El mohtaref journal of sports Science.Social And Human Science *vol (11) N° (03) (2024)*
p762-746

Search information

Received ....
Accepted30/06/2024

Printed ISSN: 2352-989X
Online ISSN: 2602-6856
21350880015:رقم الهاتف

Unveiling the psychometric properties of the BONNARDEL non-verbal reasoning test: A Rasch model Analysis

SNOUSSAOUI OkkachaBachir[1*]

[1] **Oran university (Algeria),snoussaoui.bachir@univ-oran2.dz**

ABSTRACT

This study aims to unveil the psychometric properties of the Bonnardel non-verbal reasoning test using a Rasch model analysis. The sample consistsof 404 students from the Oran University of Algeria, measured by SPSS and Winsteps programs. The results showed the items score fit well the Rasch model, high levels of unidimensionality, reliability, and separation coefficients were also found to be satisfactory, indicating the test's consistency and ability to differentiate between individuals with varying levels of non-verbal reasoning and providing valuable insights for researchers, practitioners, and test developers in the field of general intelligence factor measurement and highlighting the test potential as a robust and accurate assessment tool for evaluating cognitive abilities.

Keywords:Raschanalysis; Non-verbal reasoningtest;Unidimentiality; Reliability, Validity, Wright map.

[*] *SNOUSSAOUI Okkacha Bachir* *snoussaoui.bachir@univ-oran2.dz*

INTRODUCTION

The study of general intelligence measurement has been a captivating and multifaceted area of interest, captivating the attention of psychologists and scholars alike for decades. With its potential to evaluate cognitive abilities with exceptional precision and depth, the intelligence test has garnered significant attention in the field. In this comprehensive examination, we aim to lay the groundwork for a thorough exploration of the psychometric properties of the non-verbal reasoningtest. Through a meticulous and systematic approach, we seek to unravel the intricate measurement characteristics of this widely recognized assessment tool. By doing so, we hope to contribute to the existing body of knowledge and shed light on the effectiveness and reliability of the Bonnardelnon-verbal reasoningtest as a tool for assessing general intelligence factor.

1. History of Intelligence:

The concept of intelligence has been studied and debated for centuries. However, it was in the field of scientific psychology that the notion of intelligence began to take shape. First with Francis Galton, who argued that cognitive ability was hereditary and normally distributed in the population (Chamorro-Premuzic and Furnham, 2005)

Galton's work laid the foundation for further research in measuring individual differences in cognitive ability. Subsequently, the use of psychometric instruments, such as intelligence tests, emerged as a means to assess and predict an individual's future scholastic and occupational success, and many psychologists and researchers have since contributed to the development of intelligence tests and theories. The psychological concept of intelligence is complex and multifaceted.The history of defining intelligence is a fascinating journey that has evolved over time. The concept of intelligence has been explored and debated by scholars and researchers from various fields:

- Binet (1916) defined it as the capacity to judge well, toreason well, and to comprehend well.
- Thurstone (1921) defined it as the capacity to inhibit instinctive response, imagine a different response, andrealize the response modification into behaviour intelligence testing.
- Spearman (1923) defined it as a general ability involving mainly the ability to see relations and correlates.

• Wechlser (1939) defined it as the global capacity of an individual to act purposefully, think rationally, and dealeffectively with the environment.
• Piaget (1972) defined it as referring to the superior formsof organization or equilibrium of cognitive structuring usedfor adaptation to the physical and social environment.
• Sternberg (1985) defined it as the mental capacity toautomatize information processing and to emit contextually appropriate behavior in response to novelty
• Gardner (1986) defined it as the ability to solve problemsor fashion products valued within some setting.
The American Psychological Association (APA) provides the recent definition of intelligence: The ability to derive information, learn from experience, adapt to the environment, understand, and correctly utilize thought and reason.

2. The Rasch model:

Despite the availability of various statistical methods to measure the general intelligence, the Rasch model continues to hold a prominent position due to its unique advantages in analysing data, and can be defined as follows:

The Rasch modelis a mathematical and theoretical framework used in psychometric to analyse and interpret data from tests and surveys. The Danish mathematician Georg Rasch developed it. The model allows researchers to measure a single variable along a continuum, such as knowledge or attitudes, and to evaluate the difficulty of test items or survey questions. It also provides a way to convert raw scores into a linear scale, allowing for more accurate measurement and comparison of individual performances. The Rasch model is widely used in educational and social science research to improve the quality of measurement instruments and make meaningful inferences about individuals and groups. (Boone, 2016)

2.2 Applying the Rasch model analysis on tests:

The Rasch model analysis provides a modern approach to a psychometric assessment that can offer insights not provided by traditional methods **(**Jabir, 2013).This type of analysis ensures that the fundamental scaling properties of the test are assessed, and can determine whether all items in the test capture a single underlying construct. This analysis can be crucial in determining the overall validity and reliability of the test. The Rasch analysis can be applied to the non-verbal reasoningtestin order to conduct a comprehensive psychometric assessment of its validity and reliability to obtain a scale that meets rigorous test development.The Rasch analysis includes evaluating the fit of the test items/ person, unidimentiality, reliability and separation and the Wright map:

2.2.1INFIT and OUTFIT:

In the Rasch model, INFIT and OUTFIT are two types of statistics used to analyse how well individual items or respondents fit the model's expectations:

- OUTFIT (Outlying sensitive Fit) is sensitive to unexpected behaviours affecting responses to items far from the person's ability level. It can be influenced by random guesses or slips on items that are either too hard or too easy for the person.
- INFIT (Information-weighted Fit) is an information-weighted mean square error statistic. It is more sensitive to unexpected behaviours on items near the person's ability level. It reflects patterns in the residuals related to items that a person is expected to answer correctly or incorrectly, based on their estimated ability level.

Both statistics are reported in mean square units (MNSQ), and measure fit by comparing observed responses to what the model predicts. Ideal INFIT and OUTFIT MNSQ values indicate a perfect model prediction. If these values significantly deviate, it suggests that the data are not fitting the model well. (Linacre, 2023)

Mean-square value implication for measurement

> 2.0 Distorts or degrades the measurement system. May be caused by only one or two observations.

1.5 - 2.0 Unproductive for construction of measurement, but not degrading.

0.5 - 1.5 Productive for measurement.

< 0.5 Less productive for measurement, but not degrading. May produce misleadingly high reliability and separation coefficients.

Standardized value implication for measurement

≥ 3 Data is very unexpected if they fit the model (perfectly), so they probably do not. But, with a large sample size, substantive misfit may be small.

2.0 - 2.9 Data is noticeably unpredictable.

-1.9 - 1.9 Data have reasonable predictability.

≤ -2 Data are too predictable. Other "dimensions" may be constraining the response patterns. (Linacre,2002 :p878)

2.2.2 Unidimentiality in the Rasch model:

The principle of unidimensionality is vital for measurement because it ensures that the test or questionnaire is coherent and that it accurately reflects the ability or trait that it is supposed to measure. When a test is unidimensional, it allows for greater confidence that the total score can be interpreted as a measure of the underlying trait of interest. It also simplifies the interpretation of results and facilitates the comparison of scores between individuals. If the requirement of unidimensionalityis not fulfilled, it may mean that the test is measuring more than one construct, which can complicate the interpretation of the results and reduce its validity. (Bond and Fox, 2001)

Unidimensionality in the context of the Rasch model refers to the assumption that a single common trait or ability underlies responses to all items in a test or questionnaire. That is each question or task measured only one attribute or dimension (e.g., mathematical ability, reading comprehension). This attribute is assumed to uniformly influence responses across all items.For example, if we were using a Rasch model to analyse data from a mathematics test, unidimensionality would assume that all questions on the test are essentially measuring the same underlying trait—mathematical ability. It is an important characteristic because it allows for a simpler interpretation of a person's abilities based only on their total score across all tasks or items. It is worth noting that there are often debates about how strictly unidimensionality needs to be adhered to. Some real-world data may slightly violate this assumption due to the complexity of human abilities and behaviours. (Linacre, 2023)

2.2.3 Validity and reliability:

In classicaltheory, there are two essential elements of test quality in research and assessment:

- Validity: The validity of a test refers to the degree to which it measures what it is supposed to measure. For instance, if a test is designed to measure a specific skill or knowledge area, it's considered valid if it accurately assesses that skill or knowledge. Various types of validity are often considered, including content validity (items adequately measure the intended concept), predictive validity (test predicts future outcomes), and construct validity (test measures the theoretical trait, it's designed to measure).

- Reliability: Reliability refers to the consistency and repeatability of the test's results. If a test is reliable, it should yield similar results under consistent conditions. There are several types of reliability, including internal consistency reliability (items on a test consistently measure the same concept), test-retest reliability (test provides consistent results over time), and inter-rater reliability (different testers score responses in the same way). Both validity and reliability are essential for a test to be considered trustworthy and useful. Without validity, the test does not accurately measure what it's supposed to, and without the reliability, the results are inconsistent and not repeatable.

But in the theory of Rasch analysis specifically, reliability and validity are evaluated in slightly different ways. Rasch analysis used to evaluate the fit of items to a measurement model and assess the reliability and validity of a test, this model provides several advantages, such as estimating the ability of an individual independently of the specific items on a test and the difficulty of the test items independently of the particular group of individuals that took the test. It enables the creation of instruments that have interval-level measurement properties, making it beneficial for psychological and educational testing. Overall, Rasch analysis ensures that the items work the same way across different individuals and groups, supporting fairness and comparability. (Strobl et al., 2013)Additionally, the items and person separation are evaluated to determine the extent to which the items discriminate between individuals with different levels of intelligence, while also verifying the test's ability to accurately measure and differentiate individuals' abilities.(Ariffin et al., 2010)

2.2.4The Wright map:

The Wright map or items-person map is a graphical representation used in Rasch Analysis to assess the relationship between item difficulty and person ability. It displays the location of items and persons on a continuum based on their logit measures. The map helps visualize the distribution of item difficulty and person ability, with more difficult items located at the top and easier items at the bottom. Persons with higher ability are positioned towards the top, while those with lower ability are towards the bottom. The map also includes a dashed line representing the mean value for items and persons, with standard deviations indicated by the letters S and T. The Wright map provides valuable insights into the level of conceptual understanding of individuals and can be used to identify challenging items and areas where improvement is needed. (Abdullah et al., 2017)

3. The Rasch model in practice:

The Rasch analysis is a statistical technique that is commonly used to assess the psychometric properties of educational and psychological tests, including their reliability and validity, as well as to evaluate the measurement precision of individual items and examine differential item functioning, such as the presence of bias in item responses across different groups, such as age groups or gender. The Rasch model is particularly useful when analysing data scored in a dichotomous format, as it provides a rigorous and objective method for evaluating test performance (Wardhani et al., 2017).Using the Intelligence test in educational settings can provide valuable insights into students' non-verbal cognitive abilities and inform instructional practices and interventions. By administering this test, educators can gain a deeper understanding of students' visual memory, visual discrimination, visual organization, and visual association skills. This information can be used to tailor instruction to meet the specific needs of individual students, identify areas of strength and weakness, and develop appropriate educational strategies and interventions. (Mungkhetklang, et al., 2016).

To analyse a test using the Rasch model, researchers have a variety of options for software programs. One popular choice is Winsteps, which allows researchers to generate item characteristic curves that illustrate the relationship between item difficulty and the probability of a correct response. These curves provide valuable insights into how well each question performs in terms of its level of difficulty and ability to discriminate between different levels of proficiency or knowledge.

3.1Test definition: The Bonnard non-verbal reasoning intelligence test B53 is a standardized cognitive assessment tool that measures an individual's non-verbal reasoning. The test was created by Bonnardel and is used for evaluating intellectual abilities in the non-verbal modality.One of the key advantages of the test is that it does not rely on verbal language abilities, making it suitable for individuals with various linguistic backgrounds or those who have difficulty with expressive or receptive oral communication. This non-verbal test assesses the individual's ability to apply fluid reasoning skills in problem-solving tasks.This assessment evaluates the individual's inductive reasoning in the non-verbal modality and measures their intellectual capacity in solving logical problems. (Bonnard, 1954)

3.2Developer of test: Raymond Bonnardel is a French psychology standacademic, he is known as a specialist in psychometrics, who developed many tests like BLS4 non-verbal intelligence/Intellectual potential, BV8 vocabulary comprehension test and B53 non-verbal reasoningintelligence test. (Reuchlin, 1989)

3.3Winsteps program:Winsteps constructs Rasch measures from simple rectangular data sets, it is straightforward to use in combination with other software. Item types that can be combined in one analysis include dichotomous, multiple-choice, multiple rating-scale and partial credit items. Paired comparisons and rank-order data can also be analysed. Missing data is no problem. Winstepsis designed as a tool that facilitates exploration and communication. The structure of the items and persons can be examined in depth. Unexpected data points are identified and reported in numerous ways. Powerful diagnosis of multidimensionality through principal components analysis of residuals detects and quantifies substructures in the data. The working of rating scales can be examined thoroughly, and rating scales can be recoded and items regrouped to share rating scales as desired. Measures can be fixed (anchored) at pre-set values. Winstepsis intended for practitioners who must make practical and quick decisions along the path to constructing effective tests, and who must then communicate their results useful to end users. The developers of Winsteps use the program daily in their own work and are continually adding new features as a result of their own experience and feedback from users. Typical applications include educational tests, psychological assessments, attitude surveys, patient performance protocols, and calibrating adaptive test item banks. Winsteps can process up to 9,999,999 persons, 60,000 items, and each item can have a rating, grouped rating or partial-credit scale of up to 32,767 categories. Training courses are held regularly.

Another common is the R package, which provides tools for item calibration and fit analysis, used option by utilizing these software programs, researchers can gain a deeper understanding of their assessment instrument's quality, reliability, and validity.(Christopher and Joseph, 2022)

There are also many programs available for conducting Rasch analyses like RUMM, JMetric, BILOG and ConQuest.

Incorporating the Bonnardel test into work placement and career assessment programs can offer valuable insights into an individual's non-verbal cognitive abilities. This information can be vital in assessing their compatibility with specific occupations or fields of study that place less emphasis on verbal skills, such as visual arts, engineering, or tasks involving spatial reasoning. Non-verbal cognitive abilities are essential for success in these domains, as they require individuals to think critically and problem-solve using visual cues rather than relying heavily on language. The Bonnardel Test evaluates an individual's aptitude for fluid reasoning within a non-verbal context. By incorporating this test into assessment programs, employers and educators gain a deeper understanding of a person's intellectual capabilities when it comes to logical problem solving.This comprehensive evaluation provides crucial information in determining whether someone is well-suited for certain careers or areas of study that rely more on non-verbal thinking skills and personality. (BurrusWay, 2017)

4. Practical side of the study: The evaluation of Bonnardel test of non-verbal reasoning is necessary for several reasons. Provides valuable insights into a student's smooth thinking skills and non-verbal problem-solving abilities, and helps with educational planning and intervention strategies. In addition, assessing the reliability and validity of the test ensures a consistent measurement of non-verbal reasoning, resulting in accurate and reliable results and this is what has drawn our attention to its application in this study.

4.1 Method: The present study employed Rasch analysis to uncover the test's psychometric properties. Through the application of Rasch analysis, our objective was to assess the measurement precision, item fit, and unidimensionality of the test. This comprehensive analysis aimed to provide valuable insights into the reliability, validity, and separation and utilize the Wright map of the test.

4.2 Participants: A group of 404 students, ranging in age from 18 to 45 years, from the Oran University in Algeria participated in this study. The participants were drawn from various academic disciplines, ensuring a diverse representation. Prior to their involvement, all individuals provided informed consent, demonstrating their willingness to contribute to the research. By including a broad range of specialties, this study aims to capture a comprehensive understanding of the topic under investigation.

4.3 Data collection: Data for this study was collected from a carefully selected sample of participants who completed the non-verbal reasoning test. To ensure data accuracy, the collected information was initially processed using the SPSS program for data cleaning and preparation. Subsequently, the Rasch analysis technique was employed, utilizing the WINSTEPS program, to thoroughly analyse the data. Through this meticulous approach, we aim to uncover valuable insights into the psychometric properties of the non-verbal reasoning test, enabling us to gain a comprehensive understanding of its effectiveness and reliability. By utilizing these sophisticated software tools, we can ensure a rigorous and systematic analysis, providing robust findings from our study.

5. Results and discussion: Statistical analysis was to determine the psychometric properties of the Bonnardel non-verbal reasoning test, Rasch analysis was used, which allows for the examination of the item/ person fit, unidimensionality, separation, and reliability of items/ person, finally measure the difficulty of items and the person's ability in Wright map.

5.1 Fit statistic (item/ person): The misfit of items and persons was assessed to determine if the test items were functioning as expected and if the individuals' responses were consistent with their ability level. The Rasch analysis also allows for the evaluation of item and person separation, which assesses the extent to which the test items can differentiate between individuals with different levels of ability.

Table 1: The misfit of items

Item	Total of items
Items fit (acceptable)	**60**
Items fit (no acceptable)	**00**

Source: WinstepsProgram

From the results of the items FIT analysis, we show in Table N 1, that all the test items (60 items) are within the accepted zone of the Linacre standard, however, at different levels of difficulty, which we will check later on the Wright map.Based on the results of the Rasch analysis, the goodness of fit statistics, including items infit and outfit indicates that all the items in the Bonnardelnon-verbal reasoning test display good fit with the Rasch model.This suggests that these items effectively measure the intended constructs and contribute to the unidimensionality of the test.

Tabel 2: The misfit of person

Person	Total of person
Person fit (acceptable)	**386**
Person fit (no acceptable)	**18**

Source: WinstepsProgram

From the results of the person FIT analysis of 404 students, the results presented in this table show that there are à number of students whose answers are classified outside the aforementioned standard (in the theoretical part). The results of these individuals are considered to be distorted by the measurement results, which will be deleted and continue theanalyse with 386 persons.

The person deleted is (311, 325, 340, 58, 280, 156, 100, 361, 98, 287, 258, 374, 154, 265, 10, 78, 341, 259)

5.2 Unidimensionality:

The outcome of unidimensionality is in this table:

Table 3: Unidimensionality

```
INPUT: 404 PERSON  60 ITEM  REPORTED: 386 PERSON  60 ITEM  2 CATS WINSTEPS
--------------------------------------------------------------------------

     Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                           -- Empirical --    Modeled
Total raw variance in observations     =       136.2 100.0%         100.0%
  Raw variance explained by measures   =        78.2  57.4%          56.6%
    Raw variance explained by persons  =        23.5  17.2%          17.0%
    Raw Variance explained by items    =        54.7  40.2%          39.6%
  Raw unexplained variance (total)     =        58.0  42.6% 100.0%   43.4%
    Unexplned variance in 1st contrast =         3.1   2.3%   5.4%
    Unexplned variance in 2nd contrast =         2.5   1.8%   4.2%
    Unexplned variance in 3rd contrast =         2.3   1.7%   4.0%
    Unexplned variance in 4th contrast =         2.0   1.5%   3.5%
    Unexplned variance in 5th contrast =         1.8   1.3%   3.1%
```

Source: WinstepsProgram

Based on the information in the table above., we note that the factor variance explained by measures estimated at 57.4% Which is a strong indication of the unidimentialityof the indicators determined by (Reckase, 1979) Strong ≥40%30،% moderate level,≤20% minimum, and through other tests measured as the variability value of other factors, which should be less than (5%) The first test in this study is 2.9%, and that is another proof. The second test must not exceed the proportion (3%) The result here is estimated at (2.5%), which is also evidence, and from which all indicators are sufficient evident that the test is predominantly after one, according to Rasch indicators. This confirms our hypothesis that the test of Bonnardel is available on a one-dimensional feature based on the assumption required by the use of the Rasch model applied to Algerian students.

The result of unidimensionality: The Rasch analysis revealed that the Bonnardel non-verbal reasoning test demonstrated a good percentage of unidimensionality, indicating that the test measures a single underlying construct of non-verbalreasoning it is focused on assessing a specific aspect of cognitive ability and is not influenced by other unrelated factors.

5.3 Reliability and separation of items/ person:

The items/person separation index was used to indicate how efficiently in the measure, with higher value indicates better separation.

Table N 4: Person/ item separation and reliability

PERSON 404 INPUT 386 MEASURED					INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	89.2	60.0	-.27	.43	.99	-.2	1.17	.1
S.D.	8.8	.0	1.42	.07	.36	1.5	1.55	1.3
REAL RMSE .43	TRUE SD 1.35		SEPARATION 3.12		PERSON RELIABILITY .91			
ITEM 60 INPUT 60 MEASURED					INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	573.9	386.0	.27	.27	.98	-.2	1.56	.9
S.D.	129.7	.0	3.16	.34	.12	1.6	1.75	2.3
REAL RMSE .43	TRUE SD 3.13		SEPARATION 7.23		ITEM RELIABILITY .98			

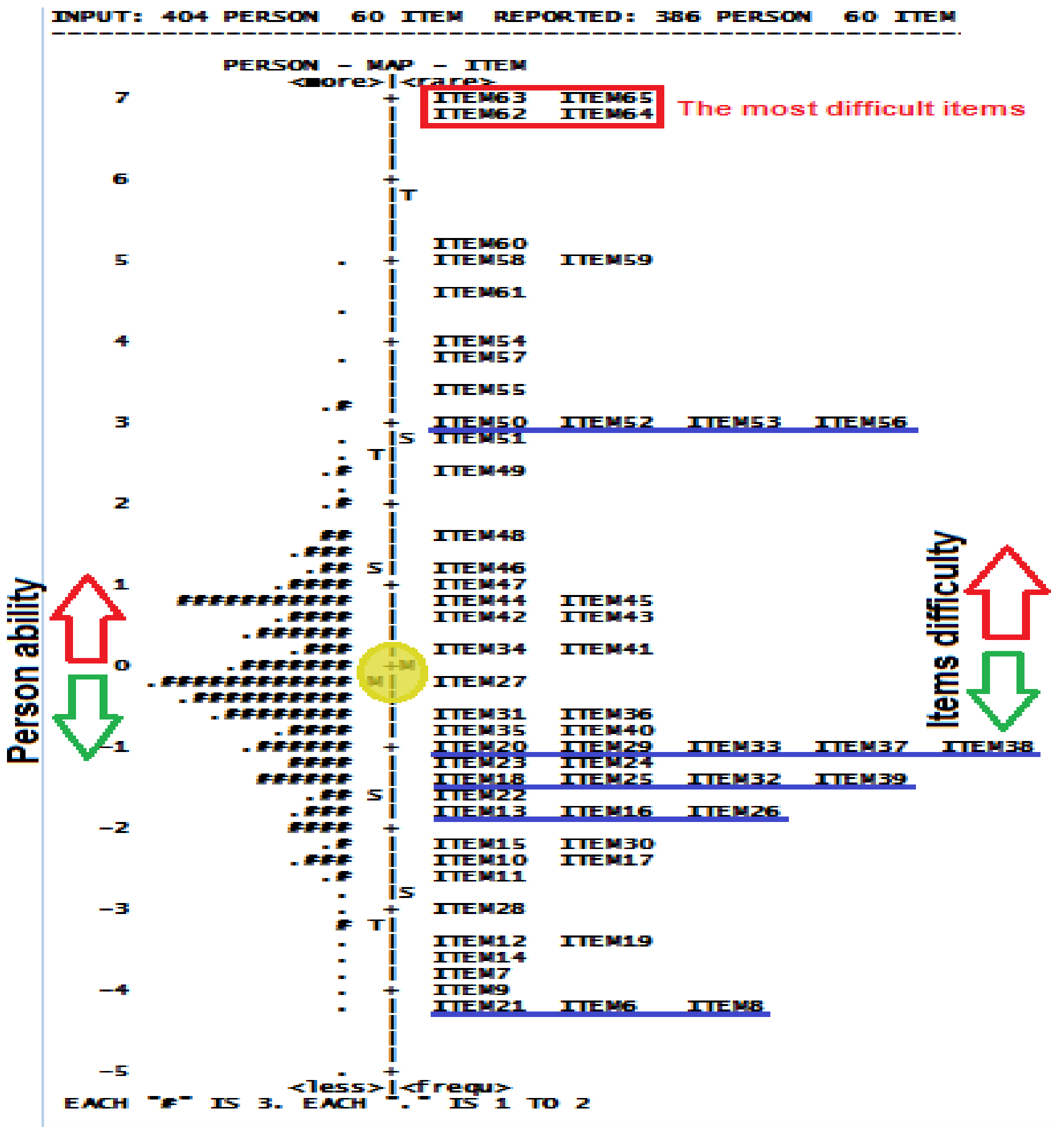
Source: WinstepsProgram

The items separation in this study is 7.23, and the person separation is 3.12 Values between 2.0 and 3.0 are considered to be acceptable and value higher than 3.0 suggests an excellent level of separation.

The reliability, separation analysis for the Bonnardel intelligence test indicates a high level of differentiation among individuals with varying levels of cognitive abilities. The separation index, which measures the ability of the test to distinguish between different levels of ability, is found to be above the recommended threshold. This suggests that the test provides reliable and precise measurements of cognitive abilities, allowing for effective differentiation between individuals with different levels of cognitive functioning.

5.4 Wright map:

Fig 1. Wright -map of person's ability and items difficulty



Source: WinstepsProgram

Wright map: The Rasch model analysis allows to allocate item difficulties and person abilities on the same interval scale, which can be used as a guide to revise or refine the test items. In Figure 1 are the item-person map for the person's ability (the left panel) and set of threshold parameter estimates of item difficulty (the right panel) on the same “logit” scale, (M in yellow) is the average (left is an average of a person’s ability) and (right is average of items difficulties).In addition, there were suitable items to discriminate persons whose ability fell into the extreme ability level (ability level between 4 and 5 logit), the range of item difficulties (in red) could not cover that person ability.

The Wright map also highlights the alignment between participants' abilities and item difficulties. Participants with higher ability levels are positioned closer to the more challenging items, while those with lower ability levels are closer to the easier items. This indicates a good match between participants' abilities and the difficulty of the test items.

Overall, the Wright map demonstrates that the Bonnardelnon-verbal reasoningtest is effectively measuring participant’s abilities and assessing a wide range of cognitive functioning. The distribution of participants and items along their respective continua displays the test's ability to provide accurate and meaningful measurements of cognitive abilities.

6. Conclusion:

Our study highlights that a robust statistical technique in terms of Rasch model analysis was used to rigorously examine the psychometric properties of the Bonnardel test. The Rasch model facilitates the disclosure of measurement problems that may not be easily detected by traditional analyses. In the Rasch model, fit analysis (in/outfit) is statistics used to analyse how well individual items or respondents fit the model detect the items or persons classified outside the standard and remove them, like the persons removed from this study. Then calculate the unidimentionality and the result that the model assumes that a single dominant latent trait influences responses to items like the results of this study.

Also, the Rasch analysis allows for the evaluation of item and person reliability and separation indices to assess the internal consistency and measurement precision of the Bonnardel test, the index indicates acceptable results for reliability and separation. Then estimates of item difficulty, and person ability by Wright map and in an ordered continuum that enables the examination of the hierarchical structure, targeting, and floor effects. Finally, based on the findings from the Rasch analysis, it can be concluded that the Bonnard non-verbal reasoning intelligence test B53 is indeed valid and reliable. The Rasch analysis provided evidence supporting the test's psychometric properties, demonstrating its ability to accurately assess intelligence. The test's validity was confirmed through measures such as construct validity, while its reliability was established through the assessment of measurement precision and item fit. Therefore, the Bonnardel non-verbal reasoning Test can be considered a robust psychometric instrument for measuring non-verbal reasoning general intelligence.

Bibliography List:

1. Abdullah, N., Noranee, S., &Khamis, M. R. (2017). The Use of Rasch Wright Map in Assessing Conceptual Understanding of Electricity. Pertanika Journal of Social Science and Humanities, 25(S), 81-88.
2. American Psychological Association. (2017). Professional practice guidelines for integrating the role of work and career into psychological practice. Retrieved from https://www.apa.org/practice/guidelines/role-work-career(consulted on 18/11/2023).
3. Christopher, N & Joseph, P. V.(2022).Assessing Rasch measurement estimation methods across R packages with. Language Testing .Volume 39(2). Retrieved from https://www.researchgate.net/publication/358312491_Assessing_Rasch_measurement_estimation_methods_across_R_packages_with_yesno_vocabulary_test_data(consulted on 01/11/2023).
4. Ariffin, S R., Omar, B., Isa, A., & Sharif, S M. (2010). Validity and reliability multiple intelligent item using rasch measurement model. Retrieved from https://doi.org/10.1016/j.sbspro.2010.12.225(consulted on 01/11/2023).
5. Boone, W J. (2016). Rasch Analysis for Instrument Development: Why, When, and How? Retrieved from https://doi.org/10.1187/cbe.16-04-0148(consulted on 01/11/2023).
6. Bond, T. G., & Fox, C.. (2001). Applying the Rasch Model. Retrieved from https://doi.org/10.4324/9781410600127(consulted on 30/10/2023).
7. Bonnard, R.(1954). Test d'intelligence non verbale (ManuelB53).
8. Burrus, J; and Way, J; D. (2017). "Using O*NET to Develop a Framework of Job Characteristics to Potentially Improve the Predictive Validity of Personality Measures," *Personnel Assessment and Decisions*: Number 3 :Iss. 1 , Article 3.
   DOI: https://doi.org/10.25035/pad.2017.003. Available at: https://scholarworks.bgsu.edu/pad/vol3/iss1/3(consulted on 07/09/2023).
9. Chamorro-Premuzic, T., &Furnham, A. (2005). Personality and intellectual competence. Retrieved from https://doi.org/10.5860/choice.43-0625(consulted on 20/09/2023).
10. Jabir S. (2013). Assessing Improvement in Quality of Life and Patient Satisfaction following Body Contouring Surgery in Patients with Massive Weight Loss: A Critical Review of Outcome Measures Employed. Retrieved from https://doi.org/10.1155/2013/515737(consulted on 30/08/2023).
11. Linacre, J. M.. (2002). What do Infit and Outfit, Mean-square and Standardized mean? Rasch Measurement Transactions. Retrieved from https://rasch.org/rmt/rmt162f.htm(consulted on 05/09/2023).
12. Linacre, J. M.. (2023). A User's Guide to Winsteps Mini Step Rasch-Model Computer Programs. Retrieved from

https://www.winsteps.com/winman/copyright.htm(consulted on 05/09/2023).

13. Mungkhetklang, C., Bavin, E. L., Crewther, S. G., &Goharpey, N.. (2016). The Contributions of Memory and Vocabulary to Non-Verbal Ability Scores in Adolescents with Intellectual Disability. Frontiers in Psychiatry, 7. Retrieved from https://doi.org/10.3389/fpsyt.2016.00204(consulted on 09/09/2023).
14. Reuchlin, M. (1989). RAYMOND BONNARDEL 1901-1988. Le Travail Humain,*52*(3), 281–284. Retrieved fromhttp://www.jstor.org/stable/40657540(consulted on 01/09/2023).
15. Reckase. MD.,(1979).Unifactor Latent Trait Models Applied to Multifactor Tests: Results and Implications. Journal of Educational and Behavioral Statistics.Vol. 4, No.3, pp. 207-230**.** Retrieved fromhttps://www.researchgate.net/publication/250185370(consulted on 01/08/2023).
16. Strobl, C., Kopf, J., &Zeileis, A.. (2013). Rasch Trees: A New Method for Detecting Differential Item Functioning in the Rasch Model. Retrieved from https://doi.org/10.1007/s11336-013-9388-3(consulted on 01/09/2023).
17. Wardhani, D. H., Suratno, & Putra, A. P.. (2017). Characteristics of School Examination Test of Biology Subject. Retrieved from https://scite.ai/reports/10.2991/seadric-17.2017.78(consulted on 22/08/2023).
18. https://www.winsteps.com/winman/copyright.htm(consulted on 16/09/2023).
19. fromhttp://www.jstor.org/stable/40657540(consulted on 22/08/2023)