Thesis

Analogical reasoning and working memory in students with intellectual disability: effects of actively constructing the response on a touch screen

DENAES, Caroline

Abstract

This thesis project focused on the evaluation of a memory overload hypothesis in analogical reasoning tasks. It is said that individuals with moderate intellectual disability (mental age: 4-7) are confronted to a memory overload when they have to treat several relations at the same time in analogical matrices. In order to test this assumption, we created a computerized test using a touch screen, the Revised - Construction of Analogical Matrices Test (CAM-R), composed of a construction version, supposed to unload the memory, and a control version, supposed to overload the memory. As expected, memory abilities played a crucial role in the classic version and less in the construction version. Our results strongly indicated that, with the support of external memories, participants with moderate intellectual disability obtained better performances than without such support, and were able to reach a similar level of performance as typically developing children of the same mental age.

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APPENDICES

Analogical reasoning and Working Memory in Students with Intellectual Disability:

Effects of actively constructing the response on a Touch Screen

Caroline DENAES-BRUTTIN
A. Raven’s Colored Progressive Matrices p.4
   a. A Form p.5
   b. AB Form p.11
   c. B Form p.17

B. Working Memory and Short-Term Memory tasks p.23
   a. Verbal Working Memory Tasks p.23
      i. Word Span Task p.23
      ii. Selective Word Recall p.26
      iii. Dual Task p.29
   b. Visual tasks p.32
      i. Memory for Positions p.32
      ii. Selective Positions p.39
      iii. Pathways p.45
      iv. Selective Pathways p.47
      v. Dual Task p.50

C. CAM-R Items p.54
   1. Ice-cream item (Training, 1st level) p.54
   2. Flower Item (Training, 1st level) p.55
   3. Lemon Item (Training, 1st level) p.56
   4. Candle Item (Training, 1st level) p.57
   5. Girl Item (Training, 2nd level) p.58
   6. Rabbit Item (Training, 2nd level) p.59
   7. Ladybird Item (Training, 2nd level) p.60
   8. Beach Item (Training, 2nd level) p.61
   9. Pear Item (1st level) p.62
   10. Bike Item (1st level) p.63
   11. Carrot Item (1st level) p.64
   12. Book Item (1st level) p.65
   13. Swimming Pool Item (2nd level) p.66
   14. Truck Item (2nd level) p.67
   15. Window Item (2nd level) p.68
   16. Mouse Item (2nd level) p.69
   17. Snail Item (3rd level) p.70
   18. Car Item (3rd level) p.71
   19. Dog Item (3rd level) p.72
   20. Umbrella Item (3rd level) p.73
   21. Clown Item (4th level) p.74
   22. Train Item (4th level) p.75
   23. Baby carriage Item (4th level) p.76
   24. Tree item (4th level) p.77
D. Standardized instructions

E. CAM-R-revised

1. Ice-cream item (Training, 1st level) p.85
2. Flower Item (Training, 1st level) p.86
3. Lemon Item (Training, 1st level) p.87
4. Candle Item (Training, 1st level) p.88
5. Girl Item (Training, 2nd level) p.89
6. Rabbit Item (Training, 2nd level) p.90
7. Ladybird Item (Training, 2nd level) p.91
8. Beach Item (Training, 2nd level) p.92
9. Pear Item (1st level) p.93
10. Bike Item (1st level) p.94
11. Cake Item (1st level) p.95
12. Curtain Item (1st level) p.96
13. Swimming Pool Item (2nd level) p.97
14. Truck Item (2nd level) p.98
15. Window Item (2nd level) p.99
16. Mouse Item (2nd level) p.100
17. Snail Item (3rd level) p.101
18. Car Item (3rd level) p.102
19. Umbrella Item (3rd level) p.103
20. Cat Item (3rd level) p.104
21. Clown Item (4th level) p.105
22. Train Item (4th level) p.106
23. Baby carriage Item (4th level) p.107
24. Tree item (4th level) p.108
Appendix A: Raven’s Colored Progressive Matrices
Appendix A.1. : CPM-A Form
Appendix A.1. : CPM-A Form

A9

A10

1 2 3

4 5 6
Appendix A.1: CPM-A Form
Appendix A.2. : CPM-AB Form
Appendix A.2. : CPM-AB Form
Appendix A.2. : CPM-AB Form
Appendix A.2: CPM-AB Form
Appendix A.2. : CPM-AB Form

[Diagram of CPM-AB Form Aa 11 with numbered patterns 1-6]

[Diagram of CPM-AB Form As 12 with numbered patterns 1-4]
Appendix A.3. : CPM-B Form
Appendix A.3. : CPM-B Form

![Diagram B5]

![Diagram B6]
Appendix A.3: CPM-B Form

B 7

1  2  3

4  5  6

B 8

1  2  3

4  5  6
Appendix A.3. : CPM-B Form

B 9

B 10
Appendix B: Working Memory and Short-Term Memory Tasks
Appendix B.1. Verbal Working Memory Tasks
Appendix B.1.i. Word Span Task

WORD SPAN TASK

The child is presented with lists of 2 to 5 words and is required to repeat the list immediately and in the same order as presented.

Eight lists of words compose the task, 2 lists of 2 words, 2 lists of 3 words, 2 lists of 4 words and 2 lists of 5 words.

Before starting the task, an example is given to the child, in order to better explain the task and to be sure that the task has been understood.

“Now I am going to tell you some words and you have to repeat them in the same order I tell them to you”

Then the experimenter reads, at a rate of a word every second, the first list of words. When finished he waits until the child repeats them.

The experimenter has to record every single word repeated by the child and the order of repetition.

The score of 1 is given when the child repeats correctly all the word of a list, otherwise the score is 0. The task is interrupted when the child fails in repeating both the lists of the same length. For the remaining lists the score of 0 is automatically given.

The minimum score is 0, the maximum is 8.
EX. HOUSE   CAT

1. BALL   MUM
2. FISH   SUN
3. MUM   CAT   SUN
4. PEAR   FLOWER   DOG
5. BALL   MUM   PEAR   CAT
6. HOUSE   DAD   DOG   MOUSE
7. APPLE   HOUSE   SUN   FLOWER   DOG
8. PEAR   STAR   APPLE   HOUSE   CAT
Appendix B.1.i. Word Span Task

WORD SPAN TASK (French version)

FEUILLE DE NOTATION

Ex : maison/chat

1. ballon/man

2. poisson/soleil

3. maman/voiture/soleil

4. banane/salade/bateau

5. ballon/man/banane/voiture

6. maison/papa/bateau/souris

7. citron/maison/soleil/salade/bateau

8. banane/nuage/citron/man/voiture

Score : /8
SELECTIVE WORD RECALL

The child is presented with one or two lists of words and is required to repeat the first word of each list after the presentation of the entire set of materials. There are 4 levels of difficulty, depending on the number of lists (1 or 2) and the number of words in each list (2, 3, or 4). In order to make clear the concept of list to the child, words are written on colored cards. The words of the same list are written on the same color cards, while every list is written on different color card. The experimenter reads, at a rate of 1 word every second, the words from the cards.

The task starts with the example.
“Here are some colored cards, see? (the experimenter shows the cards to the child). On every card there is a written word (the experimenter shows the word written on every card). Now I am going to read you the words. Listen carefully and try to remember the first word that I say”. The experimenter takes the first two cards, that are of the same color, and reads the two words written on them. After reading he puts every single card above the table, one above the other, the side with the word written down, so that the child can’t see the word. Then he asks to the child: “What was the first word that I said?”

The task starts only when the child has understood the instructions.

At the list 5, the experimenter says: Now be careful, because from now there are cards of two colors, and you have to remember two words: the first blue word (the experimenter shows the blue cards) and the first red word (the experimenter shows the red cards)”. The experimenter reads all the blue words from the cards, putting them on a pile on the table, and then all the red words, putting the red cards on a new pile. Then he asks “What was the first blue word” And the first rend word?”

The experimenter records every word said by the child, exactly in the same order. The task is interrupted when the child fails with both the lists of the same length. The score of 0 is recorded for all the remaining lists.
Appendix B.1.ii. Selective Word Recall

For the items with only one list (1 to 4), the score of 1 is given when the first word of the list is correctly recalled, otherwise the score of 0 is given. For items 5 to 8, the score of 1 is given only when the child repeats correctly the first word of both lists; in all the other cases the score of 0 is given.

The minimum score is 0, the maximum is 8.

Ex. MUM     DOG

1. **MOON**   **APPLE**     (red)
2. **CAT**    **DAD**       (blue)
3. **SUN**    **HOUSE**    **PEAR**  (red)
4. **GRANDMA** **BALL**    **MOON**  (blue)
5. **DOG**    **APPLE**    **SUN**    **GRANDMA** (blue)
6. **HOUSE**  **BALL**     (red)
    **MUM**    **CAT**       (blue)
7. **GRANDMA** **DAD**      **MOON**  (red)
    **SUN**    **APPLE**    **DOG**    (blue)
8. **MUM**    **HOUSE**    **BALL**  (red)
    **PEAR**  **CAT**      **DAD**    (blue)
# SELECTIVE WORD RECALL (French version)

**FEUILLE DE NOTATION**

Ex : `maman` | `voiture`

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><code>nuage</code></td>
<td><code>citron</code></td>
</tr>
<tr>
<td>2.</td>
<td><code>voiture</code></td>
<td><code>papa</code></td>
</tr>
<tr>
<td>3.</td>
<td><code>soleil</code></td>
<td><code>maison</code></td>
</tr>
<tr>
<td>4.</td>
<td><code>salade</code></td>
<td><code>ballon</code></td>
</tr>
<tr>
<td>5.</td>
<td><code>bateau</code></td>
<td><code>citron</code></td>
</tr>
<tr>
<td><code>soleil</code></td>
<td><code>salade</code></td>
<td>(bleu)</td>
</tr>
<tr>
<td>6.</td>
<td><code>maison</code></td>
<td><code>ballon</code></td>
</tr>
<tr>
<td><code>maman</code></td>
<td><code>voiture</code></td>
<td>(bleu)</td>
</tr>
<tr>
<td>7.</td>
<td><code>salade</code></td>
<td><code>papa</code></td>
</tr>
<tr>
<td><code>soleil</code></td>
<td><code>citron</code></td>
<td><code>bateau</code></td>
</tr>
<tr>
<td>8.</td>
<td><code>maman</code></td>
<td><code>maison</code></td>
</tr>
<tr>
<td><code>banane</code></td>
<td><code>voiture</code></td>
<td><code>papa</code></td>
</tr>
</tbody>
</table>

**Score : /8**
DUAL TASK

The child is presented with a list of 2 to 5 words and is asked to remember the first word of the list and to tap his/her hand on the table when the word “BALL” is presented. Two lists of words for every level of difficulty are presented.

In order to facilitate the comprehension of the instructions, the child is given a preliminary practice trial with the secondary tapping task only. “I am going to read you some words. When I say the word BALL, only when I say BALL, you have to tap you hand on the table, like that (the experimenter taps his hand on the table).

Training items (the experimenter reads them at the rate of 1 word every second)

MUM  BALL  HOME
BALL  SUN  DOG
CAT  MOON  BALL

When the child has understood the task, the experimenter says: “Now the task becomes a little more difficult, because you still have to tap your hand on the table when I say the word BALL, but you also have to remember the first word that I say. So you have two things to do: remember the first word that I say and tap your hand on the table when I say the word BALL”.

The task starts with the example. The experimenter reads the two words at a rate of 1 word every second, and asks: “What was the first word that I said?”. The task begins only if the child has understood the instructions. If the child doesn’t understand the task, the experimenter says: “The words that I have told you were MUM and BALL, so the first word that I have said is MUM”.

The experimenter takes note of:
- The words repeated by the child
- If the child performs the tapping task
Appendix B.1.iii. Dual Task

The task is interrupted when the child fails both the lists of the same length. The score of 0 is recorded for all the remaining lists.

The score of 1 is given every time that the child recalls correctly the first word of the list and at the same time performs the tapping task. In all the other cases, included when the child forgets to tap, the score of 0 is given.

The minimum score is 0, the maximum is 8.

Ex. MUM  **BALL**

1. DOG  **BALL**
2. **BALL**  MOON
3. HOUSE  DOG  **BALL**
4. CAT  **BALL**  DAD
5. MUM  MOON  **BALL**  HOME
6. SUN  **BALL**  MOUSE  DOG
7. CAT  GRANDMA  **BALL**  MOON  PEAR
8. APPLE  MUM  HOUSE  SUN  **BALL**
DUAL TASK (French version)

Exemple : Maman ballon

1. bateau ballon Taper

2. ballon nuage Taper

3. maison bateau ballon Taper

4. voiture ballon papa Taper

5. maman nuage ballon maison Taper

6. soleil ballon souris bateau Taper

7. voiture salade ballon nuage banane Taper

8. citron maman maison soleil ballon Taper

Score : /8
Appendix B.2. Visual Tasks

Appendix B.2.i. Memory for Positions

MEMORY FOR POSITIONS

In this task, the child has 10 seconds to remember the position of the cells filled in green on a 2×2, 3×3 or 4×4 chessboard. The task has 5 levels of difficulty according to the number of squares to be remembered (from 2 to 4) and the size of the chessboard, 2×2 at the first level, 3×3 at the second and third levels (with 2 and 3 green squares, respectively), and 4×4 at the other levels (2 and 3 green squares). Each level has two trials.

A chessboard with some of the cells filled in green is shown for 10 seconds to the child. The experimenter says to the child: “Look carefully to this chessboard and try to remember where the green squares are”. Then the experimenter remove the chessboard and shows to the child a new empty one. The experimenter asks to the child “Can you show me where the green squares were?”

An example is presented to the child and the task starts only when the child has understood the instructions.

The experimenter has to record the positions that the children shows.

The task is interrupted when the child fails with both the patterns of the same length. The score of 0 is recorded for all the remaining patterns.

The score of 1 is given for every pattern correctly recalled, 0 in all the other cases. The minimum score is 0, the maximum is 8.
Appendix B.2.i. Memory for Positions

PATTERNS

ES.

1

2

3

4

5

6

7

8

9

10

TOTAL

FOR SCORING
Appendix B.2.i. Memory for Positions
Appendix B.2.i. Memory for Positions
Appendix B.2.i. Memory for Positions
Appendix B.2.i. Memory for Positions
SELECTIVE POSITIONS

The child is presented with a 2×2 or 3×3 or 4×4 chessboard with some red and some green squares. He is required to look at it for 10 seconds. “Look carefully to this chessboard and try to remember where the green and red squares are”. Immediately after removal of the chessboard the child has to recall, looking at a white chessboard, in half of the trials the position of the red squares and in half of the trials the position of the green squares. In items 1, 3, 5, 7, the experimenter asks “Can you show me where the red squares were?”. In items 2, 4, 6, 8 the experimenter asks “Can you show me were the green squares were?”. The task has 5 levels of difficulty according to the number of squares to be remembered (from 2 to 4) and the size of the chessboard, 2×2 at the first level, 3×3 at the second and third levels (with 2 and 3 green squares, respectively), and 4×4 at the other levels (2, and 3 green squares). Each level has 2 trials.

An example is presented to the child and the task starts only when the child has understood the instructions.

The experimenter has to record the positions that the child shows.

The task is interrupted when the child fails with both the patterns of the same length. The score of 0 is recorded for all the remaining patterns.

The score of 1 is given for every pattern correctly recalled, 0 in all the other cases. The minimum score is 0, the maximum is 8.
Appendix B.2.ii. Selective Positions

SELECTIVE PATTERNS

ES. 1 2

3

4

5 6

7 8

9

10
Appendix B.2.ii. Selective Positions
Appendix B.2.ii. Selective Positions
Appendix B.2.iii. Pathways

PATHWAYS

Each child is shown a path taken by a small frog on 3×3 or 4×4 chessboard. The child has to show the pathway immediately after the presentation. There are 4 levels of difficulty depending on the number of steps in the frog’s pathway and the dimensions of the chessboard (3×3 with 2 steps at the first level, and 4×4 with 2, 3, and 4 steps for levels 2, 3, and 4 respectively). For every level of difficulty there are 2 pathways. Steps are presented at the rate of approximately one step every 2 seconds.

“This is a frog. The frog jumps in some of these squares. For example, the frog jumps here (the experimenter puts the frog in the first square of the path) and then here (the experimenter puts the frog in the second step of the pathway). Can you show me the squares where the frog has jumped?”

The child can indicate the square with his finger or he can move the frog from cell to cell. An example is presented to the child and the task starts only when the child has understood the instructions.

The experimenter has to record the position that the children shows and their order.

The task is interrupted when the child fails with both the patterns of the same length. The score of 0 is recorded for all the remaining pathways.

The score of 1 is given for every pathway correctly recalled, 0 in all the other cases. The minimum score is 0, the maximum is 8.
Appendix B.2.iv. Selective Pathways

SELECTIVE PATHWAYS

The child is shown one or two paths taken on a 4×4 chessboard, as in the previous task. He is asked to remember the frog’s starting positions. The task has 4 different levels of difficulty, depending on the number of pathways (1 or 2) and the number of steps in each pathway (2 or 3). At levels 1 and 2, one pathway with 2 steps and one with 3 steps are performed. At levels 3 and 4, respectively, 2 pathways with 2 and 3 steps are presented. For these latter levels, 2 different pathways are taken by 2 different frogs in order to facilitate the child’s understanding of where the pathway ends. Two items of the same length are included in every level of difficulty.

The experimenter shows the example.

“The frog jumps on some of these squares. This time you have to remember only the first square where the frog jumps”. The experimenter shows the pattern to the child, then he asks “What is the first square where the frog has jumped?”.

If the child did not understand the task the experimenter says: “This is the first square where the frog is jumped” (and he shows it to him).

The task starts only when the child has understood the instructions.

Before the presentation of the pathway number 5 the experimenter says:

“Now there are one frog and one monkey. You have to remember the first square where the frog has jumped and the first square where the monkey has jumped”.

The experimenter shows the first and the second pathways and then he asks:

“Can you show me the first square where the frog has jumped? And the first square where the monkey has jumped?”

The task is interrupted when the child fails with both the patterns of the same length. The score of 0 is recorded for all the remaining pathways.

The experimenter has to record the position that the child shows and their order.

For the items 1 to 4, the score of 1 is given when the first position of the pathway is correctly recalled, otherwise the score of 0 is given. For items 5 to 8 the score of 1 is given only when the child repeats correctly the first position of both pathways; in all the other cases the score of 0 is given.
DUAL TASK

The child has to remember a frog’s starting position of a pathway on a 4×4 chessboard, where one of the 16 cells is colored in red. The child also has to tap on the table when the frog jumps onto the red square. The task has 4 different levels of difficulty, depending on the number of steps involved in the pathway: 2, 3, 4, and 5 steps respectively.

In order to facilitate comprehension of instructions, the child is given a preliminary practice trial with the secondary tapping task only.

The experimenter says: “Here is a red square, see? (the experimenter shows the red square in the chessboard). Now the frog jumps in some squares, and every time that the frog jumps onto the red square, you have to tap your hand on the table, in this way (the experimenter taps the hand on the table)“. The experimenter moves the frog in the chessboard, putting in evidence when the frog jumps onto the red square, making sure that the child performs the tapping task. When the child has understood the task, the experimenter says: “now be careful because the task becomes a little more difficult. You still have to tap the hand on the table when the frog jumps onto the red square, but you also have to remember the first square where the frog jumps“.

The experimenter shows the example pattern to the child, then he asks “What is the first square where the frog has jumped?“.

If the child did not understand the task the experimenter says: “This is the first square where the frog has jumped“ (and he shows it to him).

The task starts only when the child has understood the instructions.

The experimenter takes note of:

- the positions showed by the child
- if the child performs the tapping task
Appendix B.2.v. Dual Task

The score of 1 is given when the first position of the pathway is correctly recalled as well as the tapping task is performed. In all the other cases the score of 0 is given, including when the child forgets to tap.

The task is interrupted when the child fails with both the patterns of the same length. The score of 0 is recorded for all the remaining pathways.

The minimum score is 0, the maximum is 8.
Appendix C. CAM-R Items

Appendix C.1. CAM-R, Ice-cream Item (Training, 1st level)

Note: The elements of construction (construction version) are always presented under the matrix on the left side of the page, whereas the pictures (classic version) are always on the right side of the page.
Appendix C.3. CAM-R, Lemon Item (Training, 1st level)
Appendix C.4. CAM-R, Candle Item (Training, 1st level)
Appendix C.5. CAM-R, Girl Item (Training, 2nd level)
Appendix C.6. CAM-R, Rabbit Item (Training, 2nd level)
Appendix C.7. CAM-R, Ladybird Item (Training, 2nd level)
Appendix C.9. CAM-R, Pear Item (Test, 1st level)
Appendix C.11. CAM-R, Carrot Item (Test, 1st level)
Appendix C.16. CAM-R, Mouse Item (Test, 2\textsuperscript{nd} level)
Appendix C.18. CAM-R, Car Item (Test, 3rd level)
Appendix C.21. CAM-R, Clown Item (Test, 4th level)
Appendix C.22. CAM-R, Train Item (Test, 4th level)
Appendix C.24. CAM-R, Clown Item (Test, 4th level)
Appendix D. CAM-R Standardized instructions

TRAINING ITEMS

Number of items: 8 (4 of 1st level, 2 perceptual and 2 conceptual, and 4 of 2nd level, 2 perceptual and 2 conceptual).

Aims: to familiarize the participants with the computer tool, the presentation and the layout of pictures. They also have to be familiarized with the touch screen and the way to touch the elements of answer. They have to be encouraged to compare elements, to locate the differences and finally to construct the right answer step by step (construction version) vs. to choose the right answer (classic version). They have to learn how to reason by analogy.

The experimenter warns the participant he/she’s going to see 3 pictures arranged in a square, and then shows the square. Then the experimenter says to the participant he/she has to look carefully to the pictures.

Image A appears. The experimenter asks to the participant to look carefully to this picture and to describe what he/she sees. Then, he pushes the « Continue » button and picture B appears. He asks him/her to compare both pictures by saying what is different.

1. If the difference is described by the participant, the experimenter sums it up by pointing it. For instance: « From left to right, the color changes. Here it is pink and there it is brown » (see below the procedure for all items).

2. If the difference is not noticed by the participant, the experimenter says: « Look carefully. Here the color changes, here it is pink and there brown. »

3. When the picture is composed of more than two relations:
   a. If all differences are described by the participant, the experimenter sums them up one by one and says: « That is good, you noticed that from left to right, it is the color (here it is pink and there brown) and the size (here it is big and there small) that change. »
   
   b. If only one relation is described by the participant, the experimenter sums it up: « That is good, you noticed that from left to right the color changes, here it is pink and there brown. But there is something else. Look carefully. » If the participant finds another relation after this hint, the experimenter congratulates him/her and sums up all the differences. If he/she still does not find it, the experimenter says: « Look carefully, the size also changes, here it is big and there small. »
   
   c. If no difference is described by the participant, the experimenter says: “Look carefully, from left to right the color changes, here it is pink and there brown. The size changes too, here it is big and there small.”
Then, the experimenter touches the « Continue » button, picture B disappears and picture C appears. The experimenter asks to the participant to compare both pictures by saying the differences.

- If the difference is described by the participant, the experimenter sums it up: “From top to bottom, the shape changes. Here it is round and there oval.”
- If the difference is not noticed by the participant, the experimenter says: “Look carefully. From top to bottom the shape changes. Here it is round and there oval.”
- When the picture is composed of more than 2 relations: see number 3 above.

Then the experimenter touches the “Continue” button and picture B appears again. All the differences between pictures are reminded by the experimenter.

- If all the differences are reminded by the participant, the experimenter sums them up one last time by pointing them and says: “That is good, you saw that from left to right the color changed, here it is pink and there brown, and that from top to bottom, the shape changed, here it is round and there oval.”
- If only one difference is reminded by the participant, the experimenter says: “Yes, that is good, you noticed that from left to right (or from top to bottom), the color (or something else) changes, here it is pink and there brown. But there is something else, do you remember? Look carefully. What is different between top and bottom (or left and right)?”
  - If the participant reminds the missing difference after this hint, the experimenter sums all of them one last time.
  - If the participant does still not remind the missing difference after this hint, the experimenter gives him/her the solution and sums up all the differences one last time.
- If no difference is reminded by the participant, the experimenter asks him/her to concentrate on only one part of the matrix and to look carefully first to pictures A and B and then to A and C: The experimenter asks: “Look carefully to these pictures (A and B), what is different?”
  - If the participant reminds it, the experimenter goes on: “Yes, that is good, you noticed that from left to right, the color changes, here it is pink and there brown. Now look carefully to these pictures (A and C), what is different?” If the second difference is reminded, the experimenter sums up all the differences one last time.
  - If the A-B difference is not reminded, the experimenter gives him/her the solution and says: “See, here the color changes, here it is pink and
Appendix D. CAM-R Standardized instructions

there brown”. Then he asks: “Look carefully to these pictures (A and C), what is different?” If the second difference is reminded by the participant, the experimenter sums up all of them one last time. But if the second difference is still not reminded, the experimenter says: “See, here the shape changes, here it is round and there oval.” Then he sums all the differences up one last time.

• If the picture is composed of more than 2 relations, it is the same procedure.

Description of standardized hints for training items:

• Item 1 – training – 1st level: Ice-cream (Perceptual)
  o A-B: « From left to right, the color of the ice-cream changes. Here it’s pink and there brown ».
  o A-C: « From top to bottom, the shape of the ice-cream changes. Here it’s a cone and there a stick. »

• Item 2 - training – 1st level : Flower (Perceptual)
  o A-B: « From left to right, the size of the flower changes. Here it’s big and there small ».
  o A-C: « From top to bottom, the shape of the jar changes. Here it’s round and there squared. »

• Item 3 – training – 1st level: Lemon (Conceptual)
  o A-B: « From left to right, the lemon changes, here it’s a lemon and there it’s a half lemon. »
  o A-C: « From top to bottom, the object changes, here it’s a lemon and there a cake. »

• Item 4 - training – 1st level : Candle (Conceptual)
  o A-B: « From left to right, the candle changes, here there is no light and there light is present. »
  o A-C: « From top to bottom, the object changes, here it’s a candle and there a bulb. »
Appendix D. CAM-R Standardized instructions

- Item 5 - training – 2nd level : Girl (Perceptual)
  o A-B: « From left to right, two things change. First the color of the dress, here it’s yellow and there blue. Secondly, the shape of the ball changes, here it’s round and there oval. »
  o A-C: « From top to bottom, the chair changes, here it’s present and there it’s disappear. »

- Item 6 - training – 2nd level : Rabbit (Perceptual)
  o A-B: « From left to right, two things change. First the color of the rabbit, here it’s brown and there white. Secondly, the carrot changes, here a carrot is present and there it’s not. »
  o A-C: « From top to bottom, the box changes, here it’s small and there it’s big. »

- Item 7 - training – 2nd level : Ladybird (Conceptual)
  o A-B: « From left to right, two things change. First here there is a sun and there a moon. Secondly, the object changes, here it’s a leaf and there a tree.
  o A-C: « From top to bottom, the animal changes, here it’s a ladybird and there, it’s a butterfly. »

- Item 8 - training – 2nd level : Beach (Conceptual)
  o A-B: « From left to right, two things change. First the person changes, here it’s a boy and there a girl. Secondly, the object changes, here it’s a ball and there a rubber ring. »
  o A-C: « From top to bottom, the linen changes, here it’s dry and there it’s wet. »

Then the experimenter touches the « Continue » button and the elements of answer appear at the bottom of the screen. The experimenter asks to the participant to look at them carefully, one by one. The experimenter indicates that the participant has to touch with his/her finger on the chosen elements. If he/she changes his/her mind, he/she touches the chosen element again and it slides back. In order to explain that as best as possible, the experimenter shows an example (training items are not taken into account for the total score). Test can go on only when the participant has understood the instructions.
Appendix D. CAM-R Standardized instructions

Then he asks him/her to construct/choose the right answer and says: “In order to find what fits here (shows place of picture D), you have to look carefully what changed between these pictures (A and B) and these too (A and C). Do you remind what changed? Now, try to construct/choose the right answer.”

- If the right answer is constructed/chosen by the participant, the experimenter says by pointing the pictures: “That is good, it is the right answer because you noticed that the color (or shape, size, etc.) changed here and the shape there”. Test goes further.

- If the answer has only one correct element, the experimenter says by pointing the pictures: “It is quite correct, you noticed that the color (or shape, size, etc.) changed. But there is something else, look carefully to these pictures (A and C or A and B).” If the right answer is given by the participant after this clue, the experimenter sums up all the differences. If the correct answer is still not constructed/chosen, the experimenter gives it by giving proof of it.

- If the answer is not at all correct, the experimenter asks the participant to repeat the differences expounded before and then to construct/choose the right answer.
  - If the right answer is given after this hint, the experimenter says by pointing the pictures: “That is good, it is the right answer because you noticed that the color (or shape, size, etc.) changed here and the shape there”. Test goes further.
  - If the answer has only one correct element after this hint, the experimenter says by pointing the pictures: “It is quite correct, you noticed that the color (or shape, size, etc.) changed. But there is something else, look carefully to these pictures (A and C or A and B).” If the right answer is given by the participant after this hint, the experimenter sums up all the differences. If the right answer is still not constructed/chosen, the experimenter gives it by giving proof of it.
  - If the answer is still completely wrong, the experimenter gives it by explaining the differences between the pictures.

- If the participant is making mistakes during the second trial: for instance he changed the color whereas it was the shape, the experimenter says: “Be careful, the color does not change. It is something else.”

These hints are very specific for the training items, they are less specific in the test. The 7 next items turn out in the same way. For each of them, participants can try twice. Score: training items are not taken into account for the total score.
Appendix D. CAM-R Standardized instructions

At the end of training items, the experimenter warns the participants that pictures are going to appear faster and that he/she is going to solve the items alone. Each time the matrix appears, the experimenter says: “Look carefully to these 3 pictures and look to what is different, you have plenty of time”. When the elements of answer appear at the bottom of the screen, the experimenter says: “Look carefully to each of these elements and construct/choose your answer”.

TEST ITEMS:

Number of items : 16 with 4 of 1st level (2 perceptual and 2 conceptual), 4 of 2nd level (2P and 2C), 4 of 3rd level (2P and 2C) et 4 of 4th level (2P and 2C).

Aim: to observe if the participant reason by analogy.

Feedback: 1 per item.

The experimenter presents the 1st test item.

1. If the answer is correct, the experimenter says: « That’s good, you saw that from left to right (he points at the pictures) the color and the size change (or shape, etc.) and that from top to bottom the shape changes (or something else). » Test goes further.

2. If the answer is partly correct, the experimenter says: « That is quite correct, you saw that from left to right (or from top to bottom) the color changes. But there is something else, look carefully to these pictures (A & C or A & B). » Item starts at the beginning. After the second try,
   a. if the answer is correct, see N°1. Test goes further.
   b. If the answer is still incomplete, the experimenter gives the correct answer by explaining why it’s the correct one. Test goes further.

3. If the answer is completely wrong, the experimenter says: « Look carefully to these pictures (A & B). What is different? »
   a. If the differences are reminded by the participant, the experimenter says: « That is right, you saw that from left to right, the color (or shape, etc.) changes. Now, look carefully to these pictures (A & C). What is different? » If the differences are reminded by the participant, the experimenter says: « That is right, you saw that from top to bottom, the shape (or size, etc.) changes. Item starts at the beginning. The experimenter says: « Now choose the right elements/picture which go there (show place for answer D) and remind you the differences between the pictures.” If the answer is correct, see N°1. Test goes further. If the answer is still incomplete, the experimenter gives the right answer by explaining why. Test goes further.
Appendix D. CAM-R Standardized instructions

b. If the differences are not reminded by the participant, the experimenter reminds them. Item starts at the beginning. Then he says: «Now choose the right elements/picture which go there (show place for answer D) and remind you the differences between the pictures.” If the answer is correct, see N°1. Test goes further. If the answer is still incomplete, the experimenter gives the correct answer by explaining why it’s the correct one. Test goes further.

Feedback:

All the comments are given verbally by the experimenter. We chose to give verbal hints and not hints given by the computer because we wanted a human interaction between the experimenter and the participants. Because our sample is composed of young children (4-8 years old) and of teenagers with intellectual disability, this kind of interaction is more suitable.
Appendix E. CAM-R-revised Items

Appendix E.1. CAM-R-revised, Ice-cream Item (Training, 1st level)
Appendix E.2. CAM-R-revised, Flower Item (Training, 1st level)
Appendix E.3. CAM-R-revised, Lemon Item (Training, 1st level)
Appendix E.4. CAM-R-revised, Candle Item (Training, 1st level)
Appendix E.5. CAM-R-revised, Girl Item (Training, 2\textsuperscript{nd} level)
Appendix E.6. CAM-R-revised, Rabbit Item (Training, 2\textsuperscript{nd} level)
Appendix E.7. CAM-R-revised, Ladybird Item (Training, 2nd level)
Appendix E.8. CAM-R-revised, Beach Item (Training, 2nd level)
Appendix E.9. CAM-R-revised, Pear Item (Test, 1st level)
Appendix E.10. CAM-R-revised, Bike Item (Test, 1st level)
Appendix E.11. CAM-R-revised, Cake Item (Test, 1st level)
Appendix E.12. CAM-R-revised, Curtain Item (Test, 1st level)
Appendix E.13. CAM-R-revised, Swimming Pool Item (Test, 2nd level)
Appendix E.14. CAM-R-revised, Truck Item (Test, 2nd level)
Appendix E.15. CAM-R-revised, Window Item (Test, 2nd level)
Appendix E.16. CAM-R-revised, Mouse Item (Test, 2nd level)
Appendix E.17. CAM-R-revised, Snail Item (Test, 3rd level)
Appendix E.18. CAM-R-revised, Car Item (Test, 3rd level)
Appendix E.19. CAM-R-revised, Umbrella Item (Test, 3rd level)
Appendix E.20. CAM-R-revised, Cat Item (Test, 3rd level)
Appendix E.21: CAM-R-revised, Clown Item (Test, 4th level)
Appendix E.22: CAM-R-revised, Train Item (Test, 4\textsuperscript{th} level)
Appendix E.24: CAM-R-revised, Tree Item (Test, 4th level)