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Sorting and chocolate: How to evaluate severe intellectual disabilities in adults?

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Abstract

For the purposes of not underestimating the cognitive abilities of adults living with a several intellectual disabilities, we developed a cognitive evaluation tool adapted to these individuals. Within this framework, we will first present our test series: the ID Test Series (ID for Intellectual Disabilities) for cognitive evaluation. Second, we will present the analyses (*N*=80) which enabled us to conclude that our test series did not minimize their cognitive abilities, but much to the contrary brought out their resources. All this with a goal to help these individuals use their resources in their environment and facilitate their daily life.

Keywords: Severe intellectual disabilities, Adult population, Cognitive evaluation, Non-verbal tests, Cognitive abilities, ID Test Series.

Introduction

Cognitive evaluation consists in evaluating several processes with the goal of measuring the intellectual functioning of an individual. The principal processes are memory, attention, and gnosias. They are more commonly measured using the WAIS.

The WAIS is a test series evaluating intellectual functioning in adults starting at the age of 16 years old (Ryan et al., 1990); currently the WAIS is in its 4thedition. However, there is a major problem with this evaluation: the vast majority of the test is composed of verbal tests. Language dominates in these tests, and not only does one need it to answer the questions but also to know whether the subjects have understood the instructions. But if a person doesn't respond to a question, does this mean that the person hasn't understood it? There are several ways to explain a failed response: badly communicated instruction, memory deficiency, or even a limited verbal communication. These are the types of situations that can be encountered with individuals with intellectual disabilities. Indeed, according to the DSM-IV-TR (DSM-IV, 2000), the two diagnostic criteria for mental retardation are: (1) Significantly sub-average intellectual functioning: an IQ of approximately 70 or below, and (2) impairments in communication.

There do exist adapted tools for measuring the social and adaptive aptitudes of individuals with mental retardation. However, the available tools have two inconveniences. First, they do not evaluate the individual's cognitive abilities, contrary to the WAIS-IV, and second, they only measure skills at the verbal level (Grasset et al., 2008).

If there is a suspicion of mental retardation, why continue to evaluate these individuals with a test series that is mostly verbal, knowing that these individuals have language deficits? The score results will automatically be low, thus reporting insufficient cognitive abilities. An obviously erroneous conclusion as this type of evaluation will underestimate their cognitive abilities.
This means it is important then to evaluate the abovementioned processes without relying on the verbal skills of this population, particularly those with a severe intellectual disabilities (QI<40) or very serious communication deficiencies, especially verbal communication (Giuliani et al., 2009). And this cannot be done using the commonly-used tests in which the subtests are mainly verbal.

To address these shortcomings in psychiatry, in 2008 the authors wrote a protocol to develop a cognitive evaluation test series adapted to this population. The protocol (n° 48/08) was approved by the Ethics Committee. The test series is non-verbal and composed of tests adjusted to an intellectual level of severe intellectual disabilities in order to correctly perceive the cognitive abilities of this population. It is called the ID Test Series for the cognitive evaluation of adults with a several intellectual disabilities. This test series is inspired by basic research and neuropsychological tests for evaluating the processes cited at the beginning of the introduction.

Theoretical background of the ID Test Series:
Our goal was to find the appropriate bases needed for evaluating the cognitive abilities of individuals with a several intellectual disabilities. To then take inspiration from these tests in order to create new ones which were non-verbal. The goal of this was: (a) not to skew the diagnosis or the co-morbidity, (b) determine the major deficiencies and (c) orient professional caretaking.
The tests which will be presented here below are divided into four different evaluation areas: vocabulary/knowledge of objects, attention, gnosias and memory. For each test, we were inspired by an existing test and adapted it to our adult population. We will briefly describe the existing test and how it was adapted.

1. **Vocabulary/knowledge of objects:**
   Our category entitled Vocabulary/knowledge of objects was inspired by the K-ABC. It's a test series measuring intelligence in children, in which language has a minimal role (Kaufman et al., 1987). To evaluate vocabulary, the "Follow-up word" subtest was interesting for our population. Images are laid out in front of the individual who must point to the image that corresponds to the image named by the evaluator. For the knowledge of objects, we were inspired by the "Charades" subtest. Images are also presented and the investigator describes an object using its attributes so that the individual can point to the image corresponding to the object described.

2. **Attention test:**
   Attention is the process which enables an individual to remain focused on certain characteristics of the environment, thoughts or actions and which is important in several aspects of cognition, like memory, language and perception (Goldstein, 2011). Attention is

also defined as three functions: orientation toward sensory stimulation, executive functions, and maintaining the state of alertness (Berger and Posner, 2000). There are numerous cerebral regions involved in attention and they depend on function. For example, the regions activated during visual attention are the parietal lobe, the oculo-motor system and the fusiforme gyrus; for the state of alertness it is the frontal lobes and right parietals and the coeruleus locus that are involved (Berger and Posner, 2000).

We were inspired by Corsi's blocks test, which is a neuropsychological tool evaluating visual attention and the visuo-spatial working memory (Milner, 1971). The investigator points to a series of blocks that the subject must then point to in turn. There are several trials and the sequences become longer and longer.

3. **Evaluation of gnosias:**

Gnosias are defined as the ability to recognize objects (Mazeau, 2005). A visual object agnosia is described as the inability of naming objects received through visual entry, to mimic their use, and to match them with other objects according to their function (Marendaz, 2003). Certain individuals may also have difficulties matching colors, objects, or the image of an object with the real object. An inability to match colors can signify a color agnosia, which is caused by lesions in the left temporoparietal region (van Zandvoort et al., 2007). In certain situations, there are individuals who do not manage to match two objects of the same shape or the image of an object with the real object. These individuals have an aperceptive agnosia, which is the result of bilateral lesions (Cambier, 1995).

We retained two methods of evaluating the gnosias: the abilities for classification and the visual gnosias. For these two evaluations, the method used was matching. This is an effective method for evaluating cognitive abilities because verbal language isn't necessary and it makes it possible to see if the subjects have understood the instruction.

Capacities for classification include matching shapes and matching colors, and we were inspired by the VMI and the Wisconsin Card Sorting Test. For shapes, the "Visual Perception" test from the VMI is a paper and pencil test (Heiz and Barisnikov, 2016). Subjects are asked to match geometric shapes together, following a target shape and three response choices. It is a purely perceptive test because it is non-verbal. The "Wisconsin Card Sorting Test" (Grant and Berg, 1948) is administered using cards. Although this test is more complex that a simple color matching, the idea of asking subjects to sort cards by color was a method that interested us for our test series.

Visual gnosias are evaluated using images. Gillet and collaborators (Gillet, 2009) used the "Perceptive Categorization" test to evaluate the matching abilities of children. On each test card there are three images, with the target object at the top, represented at an angle. The person must match, by pointing, the target object with one of the other images corresponding to the same object, but presented at a different angle. Another tool which helped us evaluate visual gnosias was the "ComVoor". This is a test series for evaluating precursors to communication, in which language is not used but is replaced by imitation (Verpoorten et al., 2012). One of the tests also uses images, pictures or drawn, and objects. Subjects are asked to match the image of the object or the image of the drawn object to the

real object. We were inspired by the method and the mechanism of these two tests for evaluating visual gnosias with the ID Test Series.

4. **Memory evaluation:**

   Memory is a process that makes it possible to record new information, to store this information, and to call it up (Deschamps and Moulignier, 2005, Habib, 1993). Studies conducted on animals and humans show that several brain regions are involved in memory, for example the hippocampus (Squire et al., 1992), the orbitofrontal cortex (Deschamps and Moulignier, 2005), and even the prefrontal cortex (Goldstein, 2011).

   It is important for evaluating the memory capacities of individuals with severe mental retardation that the "calling up" element of memory is non-verbal. Giuliani and collaborators (Giuliani et al., 2009) designed an experimental model adapted to their population's skills and which does not use verbal language. This was the "Cups" model. The test was inspired by animal models, in particular the "Homing Procedure" (Schenk, 1989) measuring spatial memory in adult rodents. As it is included in our series, this model will be described later.

Materials and Methods

Sample:

The test series was administered to 80 adult subjects. For all participants, their verbal communication abilities are very limited, even non-existent. The subjects are patients under care in the Section of Psychiatry of Mental Development at the CHUV. Before participating in the study, all subjects had previously been diagnosed with several intellectual disabilities. The WAIS-IV is verbal and so it was not administered because it does not make it possible to quantify the severity of the intellectual disabilities. Nevertheless, a scale evaluating various characteristics (health, autonomy, social skills, etc.) was filled out. The scale used was the AAIDD (American Association on Intellectual and Developmental Disabilities) which categorizes the limits of adaptive functioning (Table 1). Table 1 shows that our entire population has an absolute limit in cognitive areas such as: communication, utility of community resources, and functional educational skills. The results from this scale, along with other clinical signs, firmly conclude on severe mental retardation. The sample was composed of 28 women (35%) and 52 men (65%), with an IQ between 40 and 20, and an average age of 41.04 ± 9.51 years.

Table 1: Percentage of limitation associated with each area across the total population (N=80).

Areas	% of limitation
Communication	100
Personal care	46.4
Domestic skills	41.6
Social skills	45.6
Use of community resources	100
Autonomy	37.6
Health	55.2
Safety	100

Functional educational skills	100
Leisure and work	36

ID Test Series:

To measure cognitive and memory abilities, this test series was special in that it used concrete objects and not tests administered on a computer.

Our test series was composed of 9 subtests divided into four categories, which were themselves presented in the theoretical support section. Table 2 illustrates the tests that made up each category.

We hypothesized that our test series would enable us to evaluate the cognitive abilities of individuals with a several intellectual disabilities, and as a result to bring out their cognitive resources, something which does not occur with typical evaluations. The goal of this was to then transpose this tool into their environment, in the sense of valorizing their cognitive resources so they can be used in their daily life.

Table 2: List of subtests for the ID Test Series by evaluation category.

Evaluation Categories	Subtests
Vocabulary/knowledge of objects	Designation
	Designation with complex statement
Attention test	Visual attention
Evaluation of gnosias	
Classification capacities	Classification of shapes
	Classification of colors
Visual gnosias	Prototypical images
	Non-prototypical images
	Drawn images
Memory evaluation	Cups

Vocabulary/knowledge of objects:

This part of the evaluation involves 12 objects: a book, a ball, a pencil, a cup, a bottle of water, a spoon, a package of tissues, a sock, a sponge, a toothbrush, glasses, and a mobile phone (Image 1). Two tests are conducted using these objects, one for vocabulary and one for knowledge of objects.

Designation:

The 12 objects are laid out randomly in front of the subject. To evaluate the subject's vocabulary, the evaluator asks the subject to indicate the object that is mentioned: "*Show me the spoon* ", "*Show me...*".

Designation with complex statement:

The objects are also laid out in front of the subject. This time the evaluator's request is more difficult because s/he asks the subject to indicate an object by describing its function, "*Show me the object used for brushing teeth"*. This makes it a test evaluating the knowledge of objects.

For these two tests, if the subject points to the correct object it means s/he has understood the instruction and has a good capacity for understanding.

Image 1: The 12 objects making up the first category of the test series.

Attention test:

This category is comprised of a single test. It involves a visual attention diagram containing 23 points (Image 2). The diagram is presented on an A4 sheet of paper handed out to the subject.

Visual attention:

The subject is requested to link or strike out the black dots with a pencil. Depending on the subject's motor skills, it is possible to do the test without a pencil—what is important is being able to see that the subject has seen all the points.

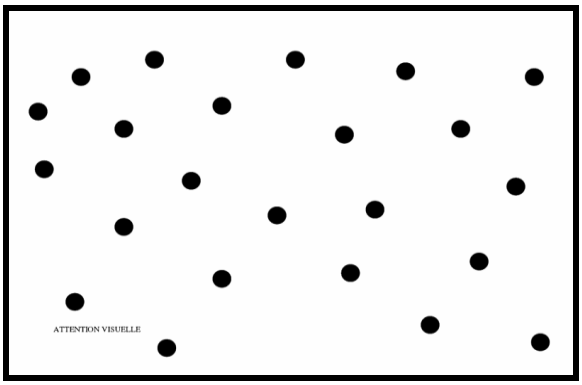

Image 2: The visual attention diagram distributed to each subject

Evaluation of gnosias:

To classify shapes, the test involves three different shapes (fish, key ring, tweezers) in the same color (blue) and a green carpet. And to classify the colors, the test involves objects of the same shape (plastic flowers) but different colors (red, yellow and blue) and the same carpet.

Classification of shapes:

The three different shaped objects are placed on the carpet in front of the subject. The evaluator places an example of the three objects on the carpet (Image 3A). The carpet enables the subject to remain focused on this space. The evaluator shows how to match the objects depending on their shape and that the subject should proceed as indicated.

Classification of colors:

The evaluator also places a flower of each color onto the carpet and shows the subject how to match the flowers by color (Image 3B). Same as for the shapes, the subject continues on to complete the task alone.

Image 3: Set-up for the "Classification of shapes" (A) and "Classification of colors" (B) subtests.

Three tests make it possible to measure the visual gnosias. They are made up of objects (those in the first category) and three kinds of images, representing the same 12 objects.

Prototypical images:

After the evaluator has demonstrated, the subject is instructed to match the image of an object presented in a prototypical angle with the real object (Image 4A). And do this for all 12 objects.

Non-prototypical images:

Same as for the 12 objects, the subject must match the image of the object presented in a non-prototypical angle with the real object (Image 4B).

Drawn images:

Here the subject must match the image of the object presented as a drawing with the real object, for all 12 objects (Image 4C).

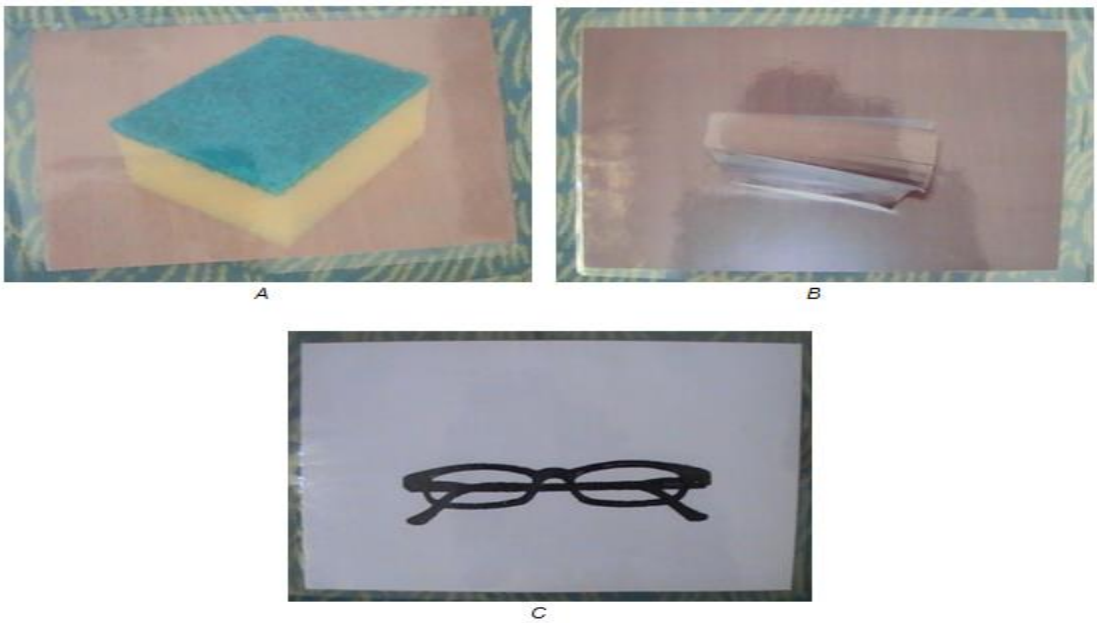

Image 4: Example for each type of image evaluating the visual gnosias: prototypical (A), non-prototypical (B) and drawn (C).

The images are photographed at two different angles: prototypical *versus* non-prototypical. This makes it possible to see if the subjects are able to picture the object, or the image of an object shown via different angles. In other words, whether the subject is able to recognize the object once it has been rotated in the subject's mind. This is the work of the mental representation of the object, using the hippocampus and the cognitive map (Jacobs and Schenk, 2003). The drawn images, in their turn, make it possible to know, even when drawn, that the object remains the object in question. It is possible, because it's drawn, that it isn't the same object for individuals with a several intellectual disabilities.

Memory evaluation:

Memory was evaluated using the "Cups" test (Guiliani et al., 2009). The model includes 6 blue cups, 1 white cup, 6 small rectangular wooden pieces, 1 chocolate and a large gray disk used to help with focus.

Cups:

This test is conducted in 7 Trials. In the first six Trials, only the blue cups are used, and are laid out in a circle on the gray disk before the subject (Image 5). In the first two Trials, a chocolate is placed under one of the cups and the small wooden rectangles are placed under the others (these are decoys). After 10 seconds, the subject is asked to find the chocolate. The same process is repeated for the 3rd Trial, only the subject is asked to find the chocolate after one minute. For the 4th Trial, after having placed the chocolate and the decoys under the cups, the subject is asked to turn 90° and then find the chocolate. Trial 5 is conducted the same way except the subject is asked to turn 180°. In Trial 6, the evaluator introduces an interference activity of at least 30 minutes before the subject is asked to find the chocolate. For the final Trial, the white cup is placed on the disk, the chocolate is placed beneath it and one blue cup is taken away. This is done in front of the subject. Then the subject is asked to go into another room, to bring us a glass of water for example, and while the subject is gone the white cup and the chocolate are moved to another location on the gray disk and a blue cup and a second chocolate are put in place of the white cup (Image 8). When the subject returns, s/he is asked to find the chocolate, and also asked whether there is another place where a chocolate might be found.

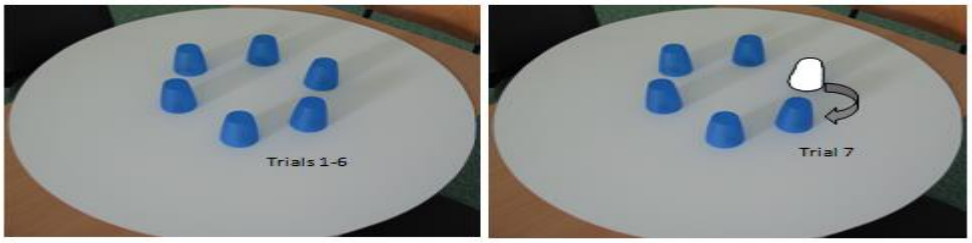

Image 5: Set-up of "Cups" subtest

An interesting point of this test is that it evaluates different kinds of memory. In Trials 1 - 3, the test is measuring short-term memory. In Trials 4 and 5, the test is measuring visuo-spatial memory and in Trial 6 it's evaluating long-term memory. And finally, Trial 7 includes short-term memory, visuo-spatial memory, as well as attention to newness.

Sequence of the Test Series:

The evaluation test series begins with the Cups test, Trials 1 - 6. During the 30-min interference activity (Trial 6), the other tests of the series are conducted in order to test long-term memory. Then Trial 6 is continued, followed by Trial 7. The total time to administer the series depends on the individuals and varies between 60 to 90 minutes.

We also asked the subject if s/he agrees to be filmed during the tests. The video makes it possible to look again at the evaluation in order to score the different subtests. Indeed, the latter are not scored while being administered so that the investigator and the subject can fully engage in a Piagetian interaction. This also means the subject can have fun and forget that this is actually a test, which helps reduce the subject's anxiety.

Results

Statistical analyses were conducted using Statview 5.0. Repeated measures ANOVA and paired T-tests were conducted in order to know the significance of each subtest, with a threshold of 0.05. To see these results, see Table 3.

Table 3: Results summary.

Subtests	***p***
Designation *vs* Designation with complex statement	*
Visual attention	*ns*
Classification of shapes	*ns*
Classification of colors	*
Visual gnosias [1]	*
Cups	*

* = significantly lower than 0.05.

[1] = the three types of images are included in the significance.

Designation versus Designation with complex statement:

The results show a significant difference between the two subtests ($t(79)=4.007$, $p<.0001$), indicating a much greater complexity for « Designation with complex statement ». The results also show significant differences of difficulty between the items.

Visual attention:

The results indicate that the test was not significant. Only 23 of the 80 subjects in our sample (28.75%) were able to cross off all the black points.

Classification abilities:

The results for "Classification of shapes" were not significant, demonstrating an indifferent perception between the three objects. While the "Classification of colors" test was significant ($F(2,77)= 4.630$, $p=.0112$), indicating a discrimination and recognition of colors from among those in our sample.

Visual gnosias:

The results indicate significant differences between the types of matching ($F(8,77)=27.800$, $p<.0001$), which signifies that the three types of images do measure different aspects of cognition. Essentially, the significance of the test implies that the images have different difficulty levels. The "Prototypical Images"

were easier to match with the real object than the "Drawn images", which were in turn easier to match than the "Non-prototypical Images".

Cups:

The analyses show that there were significant differences ($F(8,77)=47.155$, $p<.0001$) between the test trials, indicating various levels of difficulty. The results tell us that Trials 1 to 3 were better achieved than the others for the vast majority of the participants, which is shown by higher performances than in the other trials.

Discussion

Interpretation of results:

Looking at the results, we effectively show that the ID Test Series is efficient in evaluating cognitive aptitudes in individuals with severe intellectual disabilities. In other words, our results demonstrate that most of the subtests do a good job evaluating cognitive abilities because the test series make it possible to bring out the skills and difficulties of the subjects. Each category will be interpreted.

Vocabulary/knowledge of objects:

The objects selected for the two subtests composing this category are daily-use objects, implying the same level of difficulty for each subject.

The results show that the performances of our sample were higher for vocabulary than for knowledge of the objects. Although we obtained high scores for both subtests, the success percentage was higher for "Designation", with a score of 90%, than it was for "Designation with a complex statement" (75% success). This difference in success was also significant. The high performances for these two subtests indicate the subjects have high capacities for understanding and good knowledge of the objects they find in their environment and daily life.

Attention test:

As mentioned in the results section, we obtained 28.75% success in this attention test.

This indicates the difficulties in terms of attention for individuals presenting a several intellectual disabilities.

Evaluation of gnosias:

The results indicated better performances in "Classification of colors" than in "Classification of shapes." With significant results, the colors were perceived by the subjects and it seemed that certain colors were more difficult to match: red ≤ yellow < blue. The non-significant result for the shapes can be explained by the fact that the objects selected were not meaningful for the subjects and less accessible in their environment. In other words, it is possible that the subjects were unable to match the objects because they did not know their function. And that they failed this test because they did not take their shape into consideration but their meaning. The results go more in the direction of this interpretation than toward a defect in the choice of method, given that the matching method was used in other subtests of the series and that it worked, as shown by the results.

Concerning the images, the analyses show that the test was significant. But also that's certain types of images were more difficult to match with their corresponding real objects than others. Indeed, the results indicate 90% success with the prototypical images, compared to only 50% for the non-prototypical, compared to 76% for the drawn images. Additional analyses made it possible to confirm that the success gap between each type of image (prototypical, non-prototypical and drawn) is highly significant.

Although the scores were high for the three image types, the results indicate a difficulty in object permanence, as explained by Jacobs and Schenk (2003), when the objects are presented under a non-prototypical angle. This can indicate a deficiency in perception and information processing at the level of the hippocampus.

Memory evaluation:

The different performances of the subjects depending on the trials brought us to the following interpretations regarding their memory capacities: First, that's individuals with a severe intellectual disabilities have a good short-term memory, which was demonstrated by high scores in Trials 1 to 3. Then, the trials measuring long-term memory and visuo-spatial memory produced comparatively lower scores. This perhaps indicates a deficiency in passing between short-term memory and long-term memory as well as difficulties with object permanence, which is also explained by a problem in the hippocampus (Jacobs and Schenk, 2003). While scores were lower compared to short-term memory, the scores for Trials 4 to 7 were not zero, signifying that certain subjects do have memory capacities.

Limitations and contributions of this study:

This study and its results demonstrate several things. First, our study exposes the benefits brought through our test series on the cognitive evaluation of individuals with a several intellectual disabilities. It is a tool that is adapted to this adult population, evaluating the different cognitive processes without relying on verbal communication. Next, the ID Test Series has some advantages for patients: being non-verbal, the tool makes it possible for subjects to respond correctly and make themselves understood; the modalities and mechanisms are accessible for the patients. These two points mean that this evaluation is less stressful compared to a standard evaluation.

One of the limits of our study was that we did not compare our work to another cognitive evaluation tool. Another limit is that we could never administer our test series to a control group of individuals without any mental handicap because given the simplicity of the tasks, there would be a ceiling effect.

Future perspectives:

In terms of future studies, it would be interesting to conduct studies on the precision and validity of the tool since this was not investigated in this research. One idea, for example, would be evaluating different levels of mental retardation or several heterogeneous samples of mental retardation. Finally, studies looking to compare our test series with other tools measuring the same cognitive processes should be conducted across a large sample.

Conclusion:

To conclude, more than the evaluation of the cognitive abilities of individuals with severe mental retardation, our test series makes it possible to measure their cognitive resources, and by extension their difficulties. This is what we hypothesized. Our test series did not reveal a floor effect with this population, which consequently demonstrates the pertinence of cognitive evaluation. Evaluating their resources makes it possible for health professionals to bring out the functioning of their aptitudes in daily life. And this in order to establish an individualized therapeutic plan that respects their abilities, thus helping our patients transpose the resources they have in their daily life environment to create a better quality of life.

Additional comments: All authors contributed equally to this article. Fabienne Giuliani collaborated on creating the ID Test Series, conducted the trials with the patients and writing the article. Natacha D'Armi contributed through scientific research, developing the overview and writing the article.

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