

**ANALYSIS OF CREATIVE AND LOGICAL-SPATIAL SKILLS IN  
BLIND CHILDREN AND ADOLESCENTS**

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**ABSTRACT**

This paper displays the Action-research project “Analysis and strengthening of divergent thinking in blind and visually impaired children and adolescents”, funded by the University of Catania. In light of the importance of divergent and logical-spatial skills for these subjects, in terms of life skills and good educational practices, this research project is aimed to achieve the following objectives a) to realize divergent and logical-spatial skills assessment tools and to verify the validity of these instruments; b) to explore the factors of divergent thinking in order to better understand the most deficient skills; c) to proceed with the strengthening of the more inadequate divergent abilities in the subjects. We had Stamperia Braille of Catania print the Williams’ Test of divergent thinking (TCD protocol A and B) and the Raven Matrices (standard SPM and colored CPM) in relief by thermoforming on PVC with relief height not lower than 0.9mm in order to allow the haptic understanding of stimuli by the blind. For visually impaired subjects the instruments are made using full color four-color laser printing on 80gr / mq paper. In this phase of the research, in agreement with the Italian Blind Union of Catania, we began to administer these tools to five blind subjects.

**Keywords:** divergent thinking; logical-spatial skills; blind and visually impaired children and adolescents

**INTRODUCTION**

The skills related to the use of divergent thinking, in problem solving conditions, facilitate the adaptation to the environment and, therefore, the psychological well-being. The scientific literature inspired by the factorialist tradition based on the indications offered by Guilford (1952), Torrance (1962) and, in Italy, more recently by Antonietti & Pinzigrilli, 2009, underlined the multi-modularity of creativity. The factorial dimensions that constitute divergent production concern a) the ideational fluidity, that is the individual's capacity to produce a high number of ideas starting from a verbal or graphic stimulus; b) the ideational flexibility, or the ability to change mental set from one category to another, different from the previous one, and to free yourself of a succession of ideas to easily move on to other and different "ideational chains"; c) the originality, that is the ability to elaborate and create rare and unusual responses and to produce unique ideas conceived by a reduced number of individuals (Guilford, 1950; Runco, 1991); d) the elaboration, that is the ability to enrich, with sensible details, the ideas produced by the individual, combining, in an original way, the elements that constitute the conceptual structures called into question.

The results emerged from our recent empirical research, realized with the paper-pencil test of Williams (De Caroli, 2009), used to evaluate the factors of divergent thinking in the developmental age, allowed us to know that children and preadolescents with typical development (age ranging from 6 to 14) are "more gifted" in the ability to produce a high number of ideas (fluidity) and to change mental set in the ideational production (flexibility) starting from a given stimulus, but "less gifted" in the ability to elaborate original and uncommon ideas (originality), and to enrich with details the ideas (elaboration), compared to the normative average.

Divergent thinking allows the individual to flexibly manipulate and modify reality, making it more practically usable; this possibility is not always accessible to all persons on the basis of the difficulties and /or subjective limits connected not only to the quality and availability of the context, but also to the personal abilities to overcome these limits. This problem is particularly relevant in the case of people with disabilities.

These divergent abilities were also investigated in children with intellectual disabilities (De Caroli & Sagone, 2010), and it has been noted that, at the same cognitive level measured with the operative tests of the OL-Logic Operations Test (Vianello & Marin, 1997) "pre-operative" children with intellectual disabilities have obtained lower scores than those with typical development in the factors of flexibility and elaboration and that "concrete operators" children with intellectual disabilities have obtained lower scores than those with typical development in all factors (except for the ideational fluidity. More recently, in our context (De Caroli and Sagone, 2014), these divergent abilities have also been investigated in children with Down syndrome, compared to children with typical development, administering the Williams' TCD (1994) to both groups of children aged between 6 and 11. The two groups of children were paired using the traditional version of the OL Test, regardless of chronological age and IQ. The results showed that, at the preoperative and intermediate cognitive level, children with Down syndrome and those with typical development obtained the same average scores in the factors of fluidity, flexibility, originality, and elaboration, while at the concrete operational cognitive level children with Down syndrome obtained lower average scores only in verbal performances (that is the production of titles). In this sense, at the same cognitive level, there are no appreciable differences between these two groups of children in the ability to produce a high quantity of ideas, different from each other, that are original, out of the obvious and rich in details, while the differences emerged only in relation to concrete operational cognitive level.

Regarding the analysis of creativity in other types of disabilities, such as visual impairment, few researches can be found in the scientific literature. One such research was carried out by Tisdall et

al. (1967) who administered the verbal form of the Guilford's Divergent Thinking Test to blind and seeing children, discovering that sighted subjects had significantly higher mean scores than blind ones on Product Improvement Unusual Uses, and Seeing Problems tests, while day school blind subjects scored significantly higher than sighted ones in the other three scales. Beyond the interest produced by this research, it should be noted, however, the partiality of these data due to the use of exclusively verbal tools to evaluate divergent thinking in blind subjects. Indeed, this type of disability requires the mediation of the haptic perception that allows real contact with the world.

Scientific literature offers many interesting data on the realization of haptic batteries or, in any case, instruments designed specifically for blind people, for the analysis of their cognitive skills. For example, we refer to the pioneer studies of Haines (1916), who carried out a scale for the "mental measurement" of the blind, and Hayes (1918, 1923, 1930) who made an adaptation of the Binet test for blind people. These tools, as well as others, were originally designed for sighted subjects and, over time, their use in persons with impaired vision was subjected to analysis and criticism (see Reid, 1995, 2002). In order to find a solution to this problem, the verbal subscales of the WISC have been used to assess the cognitive functioning of visually impaired children (see Atkins, 2011), but even this solution proved to be inadequate because verbal scales do not provide adequate information on non-verbal reasoning. In addition these verbal scales could represent a disadvantage for blind subjects compared to sighted subjects (Tillman, 1967). For these reasons, over time, tools have been developed that allow blind people to use the haptic modality (e.g. sense of active touch, see Zigler & Barrett, 1927; Revesz, 1950) that they normally know and use. This is the direction of the study by Cassar and Lucchese (2016) who proposed a haptic version of some of the Wechsler Performance Subtest. According to the authors "The administration to a blind thirteen years old boy has shown good results. Haptic explorations not immediate as the visual one, thus we didn't consider timing. Items were neither too simple neither too difficult. The examinee was successful in all the subtests" (p.115)

This particular modality constitutes an important alternative to the visual capacity in order to evaluate the perceptual- motor and cognitive functioning of blind subjects and it seems to play a central role in the development of blind children (Withagen et al., 2010). The haptic modality, in addition to being assessed as a valid alternative to visual perception, was considered, as reported by Kirby and D'Angiulli (2011, p.67) referring to Arnheim (1990), the sensory modality most closely linked to dynamic perception, the basis of aesthetic experiences, and that which, by tangibly perceiving the interaction between space and shape, allows for the effective conveyance of expression. The deepening of the usefulness of this modality has led to the realization of the final item-set of TP (Tactical Profile) consisted of 430 items, graded according to age-level and divided in three tactual functioning domains (tactual sensory, tactual motor, and tactual perceptual), and one domain of practical skills (Withagen et al. 2005) in which concrete objects were presented to evaluate the analyzed skills in Dutch children.

Subsequently, a group of researchers (Ballesteros et al., 2005) created, for children living in and around Madrid, a new psychological test battery for assessing the perceptual and cognitive abilities of visually disabled children in using active touch. The test materials consist of 2-D tactile materials such as raised-line, raised-dot, raised-surface shapes and displays, and familiar and novel 3-D objects. A few years later, Manzella et al. (2016) undertook a research project useful to realize and validate a new haptic test battery, named Haptic-2D, using solely 2-D raised materials, as opposed to the use both of 3-D objects, as in Withagen, or a combination of 3D and 2D tactile materials, as in Ballesteros. In detail the materials consisted of raised stimuli (dots, lines, shapes, patterns, or pictures) printed on swell paper (21 X 29.7 cm) and included 11 tests, divided into five categories,

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functional to measure scanning skills, tactile discrimination skills, spatial comprehensions skills, short-term memory and picture comprehension. The exclusive choice of raised stimuli depends on the fact that “the development of tactual skills to deal with such materials is crucial for the daily activities and education of visually impaired children, but has never yet been the focus of a psychometric assessment” (p.105).

In the context of studies aimed to assess the intelligence of blind people, an interesting, although very dated, instrumental realization is by Rich who, starting from a previous empirical proposal realized by Anderson for blind adults, that is the Tactual Progressive Matrices, (TPM) (1961), made a tactile version of the Raven matrices in order to be able to evaluate the intelligence of blind children with non-verbal psychological tools. In his Dissertation submitted to the Graduate Faculty of Texas Technological College in Partial Fulfillment of the Requirements for the Degree of PhD (1963), Rich stated that Anderson (1961) “attempted to avoid the problem of variable tactual sensitivity in the blind by constructing his version of the Progressive Matrices of heavy materials and by simplifying the stimulus patterns to essential relations. Unpublished results indicate that his tactual test may correlate in a statistically significant, positive, manner with standard tests of intelligence when used with blind adults” (pp.8-9). Rich described the Raven’s Coloured Progressive Matrices: Sets A, Ab and B used in his study “Each item consisted of a ground with a raised design, so that the design was tactually perceptible (the matrix), and six pieces or choices with raised designs (the Inserts)” (p.30). In particular Rich explained that “the dimension of the matrix proper was seven by four inches, and each insert was two inches by one and a fourth inches in size. The raised designs were constructed of balsa wood, cardboard and wire. The height of the raised designs was from one-sixteenth inch to one-fourth inch, for different items. The designs were constructed on heavy illustration board.... There was no time limit and the subject’s score was the number of items correctly completed” (31). Rich verified the correlation between the scores obtained by administering the Raven test and the WISC verbal subscales, and the data indicated that “a substantial relationship existed between the two tests” (p. 48), overall in 12 to 15 year old group (p.49).

These interesting surveys were not subsequently taken up. In fact we did not find any further in-depth analyses or modifications in this promising field of research.

### **THE FIRD PROJECT “ANALYSIS AND STRENGTHENING OF DIVERGENT THINKING IN BLIND AND VISUALLY IMPAIRED CHILDREN AND ADOLESCENTS”**

Starting from these ideas and from the absence of research about the analysis of creativity in blind people using adequate tools and the importance of divergent thinking in personal adaptation and in everyday life we have decided to start a research aimed to assess creativity in visually impaired people using haptic stimuli.

In particular, considering that the WHO since 1993 called into question the use of divergent thinking always in terms of life skills and the Italian MIUR (Ministry of Education, University and Research) valued creativity as the goal of good educational practices, we proposed this two-year project FIRD (Financing of Departmental Research) aimed to deepen the analysis of creative production in subjects in developmental age with sensory limits, in particular with visual disabilities.

For this reason, this pilot project, in addition of being able to provide tools for measuring and evaluating creative skills (Williams, 1994) and problem solving (Raven, 1938) in these subjects, will be developed also with the aim of enhancing deficient skills, representing a meeting point between research activity and practical and operative intervention, also, in the scholastic context.

The main objectives of the present research-intervention project will be:

to realize and verify the validity of divergent and logical-spatial skills assessment tools in blind

and visually impaired subjects, considering that these tools are completely non-existent in this field of research and practical application;

to explore the factors of divergent thinking in blind and visually impaired subjects (compared with a control group balanced by age, sex and logical-spatial skills) in order to better understand the most deficient skills;

to proceed with the strengthening of divergent abilities that are more inadequate in blind and visually impaired (see, Tisdall et alii, 1967, Al-Dababneh et al., 2015) children and adolescents (see, Antonietti and Pinzigrilli, 2009).

### **THE FIRD PROJECT: THE FIRST AIM**

In relation to the first aim, in the first year of the project we dealt with the creation of tools for assessing creative skills and logical-spatial and problem solving skills, in collaboration with the Regional Braille Stamperia of Catania which deals with typhloid-learning aids. After numerous meetings with specialists and typhlogists working at the Stamperia Braille, the enlarged versions of the TCD, that is the Italian version of Test of Divergent Thinking (Williams, 1994) protocol A and B<sup>1</sup> to be used with the visually impaired and those with raised stimuli for the blind in relation to the typical characteristics of these specific groups was realized. In addition to the TCD, the Raven Matrices (standard SPM and colored CPM) were created in both versions, with raised stimuli for the blind and enlarged for the visually impaired.

The Test of Divergent Thinking is formed by 12 frames containing incomplete graphic stimuli shown to children, who were then asked to draw a picture; it is possible to evaluate the following five scores: fluency, flexibility, originality, elaboration, and production of titles. The fluency score was the total number of significant and meaningful pictures created by participants (range 1-12 points). The flexibility score was the number of changes of ideas from one category to a different one (range 1-11 points). The originality score was the total number of pictures drawn inside or outside each incomplete stimulus placed in the frames (range 1-36 points); one point was assigned to each picture drawn outside the stimuli, 2 points to each picture drawn inside the stimuli, and 3 points to each picture drawn both inside and outside the incomplete stimuli. The elaboration score was the number of asymmetric pictures drawn by children (range 1-36 points): zero points were assigned to the symmetrical pictures, one point to the asymmetric pictures drawn outside the incomplete stimuli, 2 points to the asymmetric pictures inside the incomplete stimuli, and 3 points to the asymmetric pictures drawn both inside and outside the stimuli. Finally, the score of the production of titles was the sum of points assigned to each title produced by children: one point was assigned for simple titles, 2 points for titles with qualifying and descriptive adjectives, 3 points for imaginative titles indicating something beyond the picture drawn by participants (range 1-36 points).

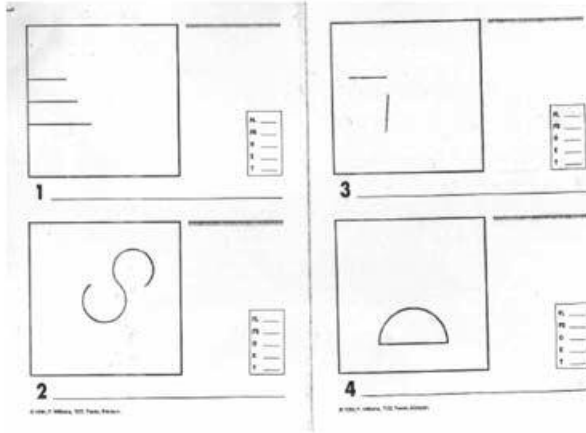
In order to adapt this material to visually impaired people, the Stamperia prepared a variant by enlarging the graphic signs that act as a stimulus (A3 sheet folded according to the orientation of the test), present in the 12 frames provided by the test and in the raised version for the blind by printing on thermoformed A4 sheets with 2 frames for each sheet. Through the use of the awl, the blind can perform the test. The raised version was specifically created to make these subjects the "haptic perception" of the stimuli that comes from the combination of tactile perception and proprioception connected to the position of the hand with respect to the stimulus. As reported by Kirby and D'Angiulli (2011, p.69) "The neurological overlapping of visual and haptic processing seems to indicate that the haptic system may be able to recruit the object representation systems of the ventral visual pathway" (see Vanlierde et al. 2003; Pietrini et al. 2004), an effect that has been observed in various studies that have investigated the neurological processes of visually impaired individuals.

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The realization of these specific versions of the TCD can make the use of this test accessible to the visually impaired and blind subjects and will allow them to express the divergent capacities up to now not verifiable with the existing psychometric tools.

Examples of frames with graphic of TCD, protocol B is in fig.1.

*Fig. 1*



With regard to the Raven test, these are booklets in the standard form consisting of 5 series (A, B, C, D, E) of 12 items each and in the colored form consisting of 3 series (A, Ab, B) of 12 items each, with a print with raised stimuli in the 20X25 cm format for the blind and an enlarged print in the 29X36 cm format for the visually impaired subjects, with binding in plastic backs containing the matrices in four-color / monochrome. The Raven Matrices provide for the identification of the correct option among the 6 or 8 alternatives present in the sheet that completes the proposed matrix as a stimulus; these specific versions (the haptic and enlarged version) will allow us to measure the logical-spatial capacities and the fluid intelligence of blind and visually impaired subjects.

We thought that it was possible to use haptic versions of these two tests also based on what the scientific literature seems to indicate and, that is, blind people may strengthen their memory skills to compensate for absence of vision. We refer, for example, to the research of Withagen et al. So, it was theoretically possible to present to the blind subjects tools such as the Raven Test, which require the storage of the matrix to be able to search for the box that completes it.

**THE FIRD PROJECT: THE SECOND AIM**

In the second year, experimentation (still ongoing) began with the administration of the TCD of Williams and Raven test and to a 5 blind children and adolescents, characterized by the absence of other psycho-sensory-neurological deficits. The decision to administer the two tests only to blind and visually impaired subjects (without other disorders) derives from the fact that in the blind subjects with other disorders a lower performance than those without other disorders was statistically noticed (Mazella et al, 2016, p.116) in one of the tests used. The recruitment of the chosen sample takes place thanks to the active involvement of the Italian Blind Union in the Catania office.

Two researchers from the research group of the FIRD project took care to meet and to put at ease the blind children and adolescents who had been contacted by the Provincial President of the

Italian Blind Union. We have decided to always use the same researchers in order to avoid possible interferences in the mode of administration also connected to the tone, the inflections of the voice, etc. and to ensure, therefore, at the maximum possible, the uniformity of the set.

The subjects, accompanied by their mothers, were led into a known and familiar room of the building where the Italian Blind Union is located, where a table, chairs and a sofa are placed. We have chosen this site precisely because it is a familiar place in which blind subjects are used to safely move. After explaining and clarifying in a simple and brief way the activities that, shortly thereafter, they would have carried out, the subjects were sent to sit on a chair in order to start the activities. Subjects were told that their moms would wait for them in a nearby room. This request was functional to avoid possible verbal interferences from the mothers. All subjects accepted our proposal, with the exception of a child who asked for the presence of his mother. In order to calm the child, we accepted his request, making his mother sit on the sofa behind the child, asking her not to verbally intervene.

When the subjects showed that they understood that they would have carried out a pleasant yet demanding activity, which was not subject to scholastic evaluations, the two researchers began the administration of the tests, starting from Williams' TCD.

As indicated by Rich for Test of Raven (1963, p.31) and in line with the pilot study profile of this project, we decided not to set time limits in the execution of the two tests. However, the overall time and the time used to perform each item have been transcribed, in order to possess data about the possible greater difficulty of specific items represented by the increase in response times.

One of the two researchers had the task to administer the tests, while the other one marked the response times and the answers given by each single subject. Each task was always performed by the same researcher.

The researcher, sitting next to the subject, placed the subject's hand on the first frame of the TCD and said "Now be careful, touch this first frame. Note that the frame is raised. There are twelve altogether. Each frame contains lines or shapes, different in each box. You have to touch these lines or shapes and, using them as starting points, you have to mark a drawing with the awl. Try to draw something new to which no one else thinks. Remember not to go outside the frame and make a drawing that contains the already present raised lines or shapes. When you have finished working in each frame, think and suggest aloud an intelligent title that describes the drawing you have performed". The researcher repeated these phrases for each new frame until when the subject showed he understood perfectly the type of activity to be performed.

Once the TCD was completed, the researcher presented the Colored Raven matrices, consisting of 3 series (A, Ab, B), saying "Now you'll do a different job. Touch this raised frame with your hand or with both. Carefully touch it, try to understand the raised stimuli that it contains. Take all the time you need. Now touch this part of the box. There is an empty part. Move the hand below (the researcher accompanies the subject's hand), you will find small frames, touch them carefully one by one to understand the raised stimuli that they contain. Try to figure out which one of them logically completes the big box you touched before. Before deciding, touch all the small squares that are under the big one and when you know for sure indicate what, according to you, logically completes the big frame". These indications were repeated until the subject showed he had perfectly understood the type of activity to be carried out.

## Participants

To date, we have administered these tests to five blind subjects aged between 9 and 14 years, and, with the exception of one, it was possible to complete all the items making up the TCD and Raven's Colored Matrices.

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With respect to each subject we tried to understand, through brief interviews at the end of the test or by transcribing the reflections produced aloud by the subjects during the execution of the task, which mental paths followed to carry out the task.

### SOME CONSIDERATIONS

In the near future, we propose to administer the two tests, carried out in haptic form, to other blind subjects, also by contacting the Italian Blind Union offices of other provinces in order to increase the sample size. It will be necessary to complete the analysis of the answers, which is still in progress, for which we think it is necessary to carry out a qualitative analysis. It will then be possible to proceed with the third objective, that is to realize specific functional training to enhance the level of creativity of blind persons, thus helping to strengthen and implement divergent thinking even in non-blind individuals.

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<sup>1</sup> We have prepared the two versions of the Williams test in order to be able to achieve, in the future, the third objective of this research. In fact, once we have assessed the level of creativity reached by blind and visually impaired subjects using protocol A, we will offer them functional training to enhance divergent thinking (see, eg, Falanga et al, 2018). The verification of the eventual change can be made using the protocol Bof the Williams Test. These protocols are perfectly comparable and are both constituted by 12 frames containing incomplete graphic stimuli (different for A and B). The same procedure can also be adopted with the control group, made up of sighted subjects, paired with blind and visually impaired subjects, involving the Raven Matrices. From the comparison between the pre-intervention phase and the post-intervention phase, following the implementation of individual laboratory activities useful to enhance divergent thinking, it will be possible to verify to what extent the actions produced will have enabled positive results.

