An Observational Study on Problem-Solving Strategies in Individuals with Down Syndrome

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Abstract. This paper is focused on the analysis of problem-solving strategies in a small group of individuals with Down syndrome aged from 13 to 22 years using the observational method. Three tasks are used to investigate one of the main components of executive functions (e.g. strategies of problem-solving): the Tower of Hanoi (structured task), Tetris Game (semi-structured task), and a set of Building Blocks (unstructured task). Together with these tasks a check-list is applied to codify the video-taped behaviours connected to the solution strategies of the provided tasks. Two independent judges reached a substantial inter-observer agreement in the coding of behavioural patterns expressed by participants. Results display that individuals with Down syndrome have difficulties to adopt flexible strategies and to be autonomous in the execution of tasks. Future research could study in deep the educational implications in school-context by means of specific trainings about the overcoming of ideational rigidity in problem-solving, specifically in unstructured wide-ranging situations, and put emphasis on the early emergence of planning skills and problem-solving for developmental interventions.

Keywords: observation, problem-solving, Down syndrome, Tower of Hanoi, Tetris

Introduction

Several researchers investigated the executive functioning in individuals with Down syndrome (DS), revealing that they performed poorly in the tasks requiring the use of different types of executive functions (Lanfranchi, Cornoldi, & Vianello, 2004; Lanfranchi, Jerman, & Vianello, 2009; Lanfranchi, Jerman, Dal Pont, Alberti, & Vianello, 2010) and they have behavioural-cognitive profiles characterized by relevant deficits in verbal processing, working memory, planning, goal-directed behaviours, and problem-solving strategies. The cited executive functions included the following main components recalling specific skills used by individuals in the adaptation to their environment (see Denckla, 1994; Diamond, 2013; Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000; Miyake & Friedman, 2012). The inhibitory control is defined as a process functional to inhibit the interfering information or previously activated cognitive processes in order to focus attention on the relevant requirements of task; this component is directly linked to the set shifting (or task switching), involving flexible switching attention and back and forth cognitive control between multiple tasks and mental sets, overcoming proactive interference caused by previously performed different mental operations on the same stimuli. The working memory is another important component of mental executive functioning that sustains and manipulates given information until the execution of tasks; it is connected with the updating that refers to monitoring and evaluating incoming information for task-relevance and then appropriately revising the existing contents in working memory by modifying older information with more recent and relevant ones. The sustaining attention is useful to focus on and register relevant information, to maintain attention on given elements for an interval of time for the purpose of successful task completion. It is also useful to allocate attention resources on specific tasks and simultaneously screen out distracting stimuli; additionally, the cognitive flexibility is considered as the ability to shift and restructure mental set or

strategies in multiple ways depending on internal or external changes, opposite to the cognitive inflexibility (or perseveration on a dominant response), demonstrating an individual's difficulty to shift to new representations. Finally, the planning consists of programming the goal-directed behaviours and ideational actions in solution of tasks and in daily life and, consistently, problem-solving process is directly involved in the solution of problems adopting efficient strategies.

Several scholars developed tests and tasks to assess the components of executive functions, both in atypically and typically developed individuals, such as problem-solving, planning, flexibility, and abstract reasoning; for example, the Wisconsin Card Sorting Test (WCST: Heaton, Chelune, Talley, Kay, & Curtiss, 1993), the Tower of London (ToL: Krikorian, Bartok, & Gay, 1994; Anderson, Anderson, & Lajoie, 1996; Costanzo, Varuzza, Menghini, Addona, Gianesini, & Vicari, 2013), the Dimensional Change Card Sort (DCCS: Zelazo, Burack, Benedetto, & Frye, 1996; Zelazo, 2006), Flexible Item Selection Task (Jacques & Zelazo, 2001), the Behavior Rating Inventory of Executive Function (BRIEF: Gioia, Isquith, Guy, & Kenworthy, 2000), the Raven Matrices (Carpenter, Just, & Shell, 1990; Gunn & Jarrold, 2004; Unsworth & Engle, 2005), the Tower of Hanoi (ToH: Numminen, Lehto, & Ruoppila, 2001; Danielsson, Henry, Rönnberg, & Nilsson, 2010), and so on. To cite one of these tasks, in detail, similarly to the ToH, the Tower of London (Krikorian *et al.*, 1994; Anderson *et al.*, 1996) is used to assess problem-solving processing and planning and consists of a set of three balls differing in colour that are moved one at a time from one peg to another; the restriction rule is that each of the three pegs of descending lengths can hold only three, two, or one ball, respectively. The total move score is the number of moves beyond the minimum number of moves required to reach the goal position summed over all problems; the total correct score is the total number of problems that are solved in the minimum number of moves; both scores are considered as indices of planning and problem-solving abilities. Furthermore, initiation time (that is, the period between the presentation of the problem space and the first move), execution time (the period between the first move and the last move), and total time are used to obtain quantitative scores about the efficiency of planning.

All tests produced standardized scores about the efficacy/inefficacy and the strength/weakness of executive functions in different populations according to a quantitative approach. Previous studies found that children, adolescents, and adults with DS typically achieved lower scores in cognitive flexibility tasks than their mental age-matched peers with typical development (Carney, Brown, & Henry, 2013; Costanzo *et al.*, 2013; Rowe, Lavender, & Turk, 2006; Zelazo *et al.*, 1996). Consistently with these early findings, several studies discovered difficulties in cognitive flexibility using nonverbal tasks (Costanzo *et al.*, 2013; Lanfranchi *et al.*, 2010) and verbal tasks (Costanzo *et al.*, 2013; Carney *et al.*, 2013). Additionally, Zelazo and colleagues (1996) documented that low-functioning individuals with DS have greater difficulty in the shifting between conflicting/incompatible events (measured by standard false-belief tasks) and concepts (valued by the DCCS task) than mental age-matched children; individuals with Down syndrome focused their mental state on a single event (e.g. the present situation) and adopted a single set of rules on all trials for sorting cards. Other investigations revealed incomparable performances produced by children with typical development and those with DS in executive functions (Lanfranchi *et al.*, 2004; Daunhauer, Fidler, Hahn, Will, Lee, & Hepburn, 2014; Lee, Fidler, Blakeley-Smith, Daunhauer, Robinson, & Hepburn, 2011). So, Daunhauer *et al.* (2014) analyzed executive functioning in children with DS and mental age-matched children with typical development using the BRIEF-Preschool version and teacher's and parent's reports about working memory, planning ability, and inhibitory control; results showed that children with DS displayed levels of impairment in working memory and planning skills beyond those

expected for their levels of development. This datum is consistent with parents' and teachers' reports.

More recently, Lanfranchi, Cornoldi, and Vianello (2004) carried out two studies concerning performances in verbal and visuo-spatial working memory, respectively. In the first study, they recruited a group of 18 children with DS (compared to 18 mental-age matched children with typically development by means of scores obtained to Logical Operations tasks) and administered four tasks requiring different levels of control of working memory (forwards word recall for low control; backwards word recall for medium-low control; selective word recall for medium-high control; dual request word recall for high control); results demonstrated that the degree of difficulty in verbal working memory for children with DS is higher when the required control is high. In the second study, twenty-two children with DS were tested in five visuo-spatial working memory tasks (memory for position with very low control; pathway forwards for low control; pathway backwards for medium-low control; starting position selection for medium-high control; dual request selective task for high control). Also in this case, children with DS performed worse than control group in visuo-spatial working memory when the required control is high.

With regard to cross-syndrome comparisons, Camp, Karmiloff-Smith, Thomas, and Farran (2016) suggested that individuals with DS tend to use compensatory strategies for problem-solving (e.g., asking for help, keeping items well ordered), while those with Williams syndrome (WS) are likely to use emotional reactions as problem-solving skills. Furthermore, Costanzo *et al.* (2013) found that individuals with DS performed worse than those with WS in verbal shifting tasks. Finally, as reported by Lanfranchi *et al.* (2010) about the analysis of executive functions measured in a small group of adolescents with DS, mentally compared to control group, results demonstrated that adolescents with DS performed at a significantly lower level in tasks of set shifting, planning/problem-solving, working memory, and inhibition/perseveration, but not in the tasks of fluency. In addition, adolescents with DS produced a greater number of errors and reduced strategies used for the sustained attention tasks. Additionally, Lanfranchi, Jerman, and Vianello (2009) analyzed the working memory and its relationships with other cognitive processes in a group of twenty individuals with DS compared to a group of twenty typically developed children (matched on vocabulary comprehension) and to a group of twenty typically developed children (matched on general verbal intelligence); the authors supposed that verbal working memory deficit was due to difficulties in verbal abilities predominantly showed by these disabled individuals, using three verbal and three visuo-spatial working memory tasks and tests assessing verbal abilities, nonverbal skills, and logical thinking. The results revealed that individuals with DS expressed deficits in both central executive functioning and verbal components of working memory.

To date, scientific literature reported little evidences about the type of problem-solving strategies used by individuals with DS in structured tasks (see Lanfranchi *et al.*, 2010; Camp, Karmiloff-Smith, Thomas, & Farran, 2016) and, although problem-solving abilities are important in everyday activities, they have been little explored in this population. The lack of data about these basic components of executive functions would require further investigations focused on the qualitative approach through the application of an observational method of analysis. For this reason, the main purpose of the current study is to analyze the problem-solving strategies of individuals with DS through the observational method to overcome the exclusivity of quantitative approach in this field.

Considering that problem-solving is described as a cycle from recognizing the problem to creating a solution, evaluating the solution, and going back to recognizing a new problem encountered (Sternberg, Jarvin, & Grigorenko, 2009, p.430), we adopted tasks directly connected to problem-solving ability and requiring the application of mental processes also

included in creative and divergent thinking (see Weisberg, 2006; De Caroli & Sagone, 2014) starting from the definition of "problem space".

The originality of this investigation (qualitative research) concerns the used method focused on the observation of behavioural patterns adopted for solving tasks of different typology in which the executive functions are involved. No research traceable to date in the main databases (e.g., Scopus, ERIC, PubMed, ISI-Web of Science) has dealt with these analyses in atypical population in developmental and adult age using this specific and systematic methodology because of the difficulty to identify the coding of observations with detailed behavioural check-lists. Additionally, pilot observations of participants with DS executing different types of tasks (chosen for the present study) allowed us to collect a depth of information about problem-solving strategies (but not a breadth of data) and reduce one of the most important limitations of this type of research, the subjectivity of the interpretation by the observers.

Method

Participants - A small group of seven participants (four girls and three boys) with Down syndrome, aged from 13 to 22 years old, attending to social cooperatives for disabled people sited in Catania, Sicily (Italy), was involved in this observational study. We used the letter "S" to identify each participant, followed by the number "1" for the first subject, "2" for the second one, "3" for the third one, and so on. About the socio-demographic information, we collected only these referred to gender and chronological age: S1=girl, 13 years old; S2=boy, 15 years old; S3=girl, 19 years old; S4=boy, 20 years old; S5=girl, 21 years old; S6=girl, 21 years old; S7=boy, 22 years old. Participants were selected among all users of these social cooperatives using the responses provided to the Raven Coloured Matrices (see Belacchi, Carretti, & Lanfranchi, 2012) and were chosen only those with mild intellectual disability. This small sample is a part of a more articulated and wide research currently in progress (see Sagone, De Caroli, Indiana, Falanga, & Napoli, 2020). At this moment, it is possible to consider these analyses as "case studies" useful to provide a level of detailed analysis not found in many other research methods. Written permission from parents of the participants involved in this study was obtained prior to data collection. All relevant details of the study were provided by researchers and parents were asked to give their informed consent in accordance with art.13 of the Italian Legislative Decree 196/2003 for data privacy (Code Regulating Personal Data Protection). Researchers followed the Ethical Code for Italian psychologists (L. 18.02.1989, n. 56) and the Ethical Code for Psychological Research (reviewed in March 27, 2015) by Italian Psychologists Association.

Measures and procedure - To analyze problem-solving strategies the three following tasks were chosen as suggested by Sagone *et al.* (2020): the Tower of Hanoi (ToH, structured task), the Tetris Game (TG, semi-structured task), and the Set of Building Blocks (SBB, unstructured task).

The **Tower of Hanoi** (ToH) has been used to observe the abilities of planning and problem-solving. This task consists of four disks of successively decreasing diameter (6 cm, 8 cm, 10 cm, 12 cm) stacked on one of three vertical pegs, moving the stack to another peg one disk at a time, never stacking a larger disk on a smaller one in the fewest possible moves. The objective of this task is to move the entire stack to another peg, responding to the following simple rules: a) only one disk should be moved at a time, b) each move consists of taking the upper disk from one of the stacks and placing it on top of another stack (i.e. a disk can only be moved if it is the uppermost disk on a stack), and c) a larger disk may not be placed over a smaller disk. The choice of this structured task is due to its composition with the presence of a minimum number of moves according to established rules necessary to its solution and only one possible correct solution; the main intent of its application is connected

to the observation of behavioural patterns adopted by individuals with DS to solve the task and not directly to the analysis of correct responses.

The **Tetris Game** (TG) is a puzzle game that requires to solvers to strategically rotate, move, and drop a procession of Tetriminos that fall into the rectangular matrix at increasing speeds. The solvers attempt to clear as many lines as possible by completing horizontal rows of blocks without empty space. In the version used in this study, we adopted a coloured wooden tetris composed by a board with raised edges inside which bricks of different shapes and colours must be positioned (shapes of the same type have the same colour) and fit together, without leaving empty spaces between one brick and another, with the final goal of covering the entire surface. This game has been selected as semi-structured task because for its solution doesn't exist only one correct modality way but different modalities ways used by individuals to occupy the given space. Again, the main goal for the use of this task is represented by the observation of behavioural patterns proposed by individuals with DS to complete the task, rather than by the analysis of type and computation of correct responses.

The **Set of Building Blocks** (SBB) consists of a container with 100 plastic pieces divided into five geometric forms (20 blocks for each form with a specific colour: yellow hexagon, red pentagon, blue rhombus, orange square, and green triangle) and it has been chosen to assess the ability to create multiple objects, forms, and ideas starting from unstructured stimuli, combining them as subject preferred. The solvers can use these plastic blocks by categorizing them according to different strategies and in a creative mental set. This task is completely free from specific rules in its resolution and allows participants to mentally operate in a more autonomous way compared to previous tasks; for this reason, it can activate divergent and creative thinking in problem-solving strategies applied by these participants, without the indication of well-documented correct responses.

In order to realize this observational study (Longobardi, 2012; Baumgartner, 2018), researchers used the check-lists previously created in the same cultural context (see Sagone *et al.*, 2020) and divided in four parts to mark both the behavioural patterns concerning the general modality way to solve the used tasks and the behavioural patterns relative to each specific task.

The **check-list** is articulated as follows (see Sagone *et al.*, 2020):

- Part n.1 consists of items for behavioural patterns adaptable to the three tasks, with reference to the comprehension of goals and rules of task, manipulative behaviours applied to the whole structure and single disks/bricks/blocks, procedural behaviours to reach the solution of tasks (that is, use of specific strategies, as, for example, reasoning loud), and adaptation behaviours during the explanation by the observer and execution of tasks (e.g., to listen the explanation, to ask for additional information, to search eye contact, and to indicate colour and shape of bricks).
- Part n.2 includes behavioural patterns used for the solution of the Tower of Hanoi, with items both referred to the comprehension of hierarchical structure of task and to specific behaviours such as the reiteration of same movements from a peg to another, the overlapping of disks in order to understand their size, and so on (e.g. to complete the task even if the disks are overlapped in wrong way).
- Part n.3 contains items for the Tetris Game, articulated in sub-dimensions to analyze rigidity/flexibility (for verifying the ability to modify spatial orientation of pieces, etc.), organizational style (for verifying the modality of task execution, according to established schema or flexible format), type of errors (with attention to ability of self-correction and self-control) and, lastly, spatial orientation (with attention to the way in which each piece or brick is rotated inside the wooden board).
- Part n.4 includes items for the set of Building Blocks referred to behavioural patterns analyzing the operational style (that is, the way in which the building blocks are

selected and chosen by individuals, e.g., randomly or in a specific way for the related position), organizational style (that is, the way in which the building blocks are inserted and allocated in the wooden board, e.g. vertically or horizontally), and final configuration (that is, the behavioural pattern adopted by each participant to create the own final product in convergent or divergent way).

The above-mentioned tasks were individually administered during three weeks, one task for each week, following the established order: a) structured task, b) semi-structured task, and c) unstructured task. During the observed sessions, participants were instructed and encouraged by the observer to solve the tasks verbalizing their thoughts. Participants' receptive knowledge of colour, shape, and size terms was assessed by asking them to select a brick or block from the used tools representing colour, shape, and size terms, respectively. All sessions were video-recorded using digital camera, transcribed for the analysis of responses, and were later judged by two independent observers by means of the previously structured check-list (Sagone *et al.*, 2020). Additionally, the check-list allowed us to record information quickly about how participants with DS performed in relation to specific strategies of problem-solving. It was written in a dichotomous format (presence or absence of behaviour) and included spaces for brief and general comments.

Data analysis - To verify the reliability and validity of these direct observations codified by the two independent observers, we calculated the inter-observer agreement using the Cohen's Kappa coefficient (1960) through SPSS (Statistical Package for Social Sciences). The calculation is based on the difference between how much agreement is actually present (observed agreement) compared to how much agreement would be expected to be present by chance alone (expected agreement). According to the suggestions of Cohen (1960), it ranges from −1 to +1, where 0 represents the amount of agreement that can be expected from random chance, and 1 represents perfect agreement between the observers. The Kappa coefficient is interpreted as follows: values ≤ 0 as indicating no agreement and 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement. In this study, the two observers showed a substantial agreement in all behavioural patterns of check-list for each participant; it ranged from 0.65 to 0.81.

Results and Discussion

Part 1: general synthesis of observations - For the initial part of check-list, the majority of participants interrupted the execution of the tasks before completing them; it happened with specific reference to the Tower of Hanoi (S1, S2, S3, S4, S5, and S6) and Tetris Game (S1, S2, S3, S4, S5). In detail, in relation to the Tower of Hanoi, some of these participants adopted the reasoning aloud approach (S3, S4, and S5). It emerged that the majority didn't count the pieces of the object, but tended to randomly manipulate the pieces, especially in the Tetris Game (S3, S4, S5, S6, and S7). A part of the participants changed the employed strategy when it didn't reach the correct result, specifically in the Tetris Game (S1, S2, S3, and S5). Almost all participants were aware of their mistakes, specifically in the Tower of Hanoi (S1, S2, S3, S4, S5, and S6); despite this awareness, most of them proceeded in a confused and random way. The majority of the participants fixed their gaze on the objects that they manipulated in all the tasks (S1, S2, S3, S4, S5, and S6). All participants were receptive and ready to accept and follow the prompts provided by the observer, with specific reference to the Tower of Hanoi and Tetris Game. The majority of the sample frequently looked for eye contact with the observer (S1, S2, S3, S4, S5, and S6).

Part 2: data for Tower of Hanoi - For the second part of check-list, with specific reference to the Tower of Hanoi (structured task), most of the participants realized that one

disk was bigger than another only after overlapping them (S1, S2, S3, S4, and S5). A part of the sample repeated the same step several times (S1, S2, S3, S4, and S5) and nobody started the task again from the first move, proceeding without any action of entire revision of the given problem.

Part 3: data for Tetris Game - For the third part, with reference to the Tetris Game (semi-structured task), regarding the sub-dimension of fixity/flexibility, half of the participants placed a brick with the same spatial orientation and persevered in the relationship between two or more bricks, positing the bricks inadequately (S1, S2, S3, and S4). Regarding the sub-dimension of the organizational style, only one participant organized the bricks off out of the wooden board and then inserted them keeping the same configuration (S7). The majority of the participants proceeded according to organized schemas (S1, S2, S3, S4, and S5), arranging the bricks in a coherent way (e.g., from top to bottom, from bottom to top, and from outside to inside), while the others alternated organizational schemas without an established order (S6 and S7). A part of the sample associated the bricks by shape or colour and made combinations (S1, S2, S3, and S4). All participants placed one brick at a time in the wooden board. With reference to the sub-dimension of the type of errors, only three participants left empty spaces (S1, S2, and S3) and, if the goal was not achieved, they rearranged their actions (S1, S2, and S3). With reference to the sub-dimension of the spatial orientation, some participants rotated the bricks in their hands and, subsequently, in the wooden board (S1, S2, S3, and S4) and the others rotated the bricks only after the established contact with the other bricks (S5, S6, and S7).

Part 4: data for Set of Building Blocks - For the set of building blocks (unstructured task), with reference to the sub-dimension of the operational style, most of participants selected the pieces blocks to be used from the container (for example, all blocks chosen by shape rectangular or yellow colour; S1, S2, S3, S4, and S5), the others took them randomly (S6 and S7). Regarding to the sub-dimension of the organizational style, most of the sample combined the pieces blocks by shape or colour (S1, S2, S3, S4, and S5) and demonstrated fixity on the geometric shapes (S6 and S7): it this means that participants showed inability to see beyond the proper shape of the blocks pieces, integrating them in order to create another shape or figure and arrange the geometric figures on the plane. Most of participants didn't associate different blocks pieces (S1, S2, S3, S4, S5, and S6). With reference to the sub-dimension of the final configuration, there is a consistency between product and mental image (e.g. creation of train using pieces blocks of container with mental image of train) only for three participants (S1, S2, and S3). Lastly, S4, S5, and S6 arranges the blocks dividing them for the same colour and shape (e.g. all green triangles, all red pentagons), but not mixing up them.

Conclusions

The analysis of behavioural patterns revealed that all the participants had no difficulties in the understanding of the rules and the objective of each proposed task; this evidence was demonstrated by the participants through direct verbalization of their understanding or showing operationally the correct steps in the solution of the three tasks.

At operational level, the emerged deficiencies can be grouped into four macro-areas which could be considered as key-factors for realizing educational training about the strengthening of executive functions in individuals with Down syndrome: 1) working memory, 2) self-monitoring ability, 3) flexibility, and 4) executive autonomy. The working memory deficit was revealed in the inability of the participants to simultaneously keep in mind all the procedural rules valid for the execution of tasks; this difficulty was pointed out

mainly in the structured task in which the most of the participants scarcely respected one of the two rules (simultaneous movement of several disks and / or positioning of a large disk over a small disk) and replaced the disks in the first peg and not in the third peg (according to the requirements by the task). Following the provided prompts by the observer, the participants used immediately the corrections, limiting them to the last realized move and then they went back to ignore the corrections and producing the same error in the subsequent moves.

It can be assumed that participants may have understood the errors and the strategies to be adopted to avoid them; however, the multiple requests of the Tower of Hanoi tended to overload the working memory making difficult to analyze all the elements necessary for a correct achievement of the final objective; it can only take place if all the rules are kept in mind and, above all, if the processes of supervisory control, self-monitoring, and inhibition of dysfunctional behaviours are active.

Regarding the self-monitoring ability, the participants let themselves be guided by the most salient and intuitive behaviours, leaving aside those of greater importance, but more complex: so, in the case of the Tower of Hanoi, participants were guided by the movement of the disks, but not respected the two rules relating to the movement of the disks; in addition, in the case of the Tetris Game, participants filled the wooden board with the bricks, but not considered the rule of completion of all empty spaces. The deficit in this capacity has generally compromised the performance of the participants who proceeded random and in a confused way, letting themselves be guided by irrelevant elements of these tasks and initial strategies that they were unable to re-modulate

Most of the errors noticed in the participants' performances could be attributed to a deficit of flexibility, which manifested itself in the inability to change the initial strategy with that based on direct experience; this deficit (or rigidity) has profoundly compromised the performance of these participants in problem-solving tasks which, by their nature, require a continuous reorganization process of information (Lanfranchi *et al.*, 2004; Lanfranchi *et al.*, 2009; Lanfranchi *et al.*, 2010). These participants who have adopted strategies of categorization, such as counting the pieces of the structure indicating the colour of the parts of the object or paying attention to the greater or lesser size of the disks, have shown an "anchorage" to these formal aspects. So, for example, in the Tower of Hanoi, the girl who paid major attention to the size of the disks (S5) categorized them in pairs labelled as "large" and "small", structured her mental project in virtue of this initial mental organization, reiterating the labelled association; furthermore, the boy who executed the movements on the basis of the count of the three pegs (S4) repeated this enumeration also during the execution of task. These behaviours highlighted the tendency to skip the phases that constitute the problem-solving process, that is, the understanding and planning of the work, and to structure ideas and procedures even before understanding the requirements of the task. It revealed a poor knowledge of the ways in which it is more appropriate to deal with new and complex situations; for this reason, probably, the participants faced the difficulties impulsively, trying to find an immediate rather than reasoned solution to them.

Similar behavioural strategies were also found with reference to the Tetris Game: so, although the ability to modify the strategy, understanding its limits, appeared to be present in the most part of the sample, the participants remained influenced by mistakes of their moves, limiting the solution possibilities. For example, some participants created frames with the same bricks and, subsequently, fitted adequately the remaining bricks one by one, while other participants placed the bricks by associating them with equal pairs and, subsequently, fitting the others. Although they have changed the approach strategy during the execution of the task, they have only done so with reference to new bricks to add without extending the "revisited" behaviours to the whole task. Additionally, some participants rotated the bricks in

their hands and, then, inserted them in the wooden board in the correct empty space, while the others realized the rotation of the bricks only after the established contact with the others proceeding by trails and errors. Referring to this last difficulty showed by half of our sample, Meneghetti, Toffalini, Carretti and Lanfranchi (2017) analyzed mental rotation abilities and their relationships with cognitive abilities and everyday spatial activities in a sample of Italian individuals with DS (matched with typically-developed children on measures of vocabulary and fluid intelligence); the performances of the two groups were compared in a rotation task that involved detecting which of two figures would fit into a hole if rotated (using five angles of rotation: 0°, 45°, 90°, 135°, and 180°) and visuo-spatial and verbal cognitive abilities were measured. The authors found that individuals with DS were less accurate in mental rotation than those with typical development, especially for smaller angles of rotation. These results deriving from quantitative approach could confirm the findings emerging by observations of behavioural pattern produced by individuals with DS in the present study. In addition, even the participants who showed higher levels of self-monitoring than the others encountered the same difficulties in taking cognition of their mistakes and extending this awareness to all the work they did. Furthermore, the rigidity of these participants has been more evident in the tendency to persevere in the relationship between one or more bricks (e.g. same joints repeated in every empty space) and in the difficulty encountered in the mental and practical rotation of the stimuli in order to correctly move them.. This evidence is in line with results previously reported by Mecca and colleagues (2015); these authors observed that deficits in the visual exploration of the figures and the skills of organization, manipulation, and mental rotation of the stimuli are extensively present in individuals with Down syndrome. These deficits compromise the visual exploration and mental rotation of the stimuli and this leads the individuals to proceed by trial and error in the inability to predict the effectiveness of the combinations.

The participants demonstrated a profound rigidity in the organization of the unstructured task (set of building blocks); specifically, they combined the geometric blocks by shape or colour, showing fixity about the category of the geometric shapes, or failing to integrate them together to create something that went beyond the specific shape. This aspect reflected the reduced attention which manifests itself with the reduction of inhibitory control; the irrelevant aspects of the tasks moved the participants away from achieving the goal and pushed them to implement behaviours which do not take into account the rules and purposes of what is required of them.

With regard to the executive autonomy of the observed participants, two relevant aspects emerged in relation to the role of the "observer". Providing examples during the explanation of the Tower of Hanoi is a counterproductive factor since the participants tended to re-propose during the execution of the task the same displacements shown them during the explanation of this task; this probably occurs because the correct behaviours are reinforced and this leads these subjects to consider the steps pursued during the initial phase as the only possible ones, leading them to re-propose these behaviours also during the execution of the task. In addition, many participants have shown a significant tendency to constantly seek eye contact with the observer between the movement of the disk and the other, frequently requesting verbal feedback; the constant search for feedback could be a substitute for the search for a secure source and approval, seeking in the others the reassurance that if, on the one hand, provides the push and the motivation to act, on the other hand, limits their autonomy because it do not allow the achievement of maximum autonomy and a sense of competence in these subjects.

This research proposed an original analysis of the problem-solving strategies in individuals with DS by using video-taped observations and applying the check-lists for data collection. The existing vacuum of qualitative investigations in scientific literature about the

deficiency of problem-solving strategies in individuals with Down syndrome underlines the necessity to examine in depth these skills in order to compare our suggestions with those of other studies carried out with similar or different disabled individuals using the observational approach.

Some limitations mainly with regard to the choice of the sample and the tasks could be noted. Concerning the first limit, the paucity of the sample does not allow to extend the evidence obtained to the other teenagers and young adults with the same syndrome and the absence of a control group does not allow us to understand if the observed data and the used strategies in the solution of these tasks are peculiar to this population or similarly present also in subjects with typical functioning. The lack of 'generalizability' is also connected to the small sample sizes for which qualitative research is known. For the second limit recognized by the researchers, the three tasks proposed in this study were used without reference to standardized and quantitative scores but rather to qualitative analyses, observing the type of solution adopted by participants for the tasks and the adequate or inadequate strategies of problem-solving employed by the chosen participants in each task. The application of this type of observation with the use of check-lists and the elaboration of assessment grids could be useful to create an advantageous linkage between qualitative and quantitative research in this field in order to enhance the knowledge concerning the problem-solving strategies in atypically developed population.

Future investigations in this field of contemporary education and developmental psychology in contact with disabled subjects could enhance the "educational good-practices" in the school-context by means of specific training about the overcoming of ideational rigidity in problem-solving, specifically in unstructured wide-ranging situations and put an emphasis on the early emergence of planning and problem-solving skills for developmental interventions.

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