



Understanding the Creyos Health Normative Database

Quickly gain validated and powerful brain health insights.



Understanding the Creyos Health Normative Database

The Creyos (formerly Cambridge Brain Sciences) normative database is one of the largest of its kind, and is a key part of the Creyos Health cognitive assessment reports. This document explains where the database came from and review important properties that may help healthcare providers understand the nuances of interpreting Creyos Health scores.

Collection of the Creyos Health Normative Database

The Creyos Health normative database was collected as part of a large-scale public study examining the properties of the Creyos cognitive tasks, with the aim of better understanding human intellectual ability.

The study, published as [Fractionating Human Intelligence](#) in the journal *Neuron*, invited volunteers from all over the world to take 12 cognitive tasks over the Internet, with calls for participation posted in *New Scientist*, *The Daily Telegraph*, *The Discovery Channel's* website, and on various social media channels, which naturally spread so that the participation link was posted widely on social media and on over 3000 different web pages. Participants were given feedback on their performance, and were directed to an early public version of the Creyos website (known as Cambridge Brain Sciences at the time) where they could retake the tasks at their leisure. As a result, over 44,000 people were included in the study, and additional data was collected from the website long after the study was published, eventually contributing to the Creyos Health normative database.

Take the ultimate intelligence test

By Adrian M Owen - New Scientist | 11/01/10 7:05PM | Comments (112)



You might think it's obvious that one person is smarter than another. But there are few more controversial areas of science than the study of intelligence and, in reality, there's not even agreement among researchers about what this word means.

[Click here to go straight to the ultimate intelligence test.](#)

NEWSLETTERS

Sign up to read our regular email newsletters

NewScientist

News Podcasts Video Technology Space Physics Health More Shop Courses Events To

Testing the 12 pillars of wisdom



26 October 2010

New Scientist has teamed up with...
This gallery illustrates the princip...
or [take it now].

DISCOVER

LOGIN REGISTER

THE SCIENCES | MIND | TECHNOLOGY | HEALTH | ENVIRONMENT | PLANET EARTH



Ads by Google

[Send feedback](#)

[Why this ad? ▾](#)

MIND

Take the "Ultimate Intelligence Test" to Find out if You're Ultimately Smart

Discoverlog | By Jennifer Walsh | Oct 28, 2010 10:54 PM



Media recruiting for the study that contributed to the Creyos Health normative database

Participants took the same engaging tasks used in Creyos Health today, alongside a demographic questionnaire that included information about age, gender, and other variables. The original tasks included simple text instructions and videos to help participants understand the rules, but they did not practice the tasks or go through interactive tutorials, so the norms are considered to be for the tasks themselves, and not associated with a particular setting or method of administration.

The Size of the Creyos Health Normative Database

Over 85,000 volunteers have contributed to the Creyos Health database, and over 8 million task scores have been collected both directly for the database and to determine psychometric properties of the tasks.

The original *Neuron* paper mentioned above focused on ages 12 to 70, but additional data has been added to the database to provide norms for ages 6 and up.

The Creyos Health normative database is much larger than the norm samples associated with comparable tests of intellectual function, such as traditional intelligence tests. For example, [Norfolk et al. \(2015\)](#) found that among 17 intelligence tests, none had normative samples larger than 5,000 participants, and most were insufficient in providing normative samples that were large, recent, and representative.

Norms are usually broken down into age blocks for more accurate comparisons—see below for specific age blocks. Norfolk et al. recommend at least 50 individuals in each age block. Creyos Health exceeds this recommendation by orders of magnitude in order to ensure as much trust in comparative scores as possible, and help guide important healthcare decision making.

Additional data collection is ongoing, and the normative database may occasionally be updated to narrow age blocks, increase the number of people in each block, incorporate additional variables into reports, and/or better represent the current population.

Ensuring the Integrity of the Database

Raw data collected from scientific studies was processed in order to ensure that the current Creyos Health database is free of errors and representative of the general population. The database is a subset of the 8 million+ task scores collected so far.

The original database of raw scores was preprocessed to eliminate invalid data. Each task was filtered to exclude outliers in two passes: 1) removing scores more than 6 standard deviations from the mean, then 2) removing scores more than 4 standard deviations from the new mean. The 6 standard deviation filter was performed to eliminate scores that were obviously data errors, and the 4 standard deviation filter was intended to remove extreme scores or participants with severe intellectual impairment. To further enhance the integrity of the Creyos Health database, questionnaire data were used to remove individuals based on impossible or nonsensical responses to questions that had free-form input. For example,

number of cigarettes per day, number of caffeine drinks per day, units of alcohol per week, and age are all numeric inputs, so participants who provided non-numeric characters or impossible values (e.g., 100 caffeine drinks per day) were removed from the database. The remaining scores in the current database are free of detectable errors and extreme impairment.

Characteristics of the People in the Normative Database

The Creyos Health normative database is designed to be representative of the general population.

Patients are compared to a group of people in the database who are in the same age category. The categories are as follows:

3-5, 6-7, 8-9, 10-12, 13-15, 16-17, 18-24, 25-34, 35-44, 45-54,
55-64, 65-74, and 75+

The range of the categories was chosen to ensure that there is enough data within each category to confidently estimate how an individual patient compares to the database, and enough data to perform calculations related to a particular session's validity and meaningful change.

Male or female genders can also be included in the comparative group, but can be omitted to compare a patient to all genders of the same age.

Age and gender are relevant to the majority of use cases, and age has a clear and consistent relationship with cognition, so these are the demographic variables included in every Creyos Health report.

Demographic Characteristics of the Database

The approximate breakdown of the adult population included in the database is included here. Demographic information is not currently included for children younger than 12, and the percentages may have changed slightly as more data has been added to the database.

Education

The breakdown of education levels in the entire normative database is as follows:

- Some high school or less: 10.7%
- High school graduate: 10.6%
- Some college: 28.2%
- College graduate: 27.4%
- Higher education: 23.2%

The education level proportions are similar to those in adults in the United States population (see the [U.S. Census Bureau's 2020 educational attainment breakdown](#)), with small differences likely due to age breakdowns and the Internet-based nature of the Creyos Health data collection process.

Education is correlated with scores on some Creyos tasks, and may be considered as a contextual variable when interpreting results in some cases. Education may be particularly relevant when interpreting tasks with a verbal component: “While level of education (calculated from those aged 20+) showed a small-medium-sized positive relationship with the mean score (~0.33) and the verbal score (0.32 SD), the [short-term memory] score showed a smaller relationship (0.23 SD), while the relationship with reasoning (0.12 SD) was of negligible scale” ([Hampshire et al., 2012](#)).

The following pages review additional demographic information about the database.

Employment

- Employed full time: 45.5%
- Employed part time: 7.8%
- Employed and student: 12.3%
- Full time student: 19.7%
- Unemployed: 11.2%
- No answer: 3.5%

Location

- Africa: 1.5%
- North America: 40.8%
- South America: 2.7%
- Asia: 5.8%
- Europe: 39.5%
- Oceania: 9.7%

Health Status

Creyos Health is a general-purpose assessment of cognitive function, and not designed to diagnose any particular disorder. Therefore, individuals in the database were not asked about or excluded due to any health conditions. Severe intellectual difficulties affecting test scores would naturally be removed as outliers or invalid data. The database is thus considered to be a generally healthy population, but some health conditions not related to intellectual disability are assumed to be present in the database in roughly equal proportions to the general population.

Familiarity With Tasks

Participants were given text instructions and had the option of watching a video before starting the tasks for the first time.

Scores on Creyos Health reports are relative to participants in the database taking the tasks for the first time. Scores are always centred on the mean and standard deviation for the first task play—even if a patient is taking a task for the third time, they are always compared to the same population mean. Therefore, small improvements due to practice are to be expected (see FAQs, below).

Participants in the database had the option of completing the tasks additional times, and the data on additional task plays is used to calculate reliability for each task, which contributes to

score adjustments and the range of percentiles shown on the patient report. The Creyos Health reliable change indicator also uses data from repeated task plays in order to determine if a change from the baseline or previous score is within the normal range of improvement from one task play to another.

Knowledge about the normative database, and similarities or differences between the database and individual patients, may help set expectations for scores on their reports, and improve the accuracy of interpretation. See the [Creyos Health Report Interpretation Guide](#) for more information on making sense of results, including details about the scores and calculations appearing on the Creyos Health report.

Frequently Asked Questions About the Creyos Health Normative Database

Why are additional demographics not included in Creyos Health reports?

There are near-infinite ways to divide the database, but age is the strongest predictor of task scores and provides a comparative group that has clear and universal applicability across all healthcare specializations. Focusing on age ensures that all providers can use Creyos Health reports, with a consistent meaning across reports and across patients, and with each patient always compared to a normative sample with thousands of individuals represented.

Demographic variables such as education, profession, and health should always be considered when interpreting the results of any cognitive assessment or mental health measure, alongside clinical judgment appropriate to a healthcare specialization's context and training.

Additional demographic norm breakdowns may be available to CBS customers with access to raw data for research purposes.

Should I expect most of my patients to be above or below the database mean?

The mean standard score on the Creyos Health report is 100. Depending on your practice, the majority of scores may be above or below the mean—the population mean does not necessarily apply to your specific subpopulation of patients.

For example, if you are treating health conditions known to impair cognition, most Creyos Health standard scores may be below 100 at baseline, with above average scores highlighting particular strengths. On the other hand, if you primarily see patients who are highly educated or in intellectually demanding professions, most scores may be expected to be above average, with even average scores highlighted as a cause for concern. The context of taking tasks in a formal healthcare setting, administered by an authority figure, may also contribute to scores generally higher than in the at-home setting of the normative database. As with all patient data, context is crucial to setting expectations and interpreting results.

Should I expect scores to improve or decline over time?

Creyos Health patients are always compared to the same comparative group, unless they change age categories.

Over a short time period, scores would be expected to improve slightly due to learning effects (see the [Science Overview](#) for learning effects for each task in an informal context without tutorials). The meaningful change indicator takes practice into account, so that meaningful change is only highlighted if improvements are outside what would be expected due to practice.

Over a longer time period, learning effects tend to level off, and participants are always compared to the appropriate age group at the time of testing. Therefore, without any

particular disruptions or interventions, only small variations over time would be expected, and declines in raw scores due to aging would not be apparent in reports, because the report always corrects for age. Only declines outside of the normal effect of aging would be expected to become apparent in trends on longitudinal Creyos Health reports.