

## Supplementary Material

### Task and Material Description

#### *Finding dots and following lines*

- *Finding dots*: this task was similar to the “efficient dot scanning” test used by Ballesteros, Bardisa, Millar, & Reales (2005). It presented participants with a series of 6 test items, with an increasing number of raised dots (2, 3, 4, 5, 6, and 15 respectively), plus an initial practice card (with a single dot). The participants had to point to each dot with the index finger of their dominant hand, so as not to omit any dots on a page or point to dots several times. The diameter of each raised dot was 0.75 cm and the raised dots were distributed non-linearly on the page. Items were presented in a booklet. Instructions were as follows: “There is a dot on this card. Find it with your fingertip and point to the dot’s location with your finger”. The examiner took out the practice card and then presented the following six test cards with an increasing number of dots one by one, as she said: “On this card there are more dots. Search for them and each time you find one, let me know by pointing to the dot”. The examiner gave two points for each card where the participant had pointed to all the dots without errors (i.e., misses or double hits).

- *Following lines*: in this task, participants were provided with a series of 6 test items (two curvilinear lines, two rectilinear lines with right angles and two rectilinear lines with acute angles), plus an initial practice card (with a short curvilinear line). They had to follow each raised line with the index finger of their dominant hand, without losing contact with the line. Each line covered an area of approximately 8 x 11 cm on the page and each had a raised circle located on the left-hand side, which made the starting point for the line to be followed easy to detect. Items were presented in a booklet, in a set order for the test items (from curved to straight with acute angles). Instructions were as follows: “There is a line on this card, which may take several turns. A small circle indicates the start of the line. Look for the circle on the

left-hand side, and then follow the line with your finger, without losing contact. You must not lift your finger until you have arrived at the end of the line”. The examiner took out the practice card and then presented the six test cards one by one as she repeated the instructions. The examiner gave two points for each card where the participant had traced the whole line, without losing contact.

#### *Matching elements based on texture, shape, and size*

For each task, participants were presented with a series of 6 test items (plus an initial practice test). Items were presented in a booklet, in a set order (which was randomly determined) for the test items. For each item, participants were first presented with a single stimulus (the standard), which they had to explore and memorize using their dominant hand. They were then presented with a series of four comparison stimuli (three distractors plus the standard), which they had to explore one after the other (from left to right). For each comparison stimulus, participants had to indicate whether or not the stimulus was identical to the standard. The matching task was performed on the basis of a memorized representation of the standard, as the participants were not allowed to refer back to the standard when they explored the comparison series. Criteria for constructing the comparison series were as follows: the location of the target stimulus in the comparison series was varied across test items such that it was never located in the first position, and its location (2<sup>nd</sup>, 3<sup>rd</sup>, or 4<sup>th</sup> position) was repeated twice for all the test items. Instructions for the three tasks were as follows (respectively): “On this card, there is a square that contains a special texture/geometric shape/shape of a specific size. Explore it with your fingers, paying careful attention to its texture/shape size and memorize it”. The examiner took out the card with the standard, and presented it along with the comparison stimuli, as she said: “On this new card, there are four squares/shapes/shapes of different sizes. Explore them one by one with your fingers and tell me for each one if the texture/shape/size is the same as the one you explored on the previous card.” The examiner

gave two points for each correct recognition of the standard stimulus without errors (no false detection).

- *Texture*: the stimuli used were raised-line squares filled with different textures (small crosses such as +, grid lines, grid points, horizontal lines, vertical lines, thick oblique lines, small horizontal rectangles, small vertical rectangles, small letter “V” in different positions, a succession of lines and oblique points, and triangular sinusoidal lines). The textures were taken from Nolan and Morris’ set of textures (Nolan & Morris, 1971; see also Lederman & Kinch, 1979). The size of each square was 4 x 4 cm.

- *Shape*: the stimuli used were complex raised-line geometric shapes (half circle, three-quarter circle, oval, parallelogram, star, equilateral triangle, square, three-quarter square, pentagon, half-moon, hexagon, isosceles triangle, trapezoid and cross). The size of each shape fell within a 3 x 3 cm area.

- *Size*: the stimuli used were basic raised-line geometric shapes (square, equilateral triangle and circle). The size of the standard shape was 2 cm, 3 cm, 4 cm, or 5 cm (line length or diameter). The comparison shapes were ranked in increasing order of size (2, 3, 4, 5 cm). There were two test items per basic geometric shape.

#### *Matching elements based on spatial location and orientation*

In both tasks, procedures and criteria for constructing the comparison series were similar to those used and described in the haptic discrimination tasks except that items were in a set order and participants used the index finger of their dominant hand to explore the stimuli et not the whole hand. Instructions for both tasks were as follows (respectively): “On this card, there is a figure made up of one or several line(s)/one or several geometric shape(s) inside a circle. Explore it with your fingers, paying careful attention to line orientation/the location of the shape(s) within the circle”. The examiner took out the card with the standard and presented it along with the comparison stimuli, as she said: “On this new card, there are four

figures made up of one or several line(s)/circles. Explore them one by one with your fingers and tell me for each one if it has the same spatial orientation/the shape(s) is(are) in the same location in the circle as the one you explored on the previous card”.

- *Spatial orientation*: the stimuli were raised-line figures made up of one, two or three rectilinear segments, with each segment having a specific orientation (horizontal, vertical, or oblique). The length of a segment was 3 cm. The practice item was a one-segment figure, whereas the test items included two items with one segment, two items with two segments and two items with three segments (presented in order of increasing complexity).

- *Spatial location*: the stimuli were raised-line figures made up of a circle (size = 4 cm in diameter) containing one, two or three **small, embossed shapes** (a square, a circle or a star). The practice item was a one-shape figure, whereas the test items included three items with one-shape figures, two items with two-shape figures and one item with a three-shape figure (shown in order of increasing complexity).

#### *Memorizing series of dots and shapes*

Both tasks were span tasks involving the presentation of increasing series of stimuli (from 1 to 6 stimuli), which participants explored from left to right and had to memorize. Immediately after the exploration of a series, participants had to report the name of each stimulus in order.

The session started with the presentation of a practice card in which the full set of stimuli was available. This practice card ensured that participants could correctly name each stimulus.

Afterwards, the test session involved presenting a one-item series and continued with series of increasing length (i.e., a two-item series up to a six-item series). There were two trials per series (therefore 12 series maximum). Criteria for constructing the series were as follows: (i) a given stimulus appeared only once in a given series, (ii) the location of a given stimulus varied across the series and (iii) the last stimulus of a series differed from the first stimulus of the next series. Items were presented in a booklet, in a set order (from one- to six-item series).

The session stopped when participants failed to report two series of a similar length in order. For both tasks, participants used the fingers of their dominant hand to explore series of increasing length (1 to 6) from left to right. Instructions were as follows: “On this card, one or several domino(es)/shape(s) are aligned. Explore it/them one by one with your fingers and memorize them. Once you have finished exploring all of the dominoes/shapes, tell me the number of dots/name of the shapes in their order of appearance”. The examiner gave one point per series when the participant had reported all the numbers/names of shapes in their correct order of appearance, without making errors (omission or inversion).

- *Series of dots*: the stimuli used were raised-line rectangles containing 1 to 6 raised dots. The dots inside the rectangles were arranged similarly to the faces of a die. The size of each rectangle was 2 x 2.6 cm. The diameter of each raised dot was 0.3 cm.

- *Series of shapes*: the stimuli used were raised-line geometric shapes (circle, square, [equilateral triangle](#), star, cross and rectangle). The average size of the shapes was 2 x 2 cm.

#### *Identifying complete and incomplete raised-line pictures*

In both tasks, the participants were presented with a series of 8 test items (plus two practice tests). Items were presented in a booklet, in a set order (which was randomly determined).

The participants’ task was to identify the object depicted (plus its missing feature for incomplete pictures). It should be noted that according to a French data base for (visual) picture naming (Cannard, Bonthoux, Blaye, Scheuner, Schreiber, & Trinquart, 2006) children as young as five could accurately identify all the depicted objects used in the picture comprehension tasks. [Pictures were outline drawings, in which each line depicted a surface edge. As outline drawings have edges that are tangible as well as visible, they are thought to make sense to congenitally totally blind as well as sighted people. They were closed shapes \(meaning there were no gaps in the lines with two line endings facing each other, requiring perceptual closure\), with few internal details. Pictures contained mostly 2D information and a](#)

few 3D elements (i.e., the internal line of the banana). In the incomplete raised-line picture task, each drawing showed an object that was missing a part such as a limb or sleeve compared to the standard version of the object. None were objects commonly depicted with a bite, such as an apple with a bite out of it (see the Apple logo).

- *Complete raised-line pictures*: the stimuli used were eight raised-line drawings of familiar objects (banana, apple, dog, butterfly, sock, shoe, car and bicycle). The practice stimuli used were drawings of a spoon and a table. The maximum picture size was 19 x 25 cm. The pictures were simplified versions of pictures developed by Snodgrass and Vanderwart (1980). The participants were asked to freely explore each drawing with both hands and to identify what the drawing represented, as quickly and accurately as possible. In line with the procedure used by Heller et al. (1996), the object's category name was given to the participants when they were presented with each picture ("fruit" for banana and apple, "animal" for dog and butterfly, "item of clothing" for shoe and sock and "vehicle" for car and bicycle). This option was selected because pilot tests indicated that picture identification where participants were not provided with semantic cues resulted in floor performance in children. Instructions were as follows: "On this card, there is a drawing of a familiar object. Carefully explore the picture with your hands and tell me what the drawing shows, as accurately and quickly as possible. You have up to two minutes to give me an answer. The drawing is of (category name provided)". Using a stopwatch, participants were timed from the moment they first touched a picture until the time they gave a verbal response. The examiner gave 1.5 points for each card where the participant had given the expected name (or a close synonym) for the object.

- *Incomplete raised-line pictures*: the stimuli used were eight raised-line drawings of familiar objects with a missing element (a human with a missing leg, a hand with a missing nail, a comb with missing teeth, a ladder with missing rungs, a sweater with a missing sleeve, a

guitar with no strings and a clock with no hands). The practice stimuli used were a house with no door and a pig with no tail. The maximum picture size was 19 x 25 cm. Pictures contained only two-dimensional information and were simplified pictures, adapted from the image completion subtest of The Wechsler Intelligence Scale for Children (Wechsler, 2005).

Instructions and procedures were similar to those used and described in the picture identification task, except that participants were also asked to identify the missing feature of the object depicted. Semantic cues about the objects were given to the participants when they were presented with each picture (“this is related to or is part of the body” for the human and hand, “this is a small object you can hold in your hand” for the comb and scissors, “this is an object used by firefighters” for the ladder, “this is an item of clothing” for the sweater, “this is a musical instrument” for the guitar and “this is an object that indicates the time” for the clock). The examiner allowed a maximum of 1.5 points for each card when the participants provided the expected name (or a close synonym) for the object (.75 points) and its missing feature (.75 points).