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Creyos Dementia Protocol Report Interpretation Guide

Quickly gain validated and powerful brain health insights

Important Information Before You Read This Document

Creyos (formerly Cambridge Brain Sciences) provides a scientifically-validated and objective measure of an individual's cognition, however, it is not a diagnostic tool. Creyos Health should be used in conjunction with other information and clinical judgment to reach conclusions regarding an individual's health. Ultimately, Creyos Health does not replace the judgment of a practitioner and Creyos does not assume responsibility for the outcome of decisions made based on Creyos Health data.

Table of Contents

A. Aging and Cognitive Decline

The Creyos dementia protocol **provides support when screening for and diagnosing age-related cognitive disorders,** such as mild cognitive impairment (MCI) and dementia. To accomplish this, the protocol gathers objective cognitive data alongside questionnaire-based health information. This guide reviews each element of the protocol and reports, explains the cognitive tasks involved, and answers common interpretation questions.

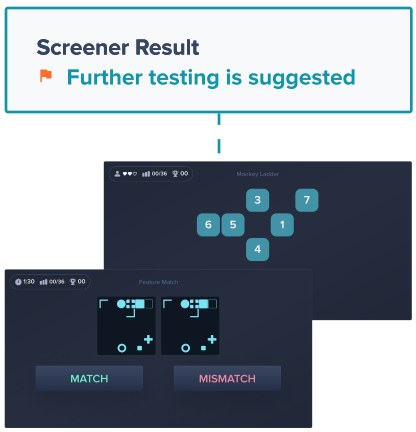
The Creyos dementia protocol includes two main parts: a screener and an assessment.

- **The dementia screener** is designed for routine screening for cognitive impairment in generally healthy older adults, or the first step when there is a concern about cognitive decline. It takes about five minutes for a patient to complete, and uses a machine learning algorithm to classify patients as potentially impaired or unimpaired. The screener does not contain details about cognitive performance or diagnostic criteria, but might suggest further testing using the full dementia assessment mentioned below.
- **The dementia assessment** is often used as the next step after the screener identifies impairment, or when more detailed information is required. It takes about 20 minutes for a patient to complete, and provides detailed information about objective cognitive deficits and subjective concerns, lining up, lining up symptoms with DSM-5-based criteria for diagnosing neurocognitive disorders, and tracking cognitive health over multiple time points.

For more information about the science behind the protocol, the link between aging and cognition, diagnostic criteria, the advantages of using the Creyos solution over other options, validation, and details on how classifications are determined, see the Creyos Dementia Protocol Science Overview.

About the Creyos Dementia Screener

The dementia screener is a two-task, five-minute cognitive testing protocol that helps determine whether or not the patient's cognitive functioning appears to be impaired. If the patient is screened for impairment, then further testing may be needed.



The Creyos dementia screener uses two cognitive tasks: **Feature Match** and **Number Ladder** (described further below). A machine learning model analyzes multiple performance outcomes from each task—such as reaction times, error rates, and interference ratios—to identify patients who may require further testing.

The dementia screener report is described in detail in Section B. For more information about the algorithm used to classify patients, see the Creyos Dementia Protocol Science Overview.

About the Creyos Dementia Assessment

The Creyos dementia assessment is often the next step after the screener identifies patients who require further testing. It was designed to assist in the diagnosis of neurocognitive disorders by assessing symptoms associated with mild or severe cognitive impairment. If the patient has completed the screener the assessment is an additional four tasks. Data from the screener tasks will be carried over as well. If the patient hasn't complete the screener, the assessment contains six tasks.

If the patient has completed the screener, then data from its two tasks will be carried forward to the assessment, so the patient only needs to complete four additional tasks. However, both the screener and the assessment can be completed independently.

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) contains diagnostic criteria for mild neurocognitive disorder (a term used interchangeably with mild cognitive impairment, or MCI, in research and clinical practice) and major neurocognitive disorder (a term used interchangeably with dementia). Creyos assesses each of the criteria as follows:

DSM-5 Criterion	Label in Creyos Dementia Assessment Report	Measurement Instrument
A decline in cognitive performance, preferably documented by standardized neuropsychological testing	Objective cognitive impairment *or* objective cognitive decline	Creyos cognitive testing (six tasks)
Modest decline in one or more cognitive domains, based on concern of the individual, an informant, or the clinician	Subjective cognitive decline	IQCODE questionnaire
Mild neurocognitive disorder: Deficits do not interfere with independence in everyday activities ***Major neurocognitive disorder:*** Deficits interfere with independence in everyday activities	Functional dependence	IADL questionnaire
Deficits do not occur only in the context of delirium and are not better explained by another mental disorder	Neurobehavioral symptoms	PHQ-9 and GAD-7 questionnaires (optional)

If cognitive deficits and subjective cognitive decline are flagged, then most of the DSM-5 criteria for a neurocognitive disorder are supported with data from the assessment. The type of neurocognitive disorder indicated depends on functional independence information:

- If functional independence is indicated, then criteria for mild neurocognitive disorder are met.
- If the patient depends on others for everyday activities, then criteria for major neurocognitive disorder are met.

The National Institute on Aging and Alzheimer's Association (NIA-AA; see Jack et al., 2018), focusing on research-based criteria and preclinical Alzheimer's disease (AD) as a cause for impairment, proposes similar criteria for identifying MCI, which the Creyos dementia assessment is also compatible with.

The Creyos dementia assessment guides patients through all the steps necessary to collect information to assist in confirmation of the presence or absence of these criteria. After the 20-minute protocol is complete, a report is automatically generated to supplement a clinician's diagnostic decisions, track changes over time, and potentially share this information with patients, families, and caregivers. See Section C for detailed information about the assessment report. Creyos also contains cognitive care planning tools that may be used to assist in next steps if a neurocognitive disorder is diagnosed—read more about care planning here.

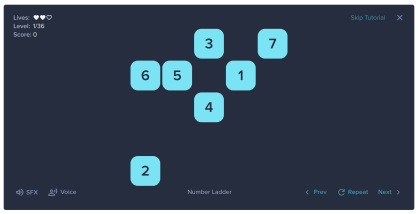
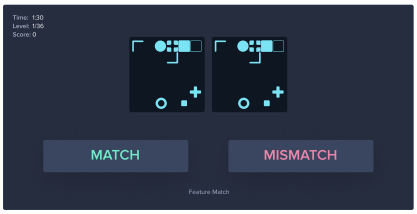
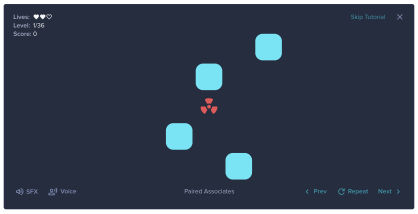
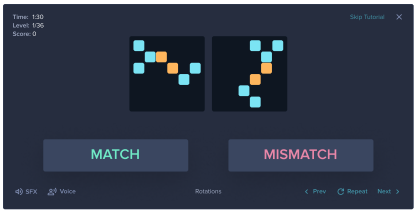
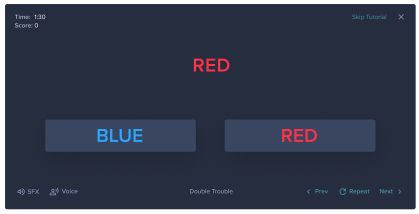
Cognitive Tasks Used to Establish Cognitive Impairment or Decline

The Creyos dementia assessment contains six cognitive tasks that collectively measure visuospatial working memory, episodic memory, attention, mental rotation, verbal short-term memory, and response inhibition. These fall into three broad domains:

- Short-term memory,
- Reasoning,
- Verbal ability.

Performance on the tasks determines if cognitive impairment or decline will be identified on the patient's report. If two or more tasks are impaired or have declined, the patient will be flagged for objective cognitive impairment or decline. If performance on both tasks within the same domain is lower than expected, then domain-specific information will be highlighted on the report as well. Section C contains information about patient classifications.

The tasks in the protocol are listed below. See the Creyos Dementia Protocol Science Overview for thresholds for impairment and more information on how each task is linked with age-related decline. See the Creyos Scientific Overview for general information about the Creyos cognitive tasks.

Short-Term Memory	Reasoning	Verbal Ability
		
Number Ladder Visuospatial Working Memory	**Feature Match** Attention	**Digit Span** Verbal Short-Term Memory
		
Paired Associates Episodic Memory	**Rotations** Mental Rotation	**Double Trouble** Response Inhibition

Questionnaires Included in the Dementia Assessment

The dementia assessment includes two questionnaires to help confirm diagnostic criteria for neurocognitive disorders. Each has established cutoffs for flagging potential concerns.

- **Subjective cognitive decline:** The Informant Questionnaire on Cognitive Decline in the Elderly, self-report version (IQCODE-SR) is used to establish subjective cognitive decline. Higher scores are indicative of more perceived decline compared to 10 years ago. A score of 3.22 or higher will flag the patient for subjective cognitive decline.

Compared with **10 years ago**, how are you at:

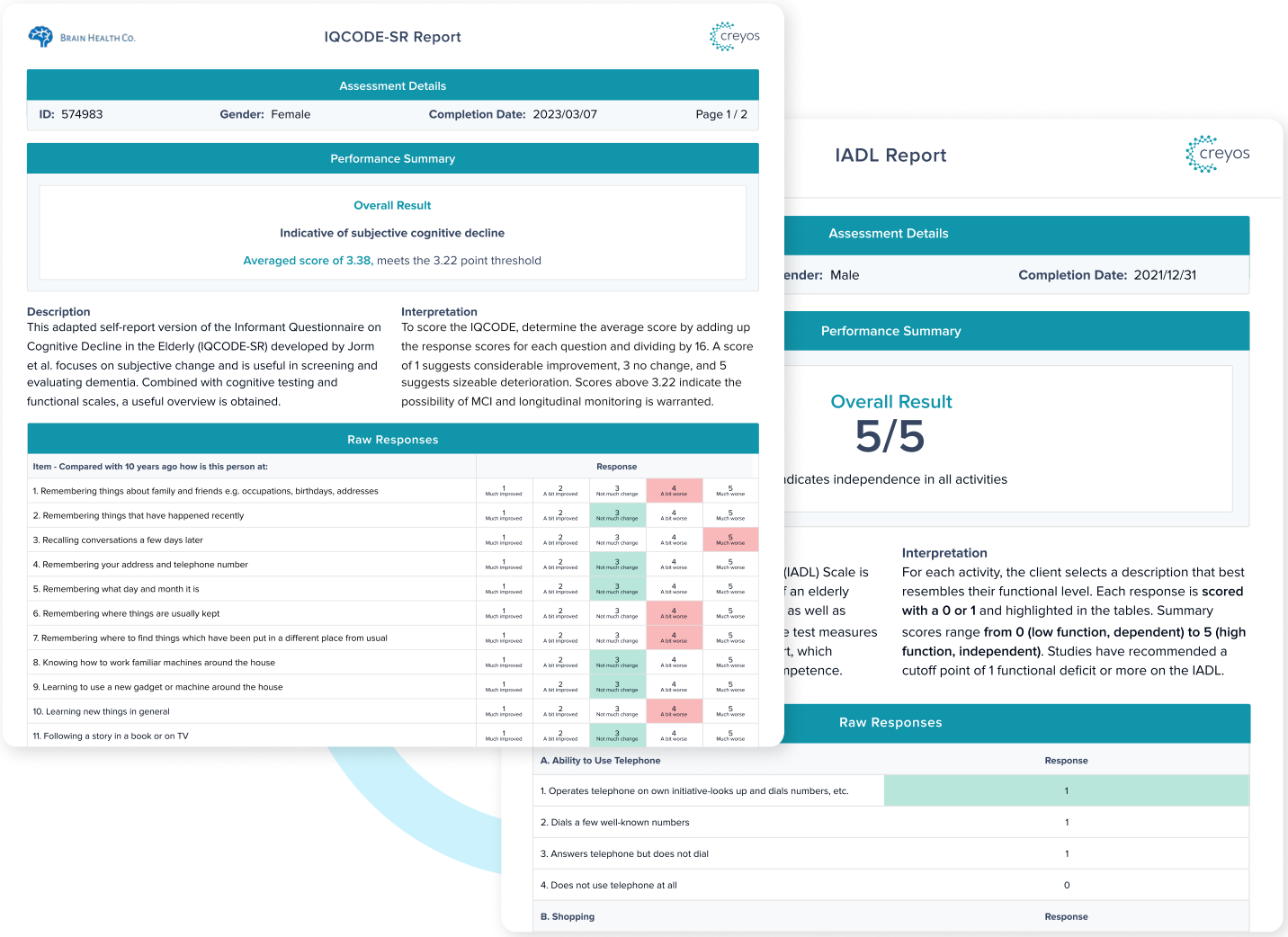
Remembering where things are usually kept

Much improved	A bit improved	Not much change	A bit worse	Much worse

- **Functional dependence:** The Instrumental Activities of Daily Living (IADL) questionnaire is used to establish functional independence or identify functional dependence that could contribute to a classification of potential major neurocognitive disorder. Lower scores represent more dependence on others for complex daily tasks. Any score below the maximum (eight for women, five for men) will flag the patient for functional dependence.

Two optional questionnaires can also be included to help rule out mental health symptoms as the primary cause of cognitive difficulties or quantify comorbidities:

- **Depression**: The Patient Health Questionnaire (PHQ-9) is used to measure symptoms of depression.
- **Anxiety:** The General Anxiety Disorder questionnaire (GAD-7) is used to measure symptoms of anxiety.



BRAIN HEALTH CO.

IQCODE-SR Report

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Assessment Details

ID: 574983 Gender: Female Completion Date: 2023/03/07 Page 1 / 2

Performance Summary

Overall Result

Indicative of subjective cognitive decline

Averaged score of 3.38, meets the 3.22 point threshold

Description

This adapted self-report version of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE-SR) developed by Jorm et al. focuses on subjective change and is useful in screening and evaluating dementia. Combined with cognitive testing and functional scales, a useful overview is obtained.

Interpretation

To score the IQCODE, determine the average score by adding up the response scores for each question and dividing by 16. A score of 1 suggests considerable improvement, 3 no change, and 5 suggests sizeable deterioration. Scores above 3.22 indicate the possibility of MCI and longitudinal monitoring is warranted.

Raw Responses

Item - Compared with 10 years ago how is this person at:	Response				
1. Remembering things about family and friends e.g. occupations, birthdays, addresses	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
2. Remembering things that have happened recently	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
3. Recalling conversations a few days later	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
4. Remembering your address and telephone number	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
5. Remembering what day and month it is	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
6. Remembering where things are usually kept	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
7. Remembering where to find things which have been put in a different place from usual	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
8. Knowing how to work familiar machines around the house	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
9. Learning to use a new gadget or machine around the house	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
10. Learning new things in general	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse
11. Following a story in a book or on TV	1 Much improved	2 A bit improved	3 Not much change	4 A bit worse	5 Much worse

IADL Report

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Assessment Details

ender: Male Completion Date: 2021/12/31

Performance Summary

Overall Result

5/5

ndicates independence in all activities

(IADL) Scale is
f an elderly
as well as
e test measures
t, which
mpetence.

Interpretation

For each activity, the client selects a description that best resembles their functional level. Each response is **scored with a 0 or 1** and highlighted in the tables. Summary scores range **from 0 (low function, dependent) to 5 (high function, independent)**. Studies have recommended a cutoff point of 1 functional deficit or more on the IADL.

Raw Responses

A. Ability to Use Telephone	Response
1. Operates telephone on own initiative-looks up and dials numbers, etc.	1
2. Dials a few well-known numbers	1
3. Answers telephone but does not dial	1
4. Does not use telephone at all	0
B. Shopping	Response

Each questionnaire is a standard third-party questionnaire commonly used to assess symptoms related to neurocognitive disorders. For more information on the origins of each questionnaire, psychometric properties, validation, and other information, see each of the articles linked above.

Administering and Interpreting Questionnaires

Note that additional information may need to be gathered via additional questionnaires, interviews, or other sources in order to confirm or rule out DSM criteria for a neurocognitive disorder, and to identify etiological subtypes. For example, the Creyos assessment does not include measurement instruments of delirium or mental disorders other than depression and anxiety that can cause cognitive deficits, and these must be ruled out as alternative explanations for any observed impairments before diagnosing a neurocognitive disorder.

Clinical judgment is always required when interpreting the results of questionnaires. If there is evidence that patients are not providing truthful results, or if self-report results contradict information from caregivers, then reassessment or additional steps may be needed to generate an accurate report.

B. Screener and Assessment Interpretation Guidelines

The Creyos Dementia Screener Report

The results of the Creyos dementia screener are designed to be easy to interpret. There are two possible outcomes:

- **Further testing is suggested:** the patient's performance is similar to a potentially impaired population. Further testing, such as the full Creyos dementia assessment, may be needed to determine the severity and nature of deficits.
- **Further testing is not suggested:** the patient's performance is similar to a healthy population. There is no evidence of cognitive impairment at the time of testing.

The PDF report contains additional information to help with interpretation:

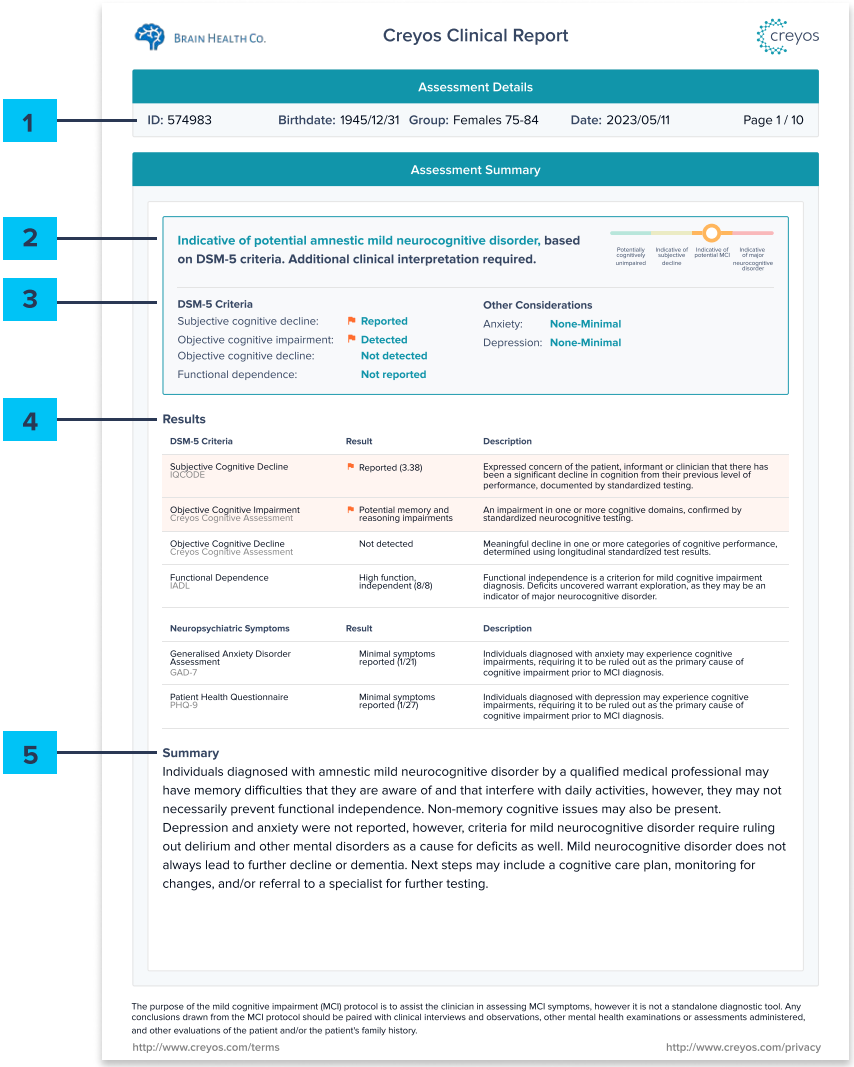
1. **Assessment details**: including the patient's ID and age information, comparative group, and the date of the assessment.
2. **Screener result:** whether further testing is suggested or not.
3. **Next steps**: more information about the patient's result and potential next steps.
4. **Supplemental information**: an explanation of how the result was determined, references, and disclaimers.

The Creyos Dementia Assessment Report

I. The Assessment Summary Page

The Creyos dementia assessment produces a more detailed report than the screener, but is still designed to be easy to read and shareable with the patient. The summary page enables a quick review of how they were classified, why they were classified that way, and the results of each cognitive task and questionnaire. Areas flagged for concern are colored orange, and the results describe alignment with DSM-5 criteria for mild or major neurocognitive disorder. Elements of the summary page are outlined below:

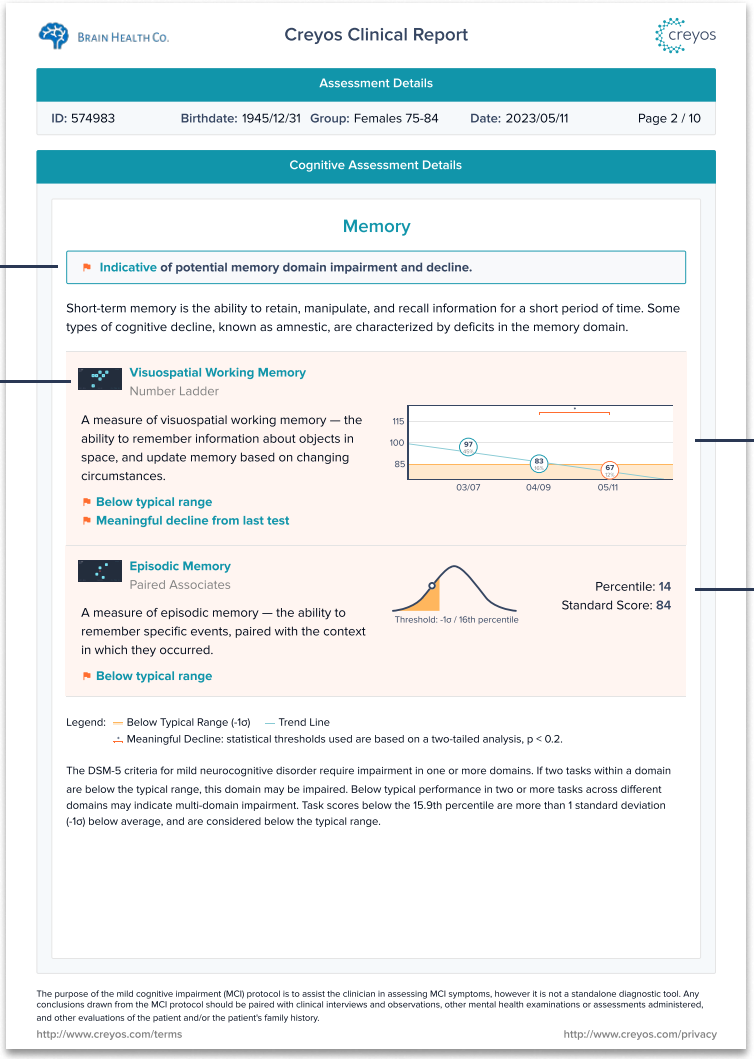
1. **Assessment details:** including the patient's ID and age information, comparative group, and the date of the assessment.
2. **Patient classification:** summary of potential classification based on DSM-5 criteria for neurocognitive disorders. Patient classification details are explained below.
3. **DSM-5 criteria:** summary of the results of cognitive assessment and questionnaire results, aligned with criteria for neurocognitive disorders.
4. **Results:** descriptions of the results from each element of the protocol. Additional details are contained on subsequent pages of the report.
5. **Summary:** a plain-language summary of the results, qualifiers, and potential next steps.



II. Cognitive Assessment Details

The details section of the report provides additional context for each task, including specific metrics about the patient's performance. Tasks are organized by cognitive domain, and domain-level information is also presented. Elements of the assessment details are described below:

6. **Domain-level impairment**: if multiple tasks within a domain are impaired or have declined, then the domain is flagged for impairment. Memory domain impairments contribute to the classification of potential amnestic disorders.
7. **Cognitive task details:** the task name, description, and screenshot. If performance was more than one standard deviation below average, the task details will be highlighted in orange, and flagged for being below typical range.
8. **Longitudinal results:** if the task has been completed more than once, recent results will be displayed. If meaningful change from baseline or the most recent result is detected, a line and an asterisk will indicate which scores have declined. The patient will also be flagged for meaningful decline on the task.
9. **Task performance details:** a graph displays where the patient performed on a normal curve representing a generally healthy population in the same age group. If a score is more than one standard deviation below average, it will be in the shaded orange region and flagged for being below typical range. Adjusted percentile ranks and standard scores are also displayed.

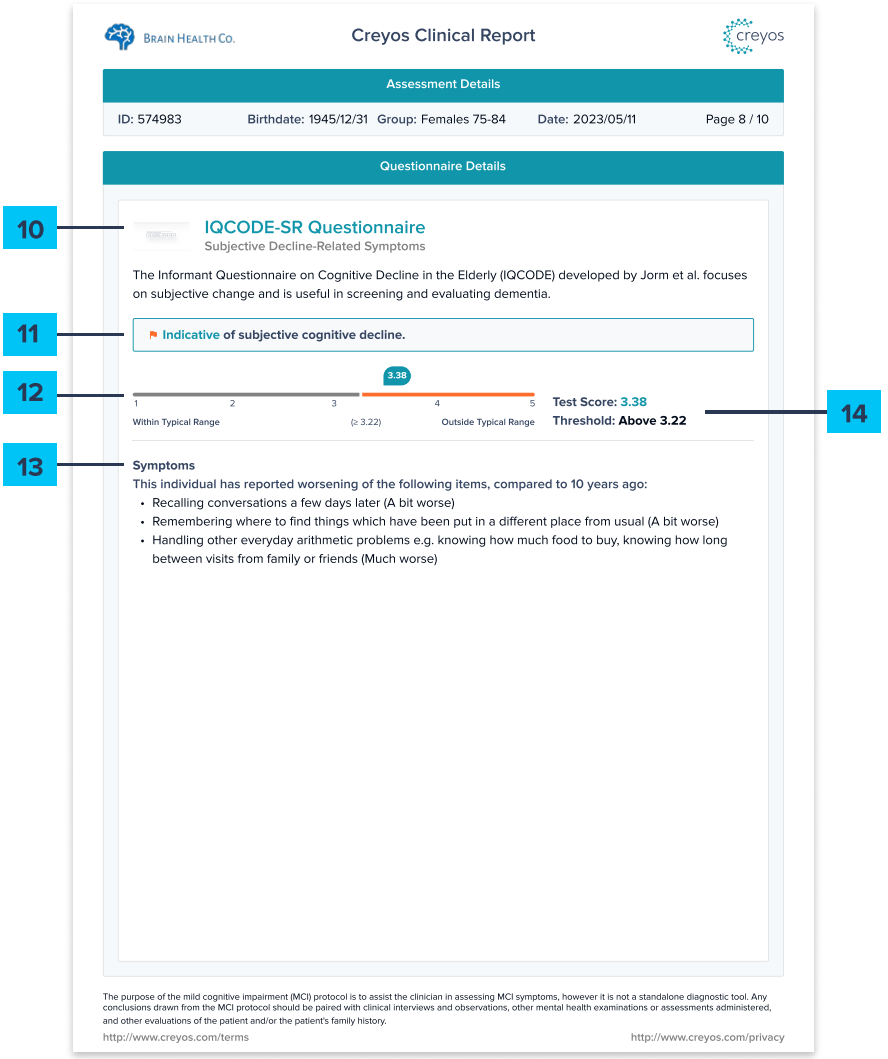


For more details on how scores, percentiles, and meaningful change are calculated, see the Creyos Health Report Interpretation Guide. The Creyos Dementia Protocol Science Overview contains more about how each element of the report was researched and validated in the context of dementia. Interpretation tips are included in Section C.

III. Questionnaire Details

The Questionnaire Details section provides more information about each of the questionnaires completed, including total scores and specific symptoms that were reported.

10. **Questionnaire name and description:** basic details and a screenshot.
11. **Questionnaire result summary:** if the score on the questionnaire reaches the threshold for concern, the patient will be flagged. For example, the IQCODE-SR flags the patient for subjective cognitive decline if their responses reached the established threshold.
12. **Visual results:** a representation of the patient's score. For example, the IQCODE-SR displays the patient's score on a line from the minimum score (1) to the maximum (5), with scores above the threshold for subjective cognitive decline in orange.
13. **Symptoms**: a list of the symptoms the patient reported on the questionnaire. For example, the IQCODE-SR results show any areas where the patient indicated declining compared to 10 years ago.
14. **Numerical results:** the patient's score, and the threshold for being flagged. For example, the IQCODE-SR's total score is calculated as the average of each item's rating from 1 to 5 (with 1 being much better, 5 being much worse, and 3 being "no change"). Research has shown that an average score above 3.22 is indicative of potential self-reported impairment.



Results for each questionnaire look slightly different. Section A contains details on each questionnaire included in this protocol.

IV. Patient Classifications

Cognitively Unimpaired

Subjective cognitive decline:	**Not reported**
Objective cognitive impairment:	**Not detected**
Functional dependence:	**Not reported**

If the patient does not report any cognitive issues in everyday life and cognitive tests do not demonstrate impairment or decline, the patient will be classified as cognitively unimpaired. They met none of the DSM-5 criteria for a neurocognitive disorder measured by this protocol.

Subjective Cognitive Decline Only

Subjective cognitive decline:	**Reported**
Objective cognitive impairment:	**Not detected**
Functional dependence:	**Not reported**

If the patient reports subjective concern about cognitive decline, but no objective impairments or declines were detected, they will be classified as having subjective cognitive decline only. Further investigation may be required to determine the reasons for subjective concern, or monitor for signs of decline over time.

Potential Mild Neurocognitive Disorder

Subjective cognitive decline:	**Reported**
Objective cognitive impairment:	**Detected**
Functional dependence:	**Not reported**

If the patient reports subjective concern about cognitive decline and cognitive impairment or decline are indeed detected, but they do not have problems with activities of daily living, then they will be classified as having potential mild neurocognitive disorder. Many of the DSM-5 criteria for mild neurocognitive disorder were confirmed by the assessment. Additional details will be provided as well, such as if the results may be indicative of amnestic (memory) impairment or non-amnestic impairment, and whether or not mental health symptoms were also reported.

Potential Major Neurocognitive Disorder

Subjective cognitive decline:	**Reported**
Objective cognitive impairment:	**Detected**
Functional dependence:	**Reported**

If the patient reports subjective concern about cognitive decline, cognitive impairment or decline is indeed detected, and they have issues with activities of daily living, then they will be classified as having potential major neurocognitive disorder. Many of the DSM-5 criteria for major neurocognitive disorder were confirmed by the assessment. Additional details will be provided as well, such as if the results may be indicative of amnestic (memory) impairment or non-amnestic impairment, and whether or not mental health symptoms were also reported.

Other Classifications

If the patient's results do not clearly rule out cognitive impairment, but they also do not meet the criteria for a neurocognitive disorder, then a specific classification cannot be provided. Information about the patient's results will still be displayed to inform clinical decision making, and action may still be required. For example, if cognitive impairment is detected, but subjective concern was not reported, clinicians may interview informants or perform additional assessments—if those steps reveal concern about impairment, then the DSM-5 criteria for a neurocognitive disorder may be met.

The summary page of the dementia assessment report starts with a classification summarizing whether or not the patient may meet the criteria for a neurocognitive disorder. A sophisticated decision tree determines which classification is displayed—see the Dementia Protocol Science Overview for details. Additional information to help with interpretation is included on the summary page.

*Note that for all classifications, if symptoms of anxiety or depression meet the threshold for concern, **the report will suggest interpreting the results with caution**—for example, consider ruling out mental health symptoms as the primary cause of cognitive issues.*

***A patient's classification should not be confused with automating a diagnosis**. Education, vocation, leisure activities, physical health, sociodemographic status, self-reported baselines, and other patient information can set expectations about a patient's cognitive performance, and determine how much weight should be placed on their classification when making clinical decisions. Every Creyos report includes a note that additional clinical interpretation is required to accurately determine next steps.*

C. Interpretation Tips and Frequently Asked Questions

Will every dementia assessment confirm or rule out a neurocognitive disorder?

Some patterns of results do not support a specific disorder. For example, a patient may not demonstrate cognitive impairment, but reports functional issues on the IADL questionnaire. Their lack of independence may be reason for concern—however, without evidence of cognitive impairment as well, the criteria for dementia are not met. In cases like this, further testing or clinical investigation may be required. Alternative explanations for functional issues (e.g., physical disability) may explain IADL results, for example, or future cognitive decline from a personal baseline may eventually meet the criteria for a neurocognitive disorder.

What are the next steps if a patient demonstrates cognitive impairment, but does not meet other criteria for a neurocognitive disorder?

Further clinical investigation may be required for unexpected patterns of results. In some cases, a patient may be flagged for cognitive impairment or decline, whilebut the self-report questionnaires do not reach thresholds for subjective or functional impairment.

There can be several reasons for this, including lack of awareness of impairment, denial, and intentional deception. Impairment can also be present without a genuine age-related problem—such as when the individual has always performed lower than other people their age. One next step may be probing further for signs of subjective concern. The DSM-5 does not specify that concern needs to be self-reported—concern of a knowledgeable informant or the clinician can also meet the criteria for a neurocognitive disorder. In other words, interviews with caregivers or direct observation may override the self-reported IQCODE results when it comes to diagnosis. On the other hand, if all sources of information agree that no concern is present, then the cognitive impairments detected may be unrelated to age-related decline.

Can the dementia protocol distinguish between types of dementia?

Not directly. The DSM-5 asks clinicians to specify the subtype of mild or major neurocognitive disorder, which can include Alzheimer's disease, vascular disease, traumatic brain injury, Parkinson's disease, and other causes. The Creyos dementia protocol was designed to detect cognitive and functional impairments regardless of cause. Additional testing, patient history, and observation may be required to diagnose a particular subtype of neurocognitive disorder.

Is scoring below average on cognitive tasks considered evidence of cognitive decline?

Impairment is often used as indirect evidence of decline. Age-related neurocognitive disorders are defined by decline —that is, lower cognitive performance now compared to when the patient was younger. However, it is rare to have a personalized cognitive baseline to compare present scores to. That is why impairment—lower cognitive performance than age-matched norms—is seen as evidence of decline, especially when paired with subjective concern that there has been a decline over time. The Creyos dementia assessment will identify decline when a baseline is available, but decline and impairment are considered interchangeable for identifying an issue with cognition.

There may be cases in which additional information calls into question the link between present impairment and decline over time. Clinical judgment must be used to hypothesize about the patient's baseline cognition from younger years. Factors like education and profession can be used to estimate a baseline.

How can patient characteristics, such as education, be taken into account when interpreting results?

Multiple patient characteristics can help determine if a patient's cognitive performance is higher or lower than expected. Age is a universal factor that tends to affect cognitive task scores, so all scores displayed on the dementia assessment are normalized to the patient's age group. Other characteristics must be considered manually. Education is often cited as protective against dementia, and patients with more education perform better on cognitive tasks (though factors like sex, ethnicity, and geographical regions can moderate this relationship; see Sharp & Gatz, 2011). When working with

patients who have little or no education, it is even more crucial to consider subjective decline and functional impairments, as cognitive task scores alone may not be able to identify decline (as opposed to performance that has always been lower than average). On the other end of the spectrum, highly educated patients may experience subjective decline but still perform within a normal range.

Having an intellectually demanding job may play a similar role as education in interpretation, and additional characteristics, like leisure activities, physical health, sociodemographic status, and other patient information can also play a role in expected cognitive performance. Incorporating this information into interpretation cannot easily be automated by software, so every Creyos report recommends additional clinical interpretation to accurately determine next steps that reflect the unique profile of the patient.

What does it mean if the screener indicates further testing is needed, but no impairment is detected on the dementia assessment?

If a patient is flagged by the screener but no impairment is detected on the full assessment, the screener results may have been a false positive. A classification of cognitively unimpaired on the assessment generally helps rule out severe cognitive impairment. The screener is designed so that most individuals with genuine cognitive issues will be flagged for further testing. However, some cognitively healthy individuals may be flagged as well, due to distraction, misunderstanding, or simply not being strong in the tasks chosen for the screener. The full assessment is more specific and more comprehensive, and can double check if impairment is severe enough to meet DSM-5 criteria for a disorder, and/or provide additional information about whether specific areas of cognition are impaired. Regular reassessment using the full assessment may be desired to monitor for signs of decline.

Are the dementia screener and assessment results checked for validity, malingering, or cheating?

Each cognitive task has a basic check to ensure that a person performed the task. For example, many tasks require at least two correct responses, to ensure that the patient was able to respond accurately, and so that it is possible to calculate certain variables that require multiple data points (e.g., reaction time variability). If any task scores could not be calculated, a warning will be displayed on the patient's report(s). For example, if a patient does not respond to the task at all, or randomly hits buttons, a warning will likely be displayed.

This check does not guarantee that results are valid, or that the patient made an honest effort. Creyos dementia testing is designed to detect impaired performance, even if it is extreme, so "outliers" are not assumed to be invalid or discarded. The clinician must ensure confidence in the results before deciding on next steps. In situations where there is motivation to perform poorly or an incentive to cheat, additional supervision or testing may be warranted.

Can the Creyos dementia screener and assessment be used in patients with low literacy levels?

Yes, Creyos tasks are designed to provide valid information about cognition in patients with a wide variety of literacy levels. The cognitive tasks are abstract, and they only require fluid performance rather than crystalized knowledge. Interactive instructions use very simple language, and are available as both text and audio. In the dementia protocol, tasks without verbal stimuli were chosen (when possible) in order to be suitable for diverse populations, including those with low literacy.

Testing has been used successfully in low-literacy populations, including children as young as 4 (Hennessy et al., 2024), teens (Laureys et al., 2022), individuals learning English as a second language (İlya, Koç & Alpay, 2022), and individuals completing testing in their non-native language (Parekh et al., 2024). In a Creyos normative database of adults aged 50 and above, there is not a significant difference between those who completed high school and those who did not, indicating that low literacy is unlikely to consistently suppress scores. However, education can provide a genuine protective effect against cognitive decline (Meng & D'Arcy, 2012), reflected in slightly higher

Creyos scores in individuals with post-secondary education. The diverse Creyos normative database provides a consistent standard to compare each patient to, and results are not corrected for education, so that the small effects of education on cognitive decline can be reflected in Creyos testing.

Results from patients with extremely low literacy levels should still be interpreted with caution, however, as certain tasks do require recognition of simple words (e.g., “red” and “blue” in Double Trouble) and numbers (e.g., in Digit Span).

> “Alternatives are required to the MMSE for the cognitive screening of individuals with low educational attainment, which do not involve a high demand of reading and writing skills when exploring cognitive abilities.”
>
> ***– Pellicer-Espinos & Díaz-Orueta, 2022***

Does the Creyos dementia assessment measure or rule out delirium?

No, delirium is not included in the Creyos protocol. Delirium is a disturbance in attention, awareness, and cognition that develops over a short period of time and fluctuates in severity. In order to meet all the criteria for mild or major neurocognitive disorder, the DSM-5 requires confirming that cognitive deficits do not occur exclusively in the context of delirium. Since the Creyos dementia assessment does not test for delirium, clinicians should ensure any cognitive deficits detected are not temporary before considering a neurocognitive disorder diagnosis.

Can fatigue, medication, and other temporary factors affect cognitive testing performance?

Yes, temporary factors may affect performance. Fatigue is a common concern, and although the screener and six-task assessment are short enough that fatigue over the course of testing is minimal, patients who enter testing in a state of fatigue may perform below their full potential. Sleep duration is associated with cognitive task performance (see Wild et al., 2018, for example. Clinicians may wish to use caution when

interpreting results from patients who report extreme fatigue. However, sleep disturbances may themselves be a risk factor for dementia (Shi et al., 2018). Thus, classifications may still provide relevant and accurate information if fatigue is common in the patient's everyday life. Medication is another temporary factor that may affect results. Clinicians may wish to adjust expectations or next steps when the patient is on medications known to affect cognition or have cognitive side effects. Some providers recommend that patients take cognitive assessments while off medication in order to remove this potentially confounding factor, when possible.

Can the Creyos dementia protocol be administered multiple times, and how often should they be administered?

Creyos cognitive tasks are designed to be administered multiple times to the same patient. Most clinicians using the dementia screener and assessment administer them once every six months to one year.

The puzzles within each task are randomized, so that on most tasks, a patient never sees the same puzzle or sequence more than once. This helps minimize practice effects, and ensure clinicians can accurately measure cognition at multiple time points. The full dementia assessment's report will display multiple time points and highlight meaningful changes in scores, when present.

Taking the protocol multiple times can lead to small improvements in performance in healthy populations. Some patients may be expected to have higher scores on subsequent administrations (and thus a lower chance of being classified as impaired). However, dementia tends to attenuate practice effects (Jutten et al., 2020), so declining performance despite practice may be another reason for concern when assessing for dementia.

Why is the cutoff for "below average" on the main Creyos cognitive report different from the cutoff for impairment in the dementia assessment?

The score on a specific cognitive task on the main Creyos cognitive reports is considered below average if it is in the bottom 20% of scores according to norms (see the Creyos Report Interpretation Guide for details). This is slightly different from the cutoff for a task to be flagged for impairment in the dementia assessment, which is one standard deviation below average, or approximately the bottom 16%. There are several reasons for this. First, a one standard deviation cutoff is common in dementia literature for identifying mild impairment, so this cutoff better matches dementia-specific research. Second, a flag for overall cognitive impairment requires several tasks to be considered impaired, so a more lenient cutoff is warranted. Percentiles and standard scores are available on both types of reports for direct comparisons between them.

Can the dementia protocol be used alongside other Creyos assessments?

Yes, administering other assessments may enhance understanding of a patient's health. The Creyos platform contains multiple types of assessments, such as additional cognitive tasks, questionnaires for mental and physical health conditions, and an ADHD-specific protocol. Examples include:

- Administering other questionnaires to assist in determining comorbidities or as part of a differential diagnosis.
- Administering all 12 core cognitive tasks to help estimate overall intelligence or identify cognitive impairments outside of the battery included in the dementia protocol.
- Administering a shorter custom battery for specialized purposes, such as quickly measuring effects of medication, scheduled assessments to track longitudinal trends, or sample assessments for marketing.

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Already using Creyos and have questions about our dementia protocol?

Contact us anytime at help@creyos.com

Not yet using Creyos and want to learn more about how it can help you with dementia screening and assessment?

Reach out at contact@creyos.com