Original Research

The validity of learning potential for predicting educational adjustment in preschoolers with Down syndrome: A longitudinal study

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Maria Auxiliadora Robles-Bello, Francisca Barba-Colmenero and Nieves Valencia-Naranjo
Department of Psychology, Universidad de Jaén (España), Spain

David Sánchez-Teruel
Faculty of Psychology, Universidad de Granada (España), Spain

Abstract

Learning Potential tests aim to assess cognitive functioning using mediation strategies by observing subsequent changes in learning patterns. In this study, this methodology was applied with the Preschool Learning Potential and Abilities Scale and two additional tests, the Kaufman Brief Intelligence Test and the Battery of Aptitudes for School Learning I, to a total of 58 children with Down Syndrome, at four and six years of age. The results demonstrate improvements in general intelligence, learning potential, and school aptitudes between the two timepoints. There was a significant, positive relationship between the variables measured in the different tests, as well as on the predictive variables of school aptitudes, in these children at six years of age. There is evidence that supports the use of this dynamic evaluation methodology, opening new fields of action in child evaluation processes.

Keywords

learning potential, cognitive functions, Down syndrome, early intervention, preschoolers, longitudinal study

Introduction

Dynamic Assessment (DA) is an alternative to the reliability and validity problems of the traditional psychometric approach in young children. Various models have helped the development of DA (see Lidz, 2001, 2014), one of which is Learning Potential, where a trained mediator modifies the

Corresponding author:
Francisca Barba-Colmenero, Department of Psychology, Universidad de Jaén (España), Campus de las Lagunillas, Jaen 23071, Spain.
Email: fbarba@ujaen.es

stimulus—or medium—so that children can perform more effectively, with the basic aim of learning strategies to improve their skills and competencies. The assumption of cognitive modifiablity (Tzuriel, 2013) and the willingness to change (Fabio, 2005) in the pursuit of performance improvement through the help of another person has contributed to broadening the range of potential applications of learning potential. In this process, Carlson & Wiedl (2013) note the need to add information from person-specific variables, the task itself, and the intervention methodology, leading to different outcomes depending on the interaction in the process.

One instrument used in DA is the Application of Cognitive Functions Scale (ACFS) (Lidz & Jepsen, 2015). The ACFS focuses on competencies and skills considered important in the developmental process from a curricular educational perspective, as well as on the study of the cognitive and metacognitive strategies that children employ when they perform a task carefully. This scale was adapted to Spanish as the *Escala de Habilidades y Potencial de Aprendizaje en Preescolares* (EHPAP) (Calero et al., 2009). This test, like the ACFS, consists of a methodology that includes a pre-test-intervention/training-posttest assessment, where the child performs the activity independently in the pre- and post-intervention phases. During the assessment, a trained mediator (expert) provides information on strategies or methods to facilitate task resolution. Each task is predetermined and follows a didactic conversation model between the learner and the mediator. Finally, in the post-test phase, the learner is asked to repeat the test by themselves. The difference between the pre- and post-test scores is considered the learning potential score. The EHPAP generates a score that indicates the child's level of ability in each task (pretest), along with other indicators of response to the intervention (posttest and score increase). The ACFS (and EHPAP) provides information about the task as well as the process for intervening in mediation as it underlies the assessment approach proposed by Carlson & Wiedl (2013). The original version of the scale (ACFS) has been adapted for Dutch children (Lidz & Van der Aalsvoort, 2005) and Spanish children with Down syndrome (Calero et al., 2010), as well as for Spanish children with language disorders (Robles-Bello & Calero, 2013).

Down syndrome (DS) is a disability that affects a person's intellectual level due to genetic causes (e.g. Lanfranchi et al., 2012), (Robles, et al., 2020). Those with DS, in comparison to people of the same age, have impaired verbal short-term memory (STM) (Lanfranchi et al., 2004) although their visuospatial short-term memory remains unimpaired (Carreti et al., 2013) and impaired working memory both verbal and visuospatial (Lanfranchi et al., 2012). Their implicit memory capacity is not impaired (Bussy et al., 2011), but there is low executive functioning, especially in adolescents (Lanfranchi et al., 2010).

Information related to phenotypes has theoretical interest, but contributes to the design of interventions tailored to individual's needs in order to focus on strengths or to work on skill deficits (Conners et al., 2008). This emphasises the importance of recognising children's performance traits. The application of methods such as DA, which are aimed at identifying those skills that can be improved at different stages of development, may be important because disorders progress in non-linear patterns (Kogan et al., 2009). For example, common limitations of DS at older ages may not be present in early years. General functioning (Fidler et al., 2006) and functioning in memory tasks involving the hippocampus or prefrontal area (Wright et al., 2006) in preschoolers with DS may be similar to the cognitive development of typically developing children. Hence, developmental differences may be especially important in early years, particularly in clinical samples, although the cognitive skill set has been little studied at that stage, especially longitudinally in preschoolers.

The aim of this study was to produce evidence from the assessment of the progression of learning potential in children with Down syndrome two years after an initial assessment. More specifically, we aimed to determine whether there were differences in general intelligence, learning potential, and

school skills between the two timepoints (4/6 years). We also attempted to verify the relationships between all the variables measured.

Method

Participants

The participants were from Spain, users of an early intervention center for the care of people with intellectual disabilities, specifically the Jaén Down Syndrome Association. The sample consisted of 58 children with Down syndrome DS (n=24, 41% girls). The inclusion criteria were: a diagnosis of DS with trisomy 21 diagnosed at birth by a paediatrician; no autistic traits and no impairment due to genetic or environmental factors. At the first timepoint, the children were 4 years old and in the second year of kindergarten (Mmonths = 48.9, SD = 2.73). At the follow-up assessment (2 years later), the children were 6 years old (Mmonths = 74.5, SD = 3.07).

Measures

The Kaufman Brief Intelligence Test (K-BIT) (Kaufman et al., 2000; Kaufman and Kaufman, 1994; Spanish adaptation by Cordero & Calonge, 2000) provides general intelligence data through two subtests: matrices and vocabulary. It can be used to obtain a non-verbal IQ, a verbal IQ coefficient and a composite IQ that summarises performance in both scales. In the Spanish adaptation, test-retest reliability for this measure was .74 for the matrices test, .88 for the vocabulary test and .83 for the total IQ in relation to a sample of five-year-old children. In addition, it exhibits moderate construct validity when compared to another scale such as the Wechsler Intelligence Scale for Children-Revised (WISC-R): with correlations of .80 for total IQ, 0.50 between the matrices and the WISC-R Perceptual Reasoning Index, and .78 for vocabulary with the WISC-R Verbal Comprehension Index. In this sample of children with DS the overall reliability was .86.

The Battery of Aptitudes for School Learning I (BAPAE-I) (De la Cruz, 1982) is a test that assesses verbal comprehension, numerical aptitude and perceptual-visual aptitude in schoolchildren aged 6 to 7 years. The instrument has a reliability index of .94 overall, and between .45 and .89 depending on the scale. In this sample of children with DS the overall reliability through alpha was .89.

Cognitive Functions Application Scale (ACFS) (Lidz & Jepsen, 2000, 2003), which was adapted for Spanish children aged 3 to 6 years as the *Escala de Habilidades y Potencial de Aprendizaje en Preescolares* (EHPAP) (Calero et al., 2009). It measures different cognitive skills through six subscales: 1) Classification-CL: where the child establishes groups with the set of blocks presented. 2) Auditory memory-AM: the child is read a short story and must listen to it attentively and then retell it with the correct order of events. 3) Visual Memory-VM: the child is asked to name the pictures presented on cards, then asked to use a strategy to memorise the names of the pictures and finally to recall them. 4) S-Series: the child is presented with a series of patterns or sequences that they have to complete with the correct piece from several possibilities. 5) Perspective taking-PT: the child has to give as many instructions as they feel necessary to teach someone how to draw a picture. 6) Verbal Planning-VP: the child has to present a sequence of behaviours involved in a given task. In addition, the EHPAP includes a Behavioural Observation Scale to qualitatively assess the child's interaction with the assessor. That subscale was not used in this research. The version in Spanish preschool children (EHPAP, Calero et al., 2009) gave adequate construct validity with six

subdimensions, confirmed by subsequent studies (Carles-Gassín, 2012) and explaining 61.12% of the total variance. The overall reliability of the EHPAP in the sample in this study was .96.

Data analysis

First, a comparison of measures (Student t) was made between all variables of intelligence, learning potential, and school skills between the two age groups of children (4/6 years). Secondly, a bivariate correlation between all variables was applied. Finally, multiple hierarchical regression was applied to assess which sub-dimensions of intelligence (K-BIT) and learning potential (EHPAP) were most predictive of participants' school aptitude at age 6. All analyses were conducted with SPSS 26 (IBM Corporation, 2020) and the minimum level of significance was $p < .05$.

Procedure

The sample of children was taken from an early childhood intervention (ECI) programme at a single centre. Parents gave their informed consent and the children were assessed individually. The first assessment was carried out when the children were 4 years old, and they were assessed again two years later, when they were 6 years old.

Results

The data showed a significant time effect for all children in K-BIT, especially in vocabulary (Table 1). Overall, the results of the analysis indicated a significant progression in K-BIT scores between the two assessment timepoints. There was also a relationship between these differences and the learning potential levels of children with Down's syndrome at age 4. The effect sizes were adequate and the effect was positive. In addition, there was a significant effect over time (between-group) in both K-BIT and EHPAP. There were significant differences between the two groups in terms of learning potential in the BAPAE, with the strongest effects in the subtest of perceptual-visual aptitude.

The results indicate strong relationships between all variables (Table 2). In particular, the vocabulary subdimension of the K-BIT exhibited strong, significant, positive correlations with all of the language-related subdimensions in both the EHPAP and BAPAE I. The K-BIT matrices subdimension also exhibited strong, significant, positive correlations with subdimensions related to numerical or perceptual aspects in EHPAP and BAPAE I. In addition, the EHPAP appeared to exhibit strong, significant, positive correlations with the BAPAE I in almost all its dimensions.

The indices indicating suitability for the application of multiple hierarchical regression (Durbin-Watson-DW and non-multicollinearity-VIF) gave adequate results, where DW = .59 to 1.96, meeting this assumption for all independent variables (IVs)—from the K-BIT (vocabulary and matrices) and EHPAP (classification, auditory memory, visual memory, series, planning and perspective taking). Non-multicollinearity was also indicated for all IVs, as the values of VIF were less than 10 (Kleinbaum et al., 1988; VIF = from 1.3 to 1.9). The applied regression model indicated that the IVs significantly explained ($F = 56.43$; $p < .01$) 62% ($R^2 = 61.89$) of the variance in the dependent variable—DV (BAPAE I). Furthermore, the best predictors of school skills (Table 3) were the K-BIT matrices subdimension and the EHPAP classification, visual memory, and series subdimensions. The remaining independent variables did not seem to modulate improvements in skills of children with DS ($p > .05$).

Table 1. Descriptive statistics and between-group comparisons in study participants (n = 58) according to age.

	4 years	6 years	Between-group	
	M(SD)	M(SD)	t	η^2
K-BIT				
Vocabulary	54(10.11)	57(14.82)	39.41**	.88
Matrices	60(9.54)	63(15.67)	9.03*	.74
EHPAP				
Classification	1.02(.39)	3(.06)	15.41**	.83
Auditory Memory	1.01(.19)	3(.68)	44.03**	.74
Visual Memory	1.05(.13)	3.2(.71)	48.22**	.95
Series	1(.96)	2.9(.22)	9.76**	.91
Verbal Planning	1.03(.82)	2.9(.63)	8.54**	.97
Perspective Taking	1.7(.17)	3.5(.94)	12.31**	.85
BAPAE I				
Verbal comprehension	10(2.43)	6(1.81)	3.26*	.89
Numerical Aptitude	8(2.91)	2(1.06)	2.59*	.71
Visual-perceptual aptitude	40.20(3.11)	20.87(5.09)	18.26**	.92

t = Students t; η^2 = Test power; *p < .05; **p < .01; ns = not significant.

Discussion

The general objective of this study was to examine the validity of learning potential to determine school adaptation to the demands and characteristics of the education system in preschoolers with Down syndrome using the Spanish version of the ACFS—the EHPAP—and to check if there was a relationship with school aptitudes two years after the initial assessment. Specifically, we found differences in general intelligence, learning potential, and school skills at the two timepoints (4/6 years). We also found significant, positive relationships between all variables. We produced data on the variables which were most predictive of school skills in six-year-old children with Down syndrome.

In addition, there were significant differences in progress in the K-BIT matrices and in the vocabulary subtest. The K-BIT scores also significantly predicted progress in the matrices subtest. There was a connection between learning potential assessed by EHPAP and performance in the BAPAE in all subtests, but most strongly with the visual-perceptual aptitude subtest, and concurrent validity in line with the results from Calero et al. (2009) and Valencia & Robles-Bello (2017). The scores in the EHPAP transfer (pretest-posttest difference) were positively related to the BAPAE in the classification, pattern sequence and visual memory subtests, and were good predictors of performance for visual-perceptual aptitude and numerical skills respectively. In contrast, the results did not show any significant relationship between learning potential obtained via EHPAP and verbal tests: K-BIT vocabulary test or verbal comprehension performance in the BAPAE battery. Both EHPAP and the BAPAE were good predictors of raw scores on the K-BIT vocabulary pretest. These results are consistent with the hypothesis supported by previous studies of dynamic assessment, in which verbal ability is more autonomous than other, more general, skills where the correlation is lower with non-verbal indices (Onnivello et al., 2022).

Table 2. Correlations between all variables at both timepoints.

	K-BIT		EHPAP						BAPAE I		
4 years	V	M	CL	AM	VM	S	VP	PT	VC	NA	VPA
V	I	.59*	.86**	.92**	.84*	.71*	.95**	.81*	.86**	.81*	.76**
M	.59*	I	.65*	.49*	.86**	.96**	.73*	.77*	.49*	.93**	.91**
CL	.86**	.65*	I	.71*	83**	. .62*	.76*	.92**	.52*	.81*	.89**
AM	92**	.49*	.71*	I	.62*	.53*	.83**	.69*	.92**	.65*	.57*
VM	.84*	.86**	.83**	.62*	I	.86**	.56*	.72*	.81*	.78*	.93**
S	.71*	.96**	.62*	.53*	.86**	I	.61*	.89**	.72*	.86**	.91*
VP	.95**	.73*	.76*	.83**	.56*	.61*	I	.69*	.94**	.65*	.70*
PT	.81*	.77*	.92**	.69*	.72*	.89**	.69*	I	.73*	.62*	.87*
VC	.86**	.49*	.52*	.92**	.81*	.72*	.94**	.73*	I	.58*	.75*
NA	.81*	.93**	.81*	.65*	.78*	.86**	.65*	.62*	.58*	I	.69*
VPA	.76**	.91**	.89**	.57*	.93**	.91**	.70*	.87**	.75*	.69*	I
6 years	K-BIT		EHPAP						BAPAE I		
	V	M	CL	AM	VM	S	VP	PT	VC	NA	VPA
V	I	.71*	.91**	.96**	.89*	.82*	.98**	.89*	.98**	.89*	.53**
M	.71*	I	.81*	.62*	.94**	.98**	.82*	.85*	.70*	.96**	.95**
CL	91**	.81*	I	.79*	.88**	.71*	.79*	.95**	.59*	.83*	.92**
AM	.96**	.62*	.79*	I	.67*	.57*	.89**	.72*	.94**	.69*	.61*
VM	.89*	.94**	.88**	.67*	I	.92**	.64*	.77*	.86*	.81*	.94**
S	.82*	.98**	.71*	.57*	.92**	I	.65*	.92**	.76*	.89**	.92**
VP	.98**	.82*	.79*	.89**	.64*	.65*	I	.72*	.96**	.68*	.76*
PT	.89*	.85*	.95**	.72*	.77*	.92**	.72*	I	.77*	.65*	.88**
VC	.98**	.70*	.59*	.94**	.86*	.76*	.96**	.77*	I	.62*	.77*
NA	.89*	.96**	.83*	.69*	.81*	.89**	.68*	.65*	.62*	I	.72*
VPA	.53**	.95**	.92**	.61*	.94**	.92**	.76*	.88**	.77*	.72*	I

K-BIT (V = vocabulary; M = matrices); EHPAP (CL = classification; AM = auditory memory; VM = visual memory; S = series; VP = verbal planning; PT = Perspective Taking); BAPAE I (VC = Verbal comprehension; NA = numerical Aptitude; VPA = visual-perceptual aptitude); *$p < .05$; **$p < .01$; ns = not significant.

The EHPAP transfer scores in this study indicate that there is potential for learning, suggesting that children who benefit most from the intervention during mediation training are able to benefit from the learning resources. On the other hand, we cannot assume that EHPAP at four years of age is a good predictor of cognitive development or performance in school skills two years after the initial intervention. With the results, we can conclude that the EHPAP is a good instrument within the assessment tests. Some studies have suggested better predictive validity when this dynamic methodology is used together with other more traditional and more static tests. (Caffrey et al., 2008; Swanson & Lussier, 2001).

On the other hand, some studies have found that modification in the mediation phase by including aids that guide the child which are tailored to their difficulties, known as scaffolding, produce significant improvements in performance levels in the post-test results (Ensing et al., 2014; Mata et al., 2017). Scaffolds are guides, supports or aids, which facilitate learning and can take the form of verbal prompts or corrections, depending on the child's actions (Brownfield & Wilkinson, 2018), or visual images and drawings, with programmes or software (Haake et al., 2015).

Table 3. Values of the regression equation for the IVs for children with Down syndrome (6 years).

	R^2	$F_{(1,57)}$	*p*	B	SE	t
Step 1 (BAPAE)	1.87	2.93	.0003			
K-BIT (vocabulary)				.48	.11	1.16^{ns}
K-BIT (matrices)				2.52	.42	8.43*
Step 2 (BAPAE)	24.32	27.14	.0001			
EHPAP (classification)				2.63	.92	.7.23*
EHPAP (auditory memory)				-1.56	.33	-1.20^{ns}
EHPAP (visual memory)				3.26	.94	5.57*
EHPAP (series)				2.49	.31	4.84*
EHPAP (verbal planning)				1.44	.72	-.92^{ns}
Step 3 (BAPAE)	61.89	56.43	.0001			
K-BIT (matrices)				10.02	.67	11.89**
EHPAP (classification)				14.52	.12	9.73**
EHPAP (visual memory)				7.56	.33	10.20**
EHPAP (series)				9.92	.67	19.54**

*$p < .05$; ** $p < .01$; ns = not significant.

It is worth noting that the use of a longitudinal design adds weight to these conclusions, and that the effect sizes indicate notable differences between groups.

In conclusion, there is evidence that supports the use of this dynamic assessment methodology with the EHPAP learning potential test, opening up new fields of action in the processes of child assessment and helping to facilitate more suitable treatment for these children in the future.

Despite these benefits, more research is still needed for this type of assessment with different populations and with different difficulties. In addition, because it is a less well-known methodology, evaluators need good training and information about it. The tests that make up the EHPAP tend to take longer, which can be tiring for the subject and may mean a need for more sessions to apply it.

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ORCID iDs

Maria Auxiliadora Robles-Bello https://orcid.org/0000-0002-4979-5399
Francisca Barba-Colmenero https://orcid.org/0009-0002-5514-4768

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