

ASSESSMENT OF NUMERICAL COGNITION IN PRESCHOOLERS: PILOT STUDY TO VERIFY THE APPLICABILITY OF THE DEVELOPED INSTRUMENT

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Abstract

During the preschool years, the main difficulty that can predict the risk of mathematical difficulties is the delay in the ability of magnitudes associated with number words and Arabic numerals. Understanding this process of mathematical learning, its difficulties and consequently academic failure is a challenge for all professionals linked to the area of education. Aim: to develop an assessment of numerical cognition for preschoolers, aged 2 years to 5 years and 11 months. Methods: From the literature review, mathematical skills were selected to compose the assessment of numerical cognition, including: subitizing, numeral knowledge, counting, one-to-one correspondence, perception of magnitude, cardinality, comparison, measurement and approximation and estimation. A pilot study was carried out to verify the applicability of the instrument developed in 74 Brazilian preschoolers at municipal public Kindergarten in the city of São Paulo, Brazil, distributed in the age groups of: Group I (GI): composed by 15 preschoolers, aged 2 years to 2 years and 11 months; Group II (GII): composed by 18 preschoolers, aged 3 years to 3 years and 11 months; (GIII): composed by 19 preschoolers, aged 4 years and 4 years to 11 months and (GIV): composed by 22 preschoolers, aged 5 years and 5 years to 11 months. The numerical tasks were presented to the children in the form of games to keep their attention. The development of an instrument to assess numerical cognition in preschoolers can contribute to the development of logical-mathematical reasoning in these children, helping teachers in the development of activities and games that teach basic numerical, spatial, geometric, measurement and statistics, contributing to future gains in mathematics learning.

Keywords: *Numerosity, mathematical abilities, dyscalculia, early childhood, early childhood education.*

1. Introduction

Children's numerical and spatial skills play a critical role in mathematical development, and it is therefore essential to understand the potential impact that age can have on these skills and their relationships with learning (Moeller et al., 2012), as they can be useful for the development of educational interventions (Geary, 2017).

There are still few studies in the literature focused on investigating mathematical development in children in early childhood (Gersten et al., 2005). In Brazil, this literature is still non-existent, therefore, the present study presents the proposal to, based on the theoretical foundation, develop an instrument to assess numerical cognition for preschoolers aged between 2 and 5 years old.

2. Objective

This study aimed to develop an assessment of numerical cognition for Brazilian preschoolers, aged 2 years to 5 years and 11 months.

3. Method

This study was approved by the Research Ethics Committee of the Faculty of Philosophy and Sciences of the São Paulo State University “Júlio de Mesquita Filho” - FFC/UNESP - Marília-SP, under number 6.138.570. The study was divided into two phases:

3.1. Phase 1: Development of assessment numerical cognition for preschoolers

Based on the national and international bibliographical survey on skills for evaluating numerical cognition for the age group of 2 to 5 years and 11 months, a protocol was developed containing the following skills: subitizing, knowledge of numerals, counting, one-to-one correspondence, perception of magnitude, cardinality, comparison, measurement and approximation and estimation.

3.2. Phase 2: Pilot study

74 Brazilian preschoolers at municipal public Kindergarten in the city of São Paulo participated this study, distributed in the age groups of: Group I (GI): composed by 15 preschoolers, aged 2 years to 2 years and 11 months; Group II (GII): composed by 18 preschoolers, aged 3 years to 3 years and 11 months; (GIII): composed by 19 preschoolers, aged 4 years and 4 years to 11 months and (GIV): composed by 22 preschoolers, aged 5 years and 5 years to 11 months.

All preschoolers were submitted to assessment numerical cognition for preschoolers. The numerical tasks were designed to be applied as games to keep your attention. Short breaks were provided between tasks as needed. The results of phase 1 were statistically analyzed at a significance level of 5% (0.05).

4. Results

Table 1 presents the comparison of the performance of preschoolers in the assessment numerical cognition or preschoolers. The table 1 showed statistically significant difference between the groups, showing that a gradual increase in performance with increasing age group.

Table 1. Distribution of the mean, standard deviation and p-value of the performance of preschoolers from GI, GII, GIII, and GIV in the assessment numerical cognition.

		Mean	Standard deviation	p-value
Verbal Counting	Group 1	1,67	2,66	<0,001*
	Group 2	5,28	5,40	
	Group 3	11,11	7,31	
	Group 4	29,32	23,44	
Sequence count	Group 1	1,80	3,14	<0,001*
	Group 2	3,67	3,91	
	Group 3	6,68	3,77	
	Group 4	9,36	2,08	
Match one to one	Group 1	3,53	3,76	<0,001*
	Group 2	5,94	4,01	
	Group 3	7,58	3,25	
	Group 4	10,00	0,00	

In this study, we found that preschoolers from the 4 groups showed similar performance in the skills of object comparison, measurement, and perception of magnitude, showing that these skills did not serve to differentiate the groups.

5. Discussion

The results of this study showed that it was possible to develop an instrument to assessment numerical cognition skills for preschoolers aged 2 to 5 years based on literature.

The ability to subitize small quantities, discern numerical patterns, compare numerical magnitudes, and estimate quantities, count, and perform simple numerical transformations are key elements of number sense in young children (Berch, 2005).

The results of this study are in line with Jordan et al. (2008), who suggested that in the age group between 3 and 6 years old, interrelated skills develop involving numbers and operations, such as subitizing, identifying quantities without counting; counting items in a set of at least five with the knowledge that the final word in the count indicates how many are in the set.

The pilot study showed that verbal counting, sequence count and match one to one were sensitive skills in characterizing the performance of preschoolers according to age group. However, the object comparison, measurement, and perception of magnitude skills did not present this sensitivity, highlighting the need to re-elaborate the assessment protocol developed in the phase 1 to adapt to the objective of the study.

6. Conclusion

The development of an instrument to assess numerical cognition in preschoolers can contribute to the development of logical-mathematical reasoning in these children, helping teachers in the development of activities and games that teach basic numerical, spatial, geometric, measurement and statistics, contributing to future gains in mathematics learning.

This study showed that was possible to develop a procedure for assessment numerical cognition skills for preschoolers while also indicating which skills differentiated the groups by age group.

References

- Berch, D. B. (2005). Making sense of number sense: implications for children with mathematical disabilities. *Journal of learning disabilities*, 38(4), 333-339. <https://doi.org/10.1177/00222194050380040901>
- Geary, D. C. (2017). Dyscalculia at an Early Age. In R. E. Tremblay, M., & Boivin, R. D. e V. (Eds.), *Encyclopedia on Early Childhood Development* [online]. <http://www.child-encyclopedia.com/learning-disabilities/according-experts/dyscalculia-early-age>
- Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of learning disabilities*, 38(4), 293-304. <https://doi.org/10.1177/00222194050380040301>
- Jordan, N. C., Glutting, J., & Ramineni, C. (2008). 3 – A number sense assessment tool for identifying children at risk for mathematical difficulties. In A. Dowker (Ed.), *Mathematical difficulties: Psychology and Intervention* (pp. 45-58). Academic Press.
- Moeller, K., Fischer, U., Link, T., Wasner, M., Huber, S., Cress, U., & Nuerk, H. C. (2012). Learning and development of embodied numerosity. *Cognitive processing*, 13(Suppl. 1), S271–S274. <https://doi.org/10.1007/s10339-012-0457-9>