procedures (often requiring focused attention) to solve novel, "on-the-spot" problems that cannot be solved by using previously learned habits, schemas, and scripts."

Each broad cognitive ability is subdivided into more specific abilities or **narrow cognitive abilities**.

Important narrow cognitive abilities of Gf are:

Induction (I): "The ability to observe a phenomenon and discover the underlying principles or rules that determine its behaviour."

Deductive reasoning (RG): "The ability to reason logically using known premises and principles."

Original Test

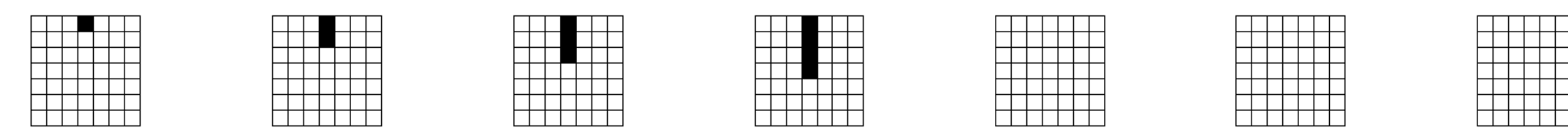
COVAT-3

Magez, Van Parijs, Joris & Tierens (under development)

- Flemish cognitive ability test based on the CHC model
- Series of proctored, classical subtests
- Developed in an educational context
- 3 subtests concerned with Gf, including Pattern Sequences (*Patroonreeksen*)
- Instruction videos

Pattern Sequences (*Patroonreeksen*, experimental version):

- **Measurement goal:** Fluid reasoning (induction & deductive reasoning)
- **Task:** discover the underlying rules of pattern sequences and use these rules to continue the sequences
- **Number of items:** 56
- **Max. test time:** 75 minutes



Aim

Unproctored test for selection and assessment contexts

In 2020 Cebir and Thomas More – Care and Well-Being Expertise Unit started a collaboration to adapt the COVAT-tests to enable remote online testing of adults in selection and assessment contexts.

The COVAT_SPACE OL was the first test resulting from this collaboration. This test measures visual processing (Gv) and was released in 2021.

The next step was to develop the COVAT_PATTERN, on the basis of the Pattern Sequences test.

COVAT_PATTERN:

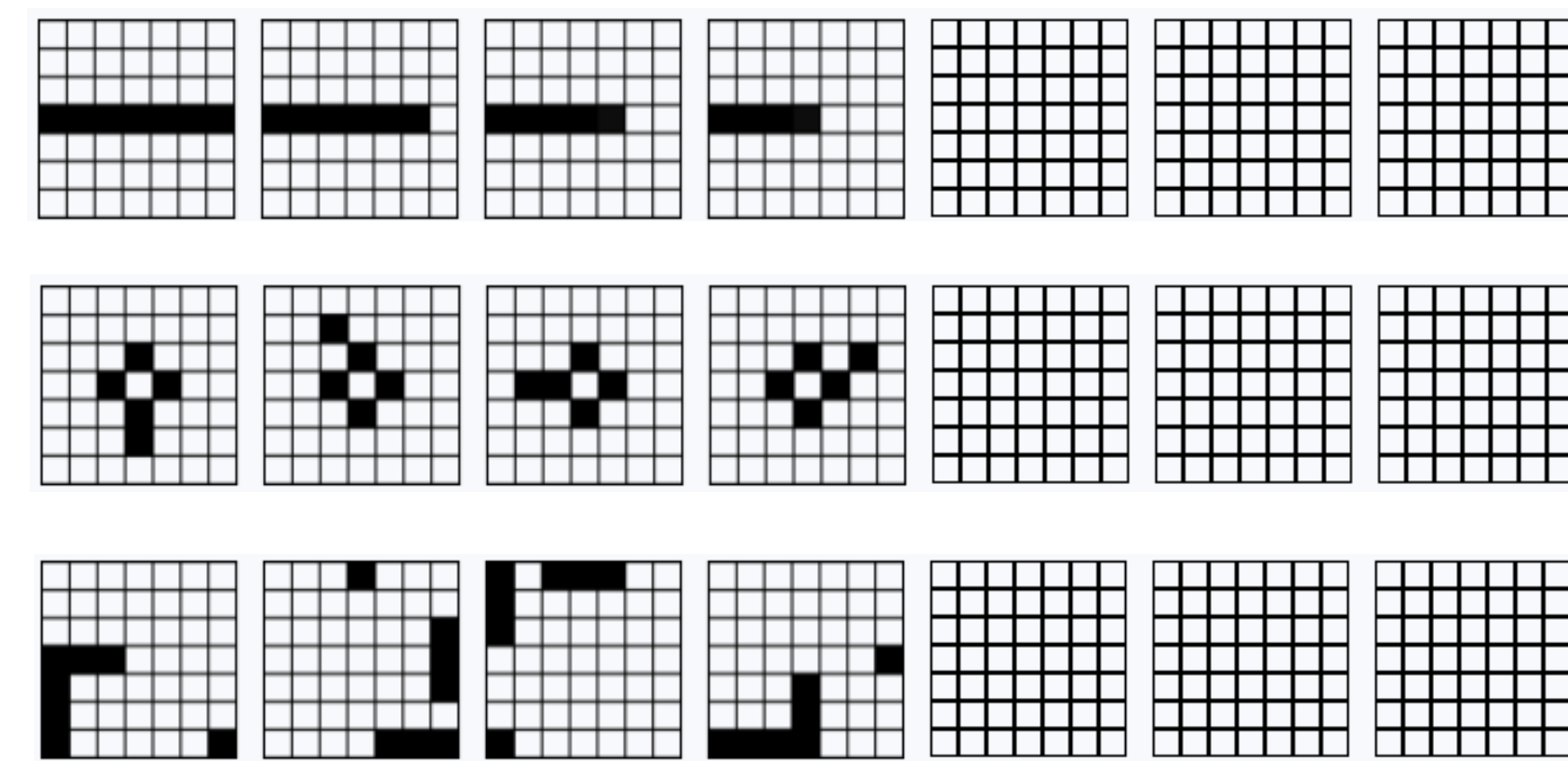
- **Aim:** Computerised adaptive test (CAT)
- **How:**
 - Rasch analysis of data to determine item parameters
 - Creation of large item bank

Step 1: Create COVAT_PATTERN OLX

Item bank (COVAT-3 items)

56 COVAT-3 items

Welke figuren moeten in de lege rasters komen?



Procedure

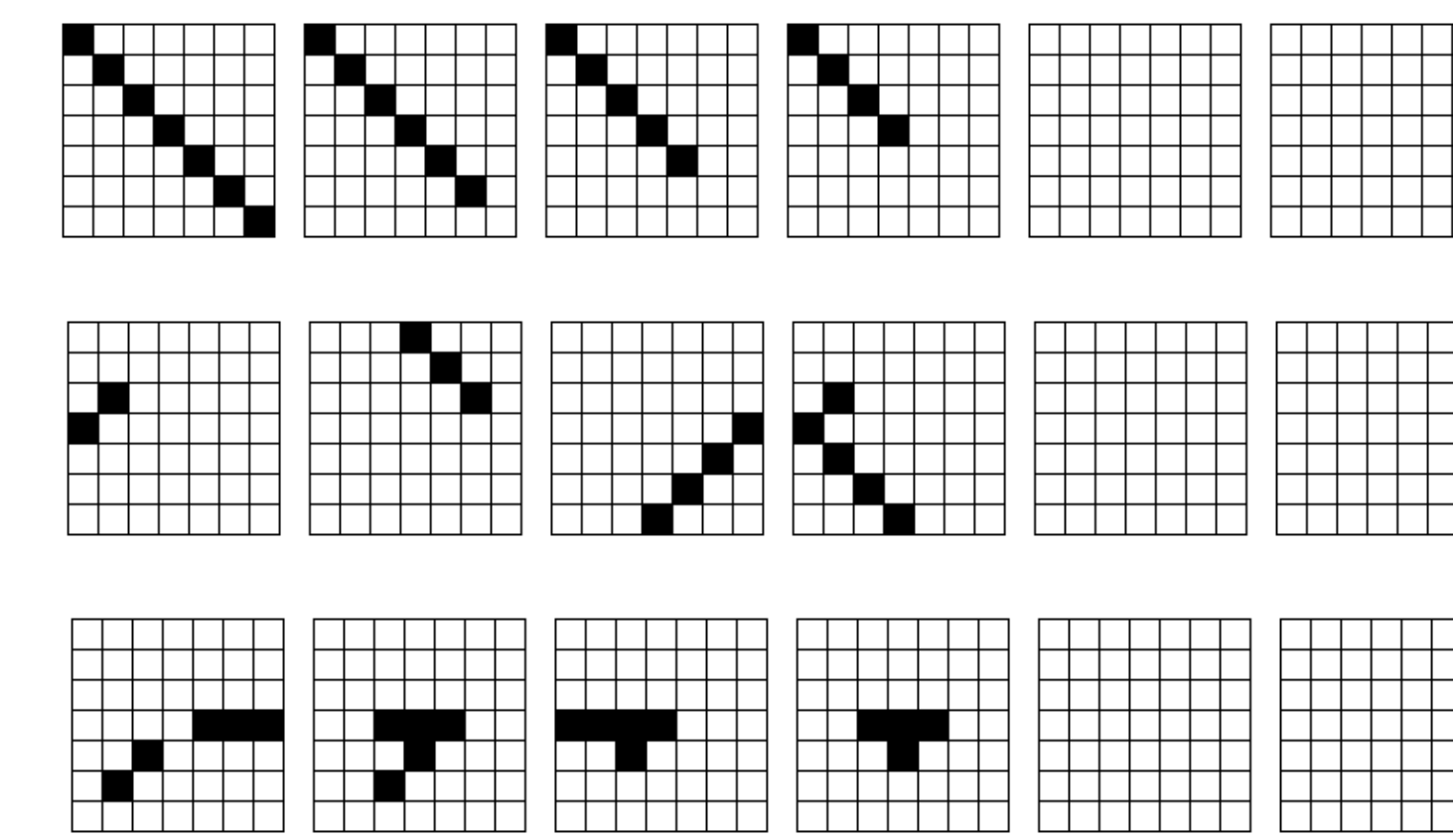
- Participants: N = 193
- 3 anchor items
- Max. number of items: 56
- Max. test time: 30 min.
- Task: complete sequences
- Combined with testing of 2 related tests:
 - Graph interpretation (ITG OL)
 - Figural-abstract reasoning (Intel OL)

Step 3: Create experimental items

Item bank (experimental items)

- 10 adapted COVAT-3 items
- 45 new items

Welke figuren moeten in de lege rasters komen?

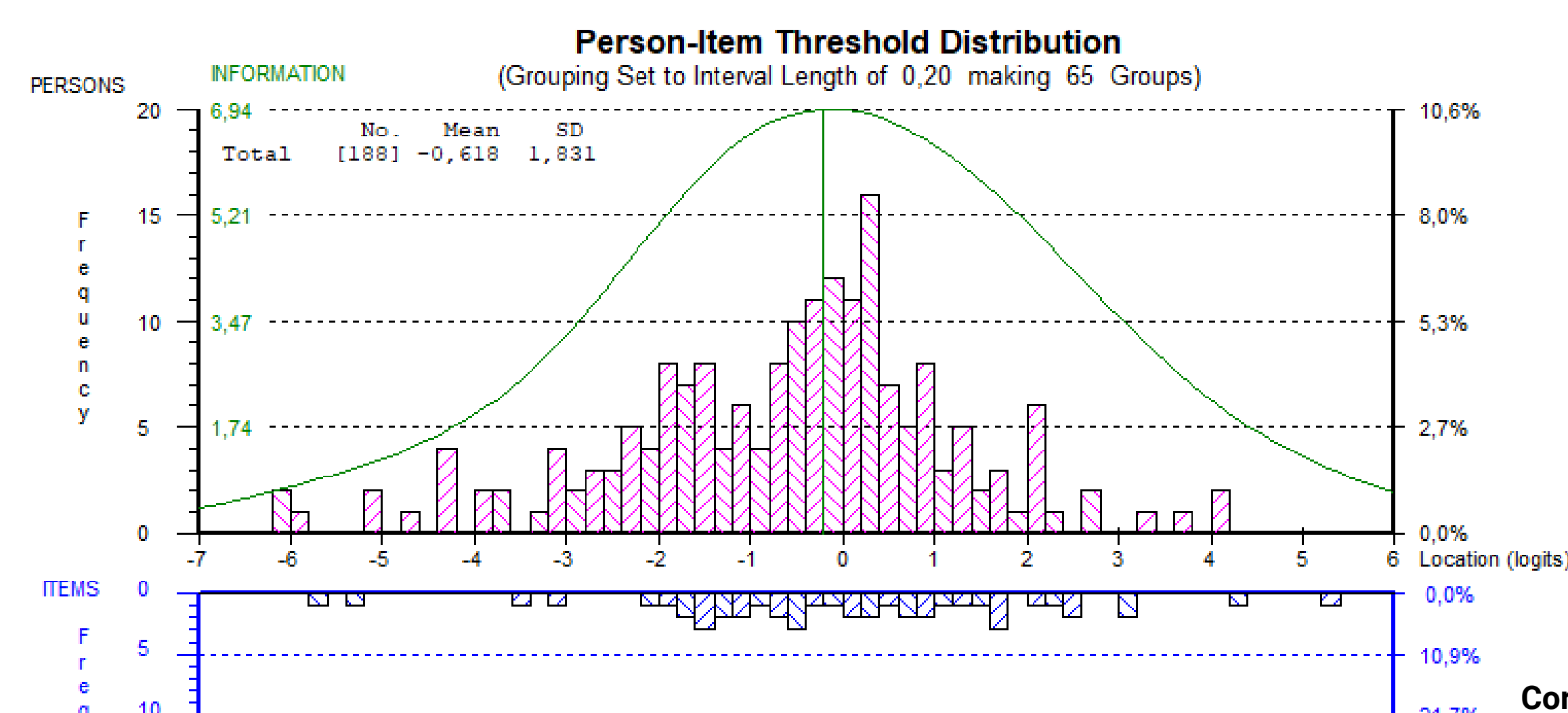


Procedure

- Participants: N = 19
- 4 anchor items
- Number of items: 59
- No max. test time
- Task:
 - complete sequences
 - rate difficulty

Step 2: Analyse COVAT_PATTERN OLX data

Rasch Analysis (COVAT-3 items)

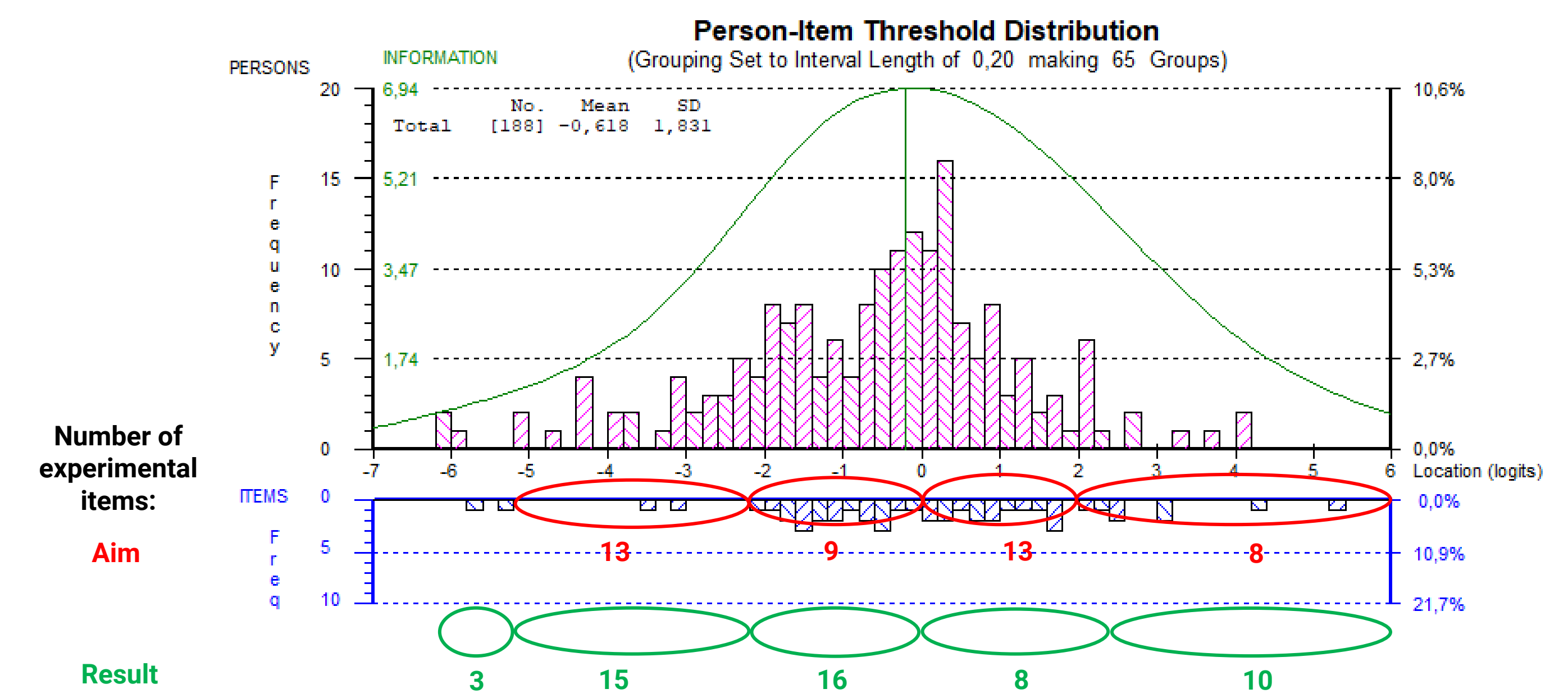


Results

- 10 items excluded: to be adapted
- Normal distribution of person abilities (thetas)
- Especially items of lower or average difficulty needed
- To reduce response time: number of response grids reduced from 3 to 2

Step 4: Create COVAT_PATTERN

Interpolation of experimental items with COVAT-3 items



Results

- 52 experimental items selected
- Good coverage of abilities by items

Test type: Computerised adaptive test

Item bank: 98 items

Max. number of items: 30

Max. test time: 25 minutes

Final Test

COVAT_PATTERN

Instructions: animated videos

Main measurement: Pattern Sequences = measurement of fluid reasoning ability

Norm groups: based on education level

Estimated reliability: > .80

Validity:

- medium to strong correlations with related tests
- clear effect of education on results

Conclusion

The COVAT_PATTERN test evaluates **fluid reasoning ability** by presenting candidates with pattern sequences constructed according to one or more rules. Candidates have to discover these rules (induction) and continue the pattern sequences based on these rules (deduction).

The original COVAT-3 subtest was adapted to allow for unproctored online testing: Pattern Sequences was transformed into a *computerised adaptive test*.

The extension of the item bank (from 56 to 98 items of a wide range of difficulties) now makes it possible to estimate a wide range of participant abilities.

Thanks to these adaptations, **quality assessment of adults' fluid reasoning ability** is now possible **within selection and assessment contexts**.

Future Perspectives

Further Collaboration Cebir – Thomas More

The original COVAT-3 test also contains other subtests for fluid reasoning, and subtests for **other broad cognitive abilities**, such as comprehension-knowledge (*crystallised intelligence*), working memory capacity, learning efficiency ... These subtests will be adapted as well within the collaboration between Cebir and Thomas More – Care and Well-Being Expertise Unit.

Currently, 4 COVAT-3 subtests are being developed: 2 subtests for the evaluation of **fluid reasoning (Gf)** and 2 subtests for the evaluation of **comprehension-knowledge (Gc, crystallised intelligence)**. Both Dutch and French versions of the verbal subtests used to evaluate Gc are being developed. The subtests are currently in various stages of development:

- Dot Sequences (Gf: *Puntreeksen*): data analysis
- Reasoning with Shapes (Gf: *Symbol Redeneren*): data collection
- Antonyms (Gc: *Tegenstellingen*): data collection
- Cloze (working title of new Gc-subtest): item creation

The collaboration between Cebir and Thomas More – Care and Well-Being Expertise Unit will thus result in a test battery based on the influential CHC-theory of cognitive abilities. The availability of this test battery in the selection and assessment domain is an important step in **improving the scientific basis of cognitive ability evaluation in selection and assessment procedures**.

References

- Magez, W., Van Parijs, K., Joris, S., & Tierens, M. (under development). COVAT-3. Psychodiagnostisch Centrum, Toegepaste Psychologie, Thomas More Antwerpen.
- Magez, W., & Tierens, M. (2016). *Moelijkheidsgraden van items, subtests en BCV met duiding voor de praktijk*. Psychodiagnostisch Centrum, Toegepaste Psychologie, Thomas More Antwerpen.
- Schneider, W. J., & McGrew, K. S. (2018). The Cattell-Horn-Carroll theory of cognitive abilities. In D. P. Flanagan & E. M. McDonough (Eds.), *Contemporary Intellectual Assessment: Theories, Tests and Issues* (4th ed., pp. 73-163). New York, NY: Guilford Press.