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Dynamic Assessment in Preschoolers with Down Syndrome and Nonspecific Intellectual Disability

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A B S T R A C T

Enhancing cognitive abilities is relevant when devising treatment plans. This study examined the performance of preschoolers with Down syndrome and nonspecific intellectual disability in cognitive tasks (e.g., nonverbal reasoning and short-term memory) as well as in improving cognitive functions by means of a learning potential methodology. The two groups with intellectual disability showed similar performance on verbal short-term memory tasks and rule-based categorization, with differences recorded in visual short-term memory tasks. Their performance was below that of typically developing children comparable in chronological age. Groups' cognitive performance improved significantly between pre- and post-intervention, with particularly significant gains in the nonspecific group. Factors that may potentially affect children's performance before and during learning potential assessment are discussed.

La evaluación dinámica en preescolares con síndrome de Down y discapacidad intelectual de tipo inespecífico

Palabras clave:
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R E S U M E N

La mejora de las capacidades cognitivas es relevante a la hora de diseñar planes de tratamiento. En este estudio se ha examinado el rendimiento en tareas cognitivas de niños preescolares con síndrome de Down en comparación con niños con discapacidad intelectual inespecífica (por ejemplo, el razonamiento no verbal y la memoria a corto plazo), así como en la mejora de las funciones cognitivas mediante una metodología de potencial de aprendizaje o evaluación dinámica. Los dos grupos con discapacidad intelectual mostraron un rendimiento similar en las tareas de memoria a corto plazo, verbales y en categorización, registrándose diferencias en las tareas visuales de memoria a corto plazo. Su rendimiento fue inferior al de los niños de desarrollo típico comparable en edad cronológica. El rendimiento cognoscitivo de los grupos mejoró considerablemente de la situación pretest a la de postest, con ganancias particularmente significativas en el grupo inespecífico. Se analizan los factores que pueden afectar potencialmente al rendimiento de los niños antes y durante la evaluación del potencial de aprendizaje.

Down syndrome (DS) is among the intellectual disabilities most commonly associated with genetic factors (e.g., Lanfranchi et al., 2012). In the nonspecific intellectual disability (NSID) group, identifying the causes of intellectual disability (ID) during diagnosis has proven unsuccessful. Individuals with DS, when compared with peers of a similar mental age, show alterations in different components related to memory abilities (Godfrey & Lee, 2018), specifically, impaired verbal short-term memory (STM) (Lanfranchi et al., 2004), relatively preserved visuospatial STM (Carretti et al., 2013); and impairment in both verbal and visuospatial working memory (Lanfranchi et al., 2012). In terms of executive functioning, Lanfranchi et al. (2010) and Loveall et al. (2017) found impairment effects among adolescents with DS, although this functioning may be better retained at preschool age (Loveall et al., 2017).

Cognitive abilities of individuals with NSID are generally considered delayed, especially when the comparison group presents similar nonverbal development (Lifshitz et al., 2016). Carretti et al. (2010) point to limitations in tasks that impose a high cognitive load (e.g., dual and updating word span tasks), with verbal and visuospatial functioning in STM, and tasks with a "moderate" cognitive load (e.g., backward and selective word span tasks) consistent with their cognitive development. Other studies offer a more unfavorable profile of NSID. Schuchardt et al. (2011) identified deficits in verbal storage capacity yet visuospatial processing capacity consistent with

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cognitive development. In the latter case, visual aspects hold better than spatial ones (Lifshitz et al., 2016; Schuchardt et al., 2010; van der Molen et al., 2014). In general, individuals with NSID show good performance on visual tasks, on some executive tasks (e.g., planning), and weaknesses when the phonological loop is involved. Furthermore, performance is influenced by the cognitive load imposed by verbal and visual tasks (Lifshitz et al., 2016).

Development in the early years may come with its own characteristics. For example, limitations in DS identified as commonplace at more advanced ages may be less pronounced in the initial years (Fidler et al., 2006; Wright et al., 2006). Furthermore, Alloway et al. (2006) suggest that visuospatial STM tasks in typically developing preschoolers may demand executive resources that are not required in older children. However, although the characteristics associated with development can prove useful when designing interventions in the first years of a child's life, the whole set of cognitive abilities in preschoolers has received little attention.

In young children, especially with regards atypical development, Dynamic Assessment may be a viable alternative when the primary goal of assessment is to identify strategies that promote an individual's abilities and competencies. Several models have contributed to the development of dynamic assessment (see Lidz, 2001, 2014). One such model is that of Learning Potential, where an expert—normally an adult—modifies the stimulus or mediates, so that it can be registered by the learner more efficiently while the learner performs the task. This expert-learner interaction may lead to different performance results upon task completion (Carlson & Wiedl, 2013) based on cognitive modifiability (Tzuriel, 2013) and the tendency to change (Fabio, 2005).

The Application of Cognitive Functions Scale (ACFS; Lidz & Jensen, 2015) features among the Dynamic Assessment tools available. The ACFS focuses not only on the abilities and competencies deemed relevant in the development process from a curriculum perspective, but also on the analysis of cognitive and metacognitive strategies that children develop when actively engaged in the task. A Spanish adaptation of the ACFS is EHPAP (standing for *Escala de Habilidades y Potencial de Aprendizaje en Preescolares*; Calero et al., 2009). Like the ACFS, each EHPAP subscale uses a pretest-intervention/training-posttest format. The characteristics of the EHPAP are described in Valencia-Naranjo and Robles-Bello (2017).

The general aim of this study was to examine learning potential in two groups of preschoolers with ID (DS and NSID), matched on cognitive development, and a group of typically developing children of a similar chronological age in cognitive tasks related to rule-based categorization and STM included in the EHPAP. This overarching aim was broken down into two specific goals. The first goal was to compare and contrast preschoolers' performance on the cognitive tasks under study. We hypothesized that we would see similar performance by preschoolers with DS and NSID at the pre-intervention stage. Both groups present significant limitations in STM when it comes to the verbal modality and visuospatial performance adapted to their cognitive development. This similarity has also been observed in rule-based categorization tasks and in the preservation of some executive functions (e.g., shifting) in preschoolers with DS. Given the limitations in the ID groups, we would expect to observe deficits when compared with typically developing children of a similar chronological age. The second goal was to determine whether intervention impacts positively on these cognitive tasks. Working memory capacity in low cognitive load tasks and the maintenance of some executive functions would suggest higher gains in NSID relative to DS. Furthermore, we would expect both groups to show intervention-related gains close to those reached by the typically developing group of a similar chronological age on the principle of compensating for deficits associated with intervention.

Method

Participants

Sixty preschoolers aged between 3 and 6 years, 20 with DS (M = 4.55, SD = 0.99), 20 with NSID (M = 4.300, SD = 0.97), and 20 with typical development (C) (M = 4.500, SD = 0.76) took part in the study. Each group included 10 boys and 10 girls. The groups did not vary in age, $F(2, 57) = 0.414$, $p = .663$. The intelligence quotient (IQ) values obtained using the Kaufman Brief Intelligence Test (K-BIT) (Kaufman & Kaufman, 1994; Spanish adaptation by Cordero & Calonge, 2000) differed between groups, $F_{\text{nonverbal}}(2, 57) = 74.426$, $p < .001$; $F_{\text{verbal}}(2, 57) = 63.696$, $p < .001$. The pairwise comparisons showed that these differences covered C and DS, $t_{\text{nonverbal}}(38) = 29.85$, $p < .001$, $t_{\text{verbal}}(38) = 43.55$, $p < .001$, and NSID, $t_{\text{nonverbal}}(38) = 29.30$, $p < .001$, $t_{\text{verbal}}(38) = 37.05$, $p < .001$, with no differences found between DS and NSID, $t_{\text{nonverbal}}(38) = 0.550$, $p = 1.00$, $t_{\text{verbal}}(38) = 6.500$, $p = .291$.

Material

The EHPAP (Calero et al., 2009) assesses cognitive abilities distributed across subscales. The subscales applied in this study were classification, auditory memory, and visual memory. For classification, the children group blocks according to their feature dimensions (e.g., color, shape, and size), evaluating the grouping used and the number of groups formed—maximum score (MS) = 12 points. The intervention utilizes attribute blocks to help the child focus attention on what to notice about the materials, which serves as the basis for grouping (e.g., working on visual matching to a model object by attribute). The auditory memory task examines the number of details included and correct temporal sequences to reproduce/retell a story (MS = 17 points). Auditory memory intervention teaches the child to build a model of symbols for the story and to use visual imagery to facilitate story recall (e.g., helping the child build a visual model for the story with shapes or pictures). Visual memory examines the number of items recalled and the strategies used to recall previously presented visual objects simultaneously (MS = 12 points). Visual memory intervention focuses on memory strategies of rehearsal, chunking, verbal elaboration, and visual imagery (e.g., asking the child to make groups based on a common attribute).

Each subscale (pretest/intervention/posttest) requires completion on the same day (it is often the case for scale implementation to also be finalized on the same day). Rest breaks can be introduced should the child need them, but only between administering one subscale (pretest/intervention/posttest) and the next. Scores from the EHPAP are quantitative and non-normative. The EHPAP was adapted from the ACFS using a sample of 278 children aged between 3 and 6 years (Calero et al., 2009). Its principal components structure was also examined in Carles Gassín's (2012) doctoral thesis (N = 176 preschoolers), yielding similar results.

The Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kauffman, 1994; Spanish adaptation by Cordero & Calonge, 2000) offers a quick overview of a child's general intelligence through two subtests: matrices and vocabulary. The test provides a nonverbal IQ, a verbal IQ, and a composite IQ that summarizes performance on both scales. Reliability (test-retest) of the Spanish adaptation of this measure was .74 for matrices, .88 for the vocabulary subtest, and .83 for the total IQ corresponding to the sample of five-year-olds. Furthermore, this version showed moderate construct validity when compared with the Wechsler Intelligence Scale for Children-Revised (WISC-R): correlations of .80 for total IQ, .50 between matrices, and the WISC-R Perceptual Reasoning Index, and .78 between vocabulary and the WISC-R Verbal Comprehension Index.

Design and Data Analysis

The design included the group variable with three levels according to a child's diagnosis (DS, NSID, C) and the two-tier time variable (pre, post), which represented the scores obtained pre- and post-intervention for the subscales classification, auditory memory, and visual memory, corresponding to the EHPAP. These subscales were administered to the children in the same order.

A multivariate analysis of variance (MANOVA) was used to analyze the study's two proposed objectives. The dependent variables corresponding to the first aim (comparing group performances on the different tasks before intervention) were the scores obtained at pretest (PreCL: pre-classification; PreAM: pre-auditory memory; PreVM: pre-visual memory). For the second aim, that is, assessing possible intervention effects on the children's performance in EHPAP tasks, the dependent variables included in the MANOVA were the gain values for each scale (classification, auditory memory, and visual memory), giving us the difference between the scores before (pre) and after (post) intervention.

Procedure

This study was approved by the Ethics Committee of the Universidad de Jaén. All procedures performed involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. This research study was approved by the bioethics committee attached to the first author's university, University of Jaen (Spain) (code: MAR.18/12.TES). All children were participating in an Early Childhood Intervention (ECI) program. Children with DS came from the same center; children with NSID attended two different centers but followed an ECI program with similar characteristics. Control group members (C) belonged to the family and social circle of the participating children with DS and NSID. Once duly signed informed consent was received from the parents, the EHPAP subscales were administered during one-on-one sessions.

Results

The data were analyzed using SPSS 24.0 (licensed from the University of Jaen). Before conducting the analyses, the assumption of normality was tested for classification, auditory memory, and visual memory. The variables that did not satisfy this assumption were transformed (positive asymmetry in auditory memory corrected using the square root method). Likewise, multivariate normality was examined by Mardia test (using Real Statistic software), equality of covariance matrices by Box M test and to examine the relationship between the dependent variables the Bartlett's test of sphericity. The results obtained in these tests suggest that it is possible to apply MANOVA to analyze the data obtained in Pre and Gain (see below). Data reported in tables are original in order to facilitate understanding. Means and standard deviations for classification, auditory memory , and visual memory at pretest as well as the "gain" scores—resulting from the difference in scores between pre- and posttest—for each subscale and for each group (DS, NSID, C) are shown in Table 1.

Wilks' lambda, Pillai's trace and Hotelling's trace are reported in the MANOVAs (pre, profit); however, Pillai's trace statistic was used in the analyses because it is a highly robust index (Warne, 2014). Pre results reveal that the group effect was significant, Pillai's trace = .643, $F(6, 112) = 8.844$, $p < .001$, $\eta_p^2 = .321$; Wilks' lambda = .377, $F(6, 110) = 11.965$, $p < .001$, $\eta_p^2 = .395$; Hotelling's trace = 1.706, $F(6, 108) = 15.357$, $p < .001$, $\eta_p^2 = .460$, and across all subscales, $F_{CL}(2, 57) = 16.351$, $p < .001$, $\eta_p^2 = .365$; $F_{AM}(2, 57) = 27.890$, $p < .001$, $\eta_p^2 = .495$; $F_{VM}(2, 57) = 20.692$, $p < .001$, $\eta_p^2 = .421$. The pairwise comparison (using the Bonferroni correction) showed the pretest C scores to be significantly higher across all subscales than those obtained for DS, $t_{CL}(38) = 3.050$, $p < .001$, lower limit = 1.727 and upper limit = 4.373; $t_{AM}(38) = 3.450$, $p < .001$, lower limit = 2.268 and upper limit = 4.632; $t_{VM}(38) = 2.550$, $p < .001$, lower limit = 1.565 and upper limit = 3.535; and NSID, $t_{CL}(38) = 1.800$, $p < .05$, lower limit = 0.477 and upper limit = 3.123; $t_{AM}(38) = 2.550$, $p < .001$, lower limit = 1.368 and upper limit = 3.732; $t_{VM}(38) = 1.550$, $p < .001$, lower limit = 0.565 and upper limit = 2.535. The comparison between DS and NSID revealed that the PreVM score in NSID was higher than that of DS, yielding no differences in the other tasks, $t_{CL}(38) = 1.250$, $p = .07$, lower limit = -073 and upper limit = 2.573; $t_{AM}(38) = 0.900$, $p = .196$, lower limit = -0.282 and upper limit = 2.082; $t_{VM}(38) = 1.100$, $p < .05$, lower limit = 0.015 and upper limit =1.985.

Table 1. Pretest and Posttest Values of Media and Standard Desviation of Classification, Auditory Memory, and Visual Memory EHPAP Subscales for Down syndrome (DS), Nonspecific Intellectual Disability (NSID), and Preschool Controls of a Similar Chronological Age (C)

EHPAP Subscales	Group	Pretest		Gain	
		M	*SD*	*M*	*SD*
Classification	DS	1.60	1.31	2.90	0.97
	NSID	2.85	1.49	3.45	1.14
	C	4.65	2.15	2.50	1.00
Auditory memory	DS	1.05	1.27	1.05	1.57
	NSID	1.95	1.46	2.90	1.41
	C	4.50	1.76	4.00	2.06
Visual memory	DS	2.00	1.69	1.85	1.18
	NSID	3.00	1.12	3.00	1.34
	C	4.55	0.83	3.70	1.36

The main effect of group was significant in the "gain" scores (Pillai's trace = .572, $F(6, 112) = 7.475$, $p < .001$ $\eta_p^2 = .286$; Wilks' lambda = .482, $F(6, 110) = 8.075$, $p < .001$, $\eta_p^2 = .306$; Hotelling's trace = .965, $F(6, 108) = 8.689$, $p < .001$, $\eta_p^2 = .326$, as well as in each subscale, $F_{GCL}(2, 57) = 4.200$, $p < .05$, $\eta_p^2 = .128$; $F_{GMA}(2, 57) = 15.568$, $p < .001$, $\eta_p^2 = 0.353$; $F_{GMV}(2, 57) = 13.306$, $p < 0.001$, $\eta_p^2 = .318$. The pairwise comparison (using the Bonferroni correction) showed C gain scores to be significantly higher than those obtained for DS in auditory memory, $t(38) = 2.950$, $p < .001$, lower limit = 1.632 and upper limit = 4.268); and visual memory, $t(38) = 1.850$, $p < .001$, lower limit = 0.957 and upper limit = 2.743, with no differences observed in classification, $t(38) = -0.400$, $p = .688$, lower limit = -1.212 and upper limit = 0.412. The C gain was lower than that of NSID in classification, $t(38) = -0.950$, $p < .05$, lower limit = -1.762 and upper limit = -0.138, yielding values close to those obtained in auditory memory, $t(38) = 1.100$, $p = .132$, lower limit = -0.218 and upper limit = 2.418; and visual memory, $t(38) = 0.700$, $p = .175$, lower limit = -0.193 and upper limit = 1.593). The gain for NSID was higher than that obtained for DS in auditory memory ($t(38) = 1.850$, $p < .05$, lower limit = 0.532 and upper limit = 3.168; and visual memory, $t(38) = 1.150$, $p < .05$, lower limit = 0.257 and upper limit = 2.043, yielding no group differences in classification, $t(38) = 0.550$, $p = .301$, lower limit = -0.262 and upper limit = 1.362.

Hypothesis contrast requires an assessment to determine whether there are differences in means (e.g., *p*-value), if the differences are large (e.g., effect size), and whether they are meaningful (e.g., practical significance) (Cárdenas Castro & Arancibia Martin, 2014). Once the level of statistical significance on each of the scales has been established (classification auditory memory and visual memory), the effect size allows to value the importance of these differences. Swanson and Lussier (2001) found that weighted effect size for Dynamic Assessment procedures in people with intellectual disabilities is .17 (range = .12-.23). The results in the scales obtained in this study are better than those suggested by Swanson and Lussier (2001). These data encourage us to consider the applied relevance of the results together with their statistical relevance.

Discussion

The first aim of this study was to compare and contrast DS, NSID, and C preschoolers' performance on rule-based categorization and STM tasks (verbal and visuospatial) prior to intervention. The second aim was to identify whether adult-led intervention influences their performance. Both aims are now discussed in relation to the rule-based categorization task (classification) and the STM tasks (auditory memory and visual memory).

Rule-based Categorization

Classification is an explicit learning process driven by forming hypotheses about discrete categories (e.g., color, shape, and size). This capacity depends on executive functioning (Gligorovic & Buha, 2013; Phillips et al., 2014; Robles-Bello et al., 2018). The PreCL results suggest that the capacity for rule-based categorization in preschoolers with ID (DS, NSID) is lower than that of controls with a similar chronological age.

The executive functioning of preschoolers with NSID in WM, shift, and inhibition is lower than that of typically developing children of a similar chronological age (Dekker et al., 2016), as well as in planning and fluency (Alloway, 2010; van der Molen et al., 2007). Loveall et al. (2017) reported much the same results for adolescents with DS. Similar classification scores for DS and NSID coincide with Carretti et al. (2010), who report similar performance when the tasks require processing skills, as well as with Phillips et al. (2014) across a wide age range (older children, adolescents, and young adults).

Typically developing preschoolers exhibit difficulties in category conceptualization when it comes to identifying and consistently applying the grouping strategy (Rabi & Minda, 2014), and performing set shifting between mental representations (Gligorovic & Buha, 2013). Overcoming these limitations is one of the key objectives in classification intervention. The gain achieved by preschoolers with NSID was greater relative to the C group, yielding no differences between NSIS and DS or between C and DS. This pattern of results is consistent with the principle of compensating abilities as suggested by Titz and Karbach (2014) and that of learning potential (compensation in the most disadvantaged groups initially). However, the factors that contribute to this result may differ in NSID and DS.

Following the model proposed by Friedman and Miyake (2017), two capacities play out in rule-based categorization: that represented in the common factor, which is linked to the establishment, control, and implementation of valid objectives during task performance; and integrating the dedicated capacity for shifting alongside this common factor. This integration allows us to balance stability with behavioral change, a necessary process for meeting changing objectives. The abilities of children with NSID and DS in both these capacities may be different.

In our view, DS may present limitations not only in interference control, affecting the common factor, but also when controlling dominant responses, thus altering the capacity to integrate with the common factor and, in turn, shifting capacity. Blackwell et al. (2014) define interference control as the ability to ignore certain information which is strongly linked to other information, but which prompts an inappropriate response, whereas dominant response inhibition corresponds to the voluntary control of an encouraged motor response. Borella et al. (2013) ascribe both deficits to the inhibitory difficulties in DS. Furthermore, these limitations may play a role in the executive pattern observed by Loveall et al. (2017) in small children with DS (shifting capacity consistent with cognitive development; inhibition limitations and significant deficits in WM). Friedman and Miyake (2017) found that it is possible to identify altered executive skills with good set-shifting performance when the functioning of the common factor is affected (deficient executive skills) and when the common factor integrates with the ability to replace some objectives with others at the correct moment (shifting preservation).

Similarly, the study conducted by Will et al. (2017) also suggests different contributions for both inhibition types: voluntary response control (e.g., snake delay task) and WM/inhibition (e.g., pony/gator task). The aim of this research was to determine the participatory factors in predicting academic skills in preschoolers with DS and typically developing peers matched for cognitive development. The beta weight in the snake delay task (response inhibition) was negative in typically developing children, positive in children with DS, and positive for both groups on the pony/gator task (interference control) (see Table 1).

Gligorovic and Buha (2013) found that when engaging in rule-based categorization, children's ability to create conceptual patterns and replace one conceptual representation for another (mental set rigidity) is altered in NSID. The high rate of perseverative errors suggests deficits in substituting one set for another, even when the children correctly frame their mental set. Based on these results and others discussed further on, we believe that preschoolers with NSID show deficits in controlling dominant responses (integration of the specific shifting factor) as well as improved development of the common factor. This performance pattern can also be observed in typically developing preschoolers. Cognitive flexibility, measured using fluency tests, and inhibitory control are related yet different characteristics in typically developing preschoolers' executive functioning (Memisevic and Biscevic, 2018). Furthermore, typically developing preschoolers can demonstrate cognitive flexibility and good interference control without response inhibition (Blackwell et al., 2014).

Flexibility in children with NSID is adjusted to their cognitive development and, in a high percentage of studies, functioning of the central executive is maintained (Lifshitz et al., 2016). This good fluency and switching performance may be accompanied by limitations in motor and verbal inhibition (Danielson et al., 2012). Similarly, the results of Memisevic and Sinanovic (2014) for older children with DS and NSID reveal different executive functioning across the BRIEF subscales. Specifically, the authors observed greater difficulties for DS in shift and WM with similar inhibition performance. These between-group differences are particularly significant when the DS group is compared to a group of children with NSID classified as mild.

The circumstances in C may be different. The lesser gain in C relative to both groups with ID may have been limited because intervention does not prompt significant improvements in their prior abilities and falls short when it comes to facilitating a more mature performance. Gligorovic and Buha (2013) summarized the maturation of this conceptualization process in typically developing children as follows: to begin by generating concepts and performing classification using grouping criteria (3-4 years); and to pay attention to two criteria in the same set of stimuli approaching 4-5 years with a significant increase in flexibility. Attention and switching to a third criterion occurs between the ages of 5 and 7 years, a still-emerging ability in our study's typically developing participants (3-6 years). Furthermore, the better established the representations, the more difficult to switch between them (Friedman & Miyake, 2017).

Short-term Memory

Verbal STM task (auditory memory) requires participants to retell the elements of a short story immediately after hearing it. The visuospatial task (visual memory) calls upon the STM recall of different visual stimuli displayed together. The number of words recalled by preschoolers with DS and NSID on the auditory task (PreAM), and of visual stimuli in the visuospatial task (PreVM), was below that of peers with a similar chronological age. These results coincide with the difficulties found for DS (Frenkel & Bourdin, 2009; Godfrey & Lee, 2018; Smith & Jarrold, 2014) and NSID (Maehler & Schuchardt, 2009; Schuchardt et al., 2010; Lifshitz et al., 2016), with limitations in verbal STM exceeding the expected relative to cognitive development. These deficits are commonly regarded as structural in nature, specifically, in terms of the capacity for storage. The visuospatial abilities in DS and NSID on STM tasks are also weaker when compared with children matched for chronological age (Schuchardt et al., 2010; van der Molen et al., 2009).

The contrast in scores between the ID groups varies according to the STM task. The mean scores were close in auditory memory and higher for NSID in visual memory. The lack of differences between DS and NSID in verbal STM was also reported by Stavroussi et al. (2016). This result is congruent with the structural difficulties in verbal STM highlighted in the literature. Although visuospatial processing in DS and NSID remains a strength, this ability is relative. In DS, the deviation from what is expected in visual STM is slight (Godfrey & Lee, 2018), yielding more evident difficulties in visuospatial tasks that call for the simultaneous processing of information (Frenkel & Bourdin, 2009; Lanfranchi et al., 2004). The recall of visual patterns in NSID is good (Lifshitz et al., 2016; Schuchardt et al., 2010; van der Molen et al., 2009), with mixed results when it comes to processing spatial information (van der Molen et al., 2009) and greater ones if it involves a complex task (Lifshitz et al., 2016). The collective presentation of the different stimuli in this study may have influenced the higher PreMV scores in NSID relative to DS.

The gain in both STM tasks (auditory memory and visual memory) is similar in C and NSID and higher than that obtained by DS. During auditory memory intervention, the preschoolers initially selected visual elements that represent some of the main elements shared in the story. They then told the story using these visual aids. Visual memory intervention involved analyzing and applying recall strategies (e.g., visual information analysis, item repetition, and grouping into categories).

Turley-Ames and Whitfield (2003) argue that the efficacy of strategic training is influenced by WM capacity and/or the ability shown by participants to allocate their attentional resources. Specifically, individuals with a low span present deficits in the available resources and in their efficient use. In these cases, strategic training contributes toward facilitating the reallocation of their WM resources and managing the task demands. Intervention in both STM tasks may have had this function in the NSID group, encouraging gain scores comparable to those obtained by C.

The functioning of working memory in the visual modality is a relatively preserved skill in people with NSID (Lifshitz et al., 2016), and consistent with what is expected relative to their cognitive development (van der Molen et al., 2009). The visual material used as a memory aid system during verbal STM intervention and the recall of material presented visually in visual memory may have contributed to improving performance in both tasks for this group. The capacity to recall verbal and visual material following intervention suggests, in the direction proposed by Poloczek et al. (2016), that preschoolers with NSID can learn to use strategies to enable recall, irrespective of the modality (verbal or visual).

An important aspect is the reduced efficacy of strategic training in DS, an outcome that goes against the established hypothesis. Turley-Ames and Whitfield (2003) suggest that the efficacy behind STM recall strategies is moderated by the degree of cognitive effort demanded of the participant when applying this strategy (e.g., rehearsal can prove more effective than semantic grouping or imagination-based strategies). These authors hold that effective strategies are those which allow us to free attentional resources during processing (e.g., make them more accessible to the individual) and guide them toward information storage. Differences in the degree of effort/difficulty imposed by the strategies were also reported by Bruns et al. (2019). Intervention in this research, that is, to link parts of the story to visual representations, can prove an extremely complex endeavor for preschoolers with DS. The development of episodic memory consumes processing resources (Henry & Botting, 2017), resources which are very limited in DS (Godfrey & Lee, 2018). Despite this, the gain obtained by this group was higher than that reported in Valencia-Naranjo and Robles-Bello's (2017) study where preschoolers with DS and FXS did not significantly improve their auditory memory performance.

The conclusions drawn for visual memory are similar to those for auditory memory. The strategies implemented during the visual memory intervention stage required an analysis of the characteristics of the different elements and how to repeat and group them. These strategies are similar to those used by typically developing children in Henry and Conners' (2008) study. Specifically, the first strategies are visual in nature (e.g., characteristics of the stimuli and/or spatial position of the components); next, they apply visual and verbal coding of the various stimuli to strategies such as grouping and rehearsal. At subsequent stages, they essentially resort to a verbal coding system, although the visual strategies reinforce performance when the verbal recoding is overly complex. We argue that the higher gain obtained by NSID is linked to the preschoolers' ability to allocate their attentional resources in the direction proposed by Turley-Ames and Whitfield (2003).

Conclusion and Limitations

Previous research (e.g., Carretti et al., 2010; Lanfranchi et al., 2004) highlights how group differences in ID are more significant in WM components associated with storage, showing close performance on tasks with an increased cognitive load. The contribution made by different executive functions may have influenced the lack of differences between DS and NSID in rule-based categorization (classification). This general finding coincides with other research studies which have reported deficits in DS, but less pronounced ones in the first years of life. However, these results may be due not to an adjusted performance but to an inefficient development of executive skills and progressive integration. This calls for a direct verification process in future studies.

The results from both STM tasks indicate a more efficient processing capacity in NDIS relative to DS, achieving gains close to C. Both groups show limitations in limited short-term recall (e.g., pre-stage) and differ in terms of efficacy when processing and/or using information extracted from intervention when performing the same or a very similar task. These results suggest that cognitive abilities are better stimulated in NSID. The meta-analysis performed by Danielsson et al. (2015) reports how ID intervention is more effective when STM-related tasks are involved; this is especially the case in the NSID group. Integrated models such as the one proposed by Gray et al. (2017) can enhance our knowledge of intellectual disability. In this model, efficient executive processes enable activation of a greater number of components in the focus of attention and/or the use of more efficient mnemonic strategies.

There are two limitations to this study. The first is the lack of a control group with cognitive development comparable to that of children with ID. The limited studies on laboratory tasks involving young children encourages us to look at the differences by addressing chronological age in this population. From this perspective, it highlights the lower scores obtained in Pre and the comparable gains in some tasks, mainly in NSID. Despite this, the decision to include this control group of a similar chronological age would enable us to verify whether these gains and/or performance better adjust to a developmental delay pattern. The second limitation is having excluded other types of tasks and/or the assessment of other abilities that allow us to not only examine the intervention's transfer effects, principally near effects, but also to assess whether the gains are transferred to other untrained activities or whether they depend on previous experience in the task.

Conflict of Interest

The authors of this article declare no conflict of interest.

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