How Do We Measure Intelligence?

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Introduction

Intelligence is something that scientists have studied for centuries. From a neuropsychological standpoint, intelligence can be defined as one's abilities to adapt and change according to different environments and learn from one's experiences (Sternberg, 2012). This somewhat vague definition has led to multiple ways to measure it over the years, with each one prioritizing and measuring different aspects of cognitive function.

Alfred Binet was the father of the IQ test, working with Theodore Simon to create the Binet-Simon IQ test in 1905. This test consisted of 30 questions and had many issues as it did not consider the complexities of IQ and intelligence and therefore, could not provide a holistic result (Sternberg & Jarvin, 2015). However, this IQ test stands as the first prolific intelligence measurement exam. Consequently, it has acted as a basis for almost every IQ exam that has followed.

Some examples of IQ tests that have been derived from the Binet-Simon test are the Stanford-Binet test in 1916 (Sternberg & Jarvin, 2015) and the Army Alpha/Army Beta exams used by military generals during World War I (Warne et al. 2019). The Stanford-Binet IQ test would provide a single number, an IQ quotient, that represented an individual's place on the scale. The Army Alpha test was written, while the Beta version was pictures, for soldiers who could not read. They were used in determining what soldiers were suited for—which positions and leadership roles. However, the most prominent and used example is the Wechsler Intelligence Scale (WAIS), developed by David Wechsler (Niileksela & Reynolds, 2019), and has many uses.

IQ: An Introduction

Due to the complexity of intelligence, research on the neurobiological aspect of intelligence is reliant on two main forms of information gathering: brain imaging and genetic studies. These studies are thought to be able to help researchers learn more about higher-level cognitive processing. Several brain scans have shown that IQ scores were correlated with intracranial, cerebral, temporal lobe, hippocampal, and cerebellar volumes, which essentially makes up the entirety of the brain (Goriounova & Mansvelder, 2019). However, Voxel-based morphometry (VBM), a neuroimaging technique that allows scientists to make estimations about the spacing and distribution of differences between important or central brain regions, has been used to study IQ in the brain as well. Goriounova and Mansvelder (2019) found positive correlations between intelligence (found using the WAIS) and cortical thickness were seen in several different regions of the temporal and frontal lobes.

Studies like these show the many different parts of the brain that are affected by and interact with one another. As a result of the complex interplay between a multitude of brain regions, it is essential to utilize a complex and comprehensive IQ examination in order to best measure the trait of intelligence (Colom et al. 2010). These intricacies need to be reflected in the IQ and intelligence examinations that psychologists and neuroscientists use to study higher-order cognition.

The current most popular IQ test in usage is the WAIS-V, which David Wechsler developed to study the cognitive abilities of adults (Sternberg & Jarvin, 2015). This test provides a comprehensive measure of one's cognitive functioning in both verbal and performance situations. This scale assesses several unique types of intelligence through five main areas: Fluid Reasoning, Processing Speed, Verbal Comprehension, Visual-Spatial Ability, and Working Memory. Each of these sections contains several different tests within them. Along with these, two broader areas are scored: Full-scale IQ, which is based on the total combined performance of the past five categories and General Ability Index (GAI), which is only based on the Perceptual Reasoning Index and Verbal Comprehension Index. Together, all of this is expected to provide a holistic view of one's IQ (Niileksela & Reynolds, 2019).

These scores are calculated through a complex process. On the WAIS, the scores of the test-taker are compared to the scores of others within their general age group. From there, the average score is set around 100, and having a score of 90 to 110 is considered average intelligence (Loring & Bauer, 2010).

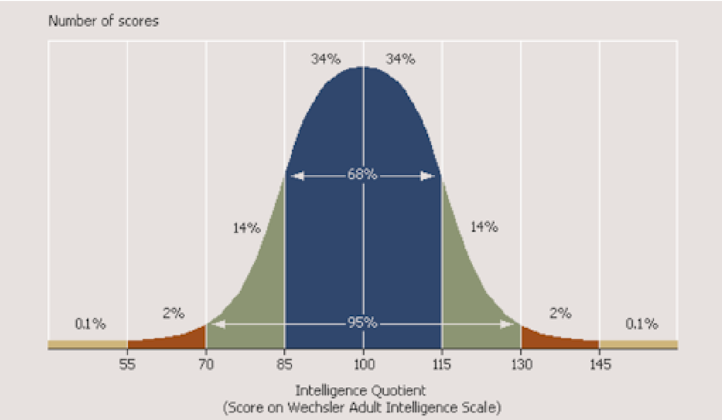

Figure 1. (SFU, 2005)

Benefits and Downsides

The WAIS is incredibly useful for determining one's intellectual abilities, identifying learning disabilities, and has been utilized to guide education and learning throughout the many years of its use (Koriakin et al. 2014). This test can also be used to diagnose and assess traumatic brain injuries, and is used in clinical trials and studies to learn about the effects of TBIs (Lida et al, 2021).

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In addition, the WAIS has good test-retest reliability (Watkins & Smith, 2013). This ensures that the results that scientists are getting through these tests are accurate and consistent between each person. This consistency is incredibly important, especially when it comes to situations where an individual's data will be compared against that of the "entire population."

On the other hand, the WAIS does not cover every form of intelligence believed to exist. For example, creativity is not tested on the exam (Niileksela & Reynolds, 2019) but is considered to be a crucial type of intelligence (Dechaume et al. 2024). This exclusion of important intelligence factors may lead to several people high in related types of intelligence doing poorly on the WAIS.

Additionally, there are many concerns that factors such as race, gender, or nationality could play a role in testing and lead to unfair results. These exams are administered by psychologists, and their inherent biases could lead to results being different than the expected or accurate results from the person. This is seen most prominently regarding the Black and Hispanic American communities, which often face external stereotyping and discrimination. This bias can be seen through the Cultural Test Bias Hypothesis (CTBH), the idea that any gender, ethnic, or other minority groups that perform differently on the mental examinations are due to flawed methodology that was used to make and administer the exam (Reynolds et al, 2021).

Finally, the reliability of IQ exams has been brought into question. While all IQ exams have the same structure and format for the questions and sections, there are many external factors that could play a role in test results. One pilot study of the WAIS-II, one of the older versions, showed that testing reliability changed depending on the testing conditions. Elements such as which psychologist is proctoring the exam or what room the examination is being taken in can greatly affect one's score and results (Worhach et al., 2021).

Conclusion

Intelligence has been studied by scientists for centuries, and the complex interplay between brain regions is still not understood today. Despite testing flaws, scientists continue to use IQ testing to learn more about intelligence levels because they are a useful tool to reflect what is understood about the trait of higher-order cognitive functioning. In the future, scientists will use tools such as functional brain imaging in order to learn more about intelligence's changes to the brain. For example, a recent study that used lesion-mapping technology and WAIS-III index scores showed scientists that higher scores were correlated with more localized regions for the Verbal Comprehension Index (VCI), and Working Memory Index (WMI) than for other regions of the brain (Coalson et al., 2010). While not perfect, researchers continue to work on reducing the flaws and mistakes that these examinations make so that IQ testing can continue to act as a dependable tool for intelligence testing and research.

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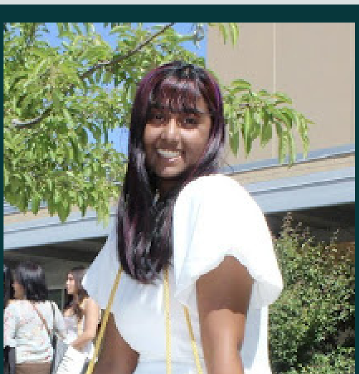

About the Author

Ananya Sampathkumar is a sophomore, majoring in Neuroscience with minors in Chemistry and Public Health. Outside of Brain Matters, Ananya is an assistant editor-in-chief for Double Helix Digest, a member of Starcourse, a volunteer at Carle Hospital, and works at the Office of Undergraduate Admissions as a tour guide and student ambassador. In her free time, Ananya likes to read books, make jewelry, watch movies, and hang out with her friends.