Original Article

Artigo Original

Psycholinguistic and scholastic abilities in children with myelomeningocele

Habilidades psicolinguísticas e escolares em crianças com mielomeningocele

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Keywords

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ABSTRACT

Purpose: To describe the performance of individuals with myelomeningocele regarding psycholinguistic and scholastic abilities. **Methods:** Participants were five individuals with myelomeningocele and lumbar sacral abnormalities, and chronological age between 9 years and 10 months and 11 years and 7 months (Group 1 – G1); five subjects with typical development (Group 2 – G2), matched to G1 for age, gender, and educational level. The evaluation consisted of interview with parents/caregivers, and application of the following tests: Illinois Test of Psycholinguistic Abilities (ITPA); School Performance Test; Speed Reading Test; and Rapid Automatized Naming Test. **Results:** The between-groups comparison in the ITPA subtests showed that the maximum values obtained by G1 corresponded approximately to the minimum values obtained by G2, confirming the difference between the groups, except for the auditory closure subtest. In the Scholastic Performance Test, significant alterations were observed on the performance of G1 in all tasks. In the Speed Reading and Rapid Automatized Naming tests, individuals in G1 also presented considerable deficits, making more mistakes and spending more time than G2 to perform the same tasks. **Conclusion:** Individuals with myelomeningocele present deficits in psycholinguistic abilities, school performance, reading speed, and rapid automatized naming.

Descritores

Meningomielocele
Leitura
Aprendizagem
Transtornos de aprendizagem
Transtornos da percepção
Linguagem

RESUMO

Objetivo: Descrever o desempenho de indivíduos com mielomeningocele quanto às habilidades psicolinguísticas e escolares. **Métodos:** Participaram cinco indivíduos, com idade cronológica entre 9 anos e 10 meses e 11 anos e 7 meses, com diagnóstico de mielomeningocele e lesão lombo-sacral (Grupo 1 – G1), e cinco indivíduos com desenvolvimento típico (Grupo 2 – G2), que foram pareados ao G1 quanto a idade, gênero e grau de escolaridade. A avaliação constou de entrevista com os responsáveis e aplicação dos seguintes testes: Teste de Illinois de Habilidades Psicolinguísticas; Teste de Desempenho Escolar; Teste de Velocidade de Leitura; e Teste de Nomeação Automática Rápida. **Resultados:** A comparação entre os grupos nos subtestes do Teste de Illinois de Habilidades Psicolinguísticas indicou que os valores máximos obtido pelo G1 corresponderam aproximadamente aos valores mínimos obtidos pelo G2, confirmando a diferença entre eles, exceto para o subteste closura auditiva. No Teste de Desempenho Escolar foram observadas alterações significativas no desempenho do G1 em todas as provas. Nos testes de Velocidade de Leitura e de Nomeação Rápida, os indivíduos do G1 também apresentaram prejuízos consideráveis, cometendo mais erros nas tarefas e realizando a atividade de modo mais lento. **Conclusão:** Indivíduos com mielomeningocele apresentam alterações nas habilidades psicolinguísticas, no desempenho escolar, na velocidade de leitura e na nomeação automática rápida.

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INTRODUCTION

Myelomeningocele is a defect in the closing of the neural tube, which causes congenital malformation characterized by cystic protrusion that contains abnormal meninges, cephalorachidian fluid, elements of the spinal marrow and nerves[1,2]. The severity of the clinical manifestations of the myelomeningocele varies from discrete sensitive-motor deficiencies of distal localization and neurogenic disfunction of the sphincters, to complete paralysis, serious bone malformations and a series of concomitant anomalies of the cognitive development and the nervous system, with deficits of perception or attention that affect the deambulation, the independence of the activities of daily life, scholastic performance and the quality of life[3-11].

Individuals with myelomeningocele tend to present variable intellectual level, to depend on the neuropathological anomalies, neural embryogenesis anomalies, complications resulting from the surgical treatment, hydrocephalia, environmental stimulation, among others[3,4,9,12]. Moreover, they present strong potential to develop learning problems associated to the reduction of the cognitive functioning, perceptual deficits, and alteration in the non verbal abilities[2,5,8,13-20]. We also expect deficits in control, organization and quality of the motor skills and difficulty in dealing with stimulations[2,5,6,9,12,14-17].

Literature indicates that basic linguistic abilities in children with myelomeningocele are frequently intact. However, speech abilities and flexibility in the use of language can be harmed, influencing mainly scholastic learning[17-25].

Based on what has been presented, the objective of this study is to describe the performance of individuals with myelomeningocele in regards to the psycholinguistic and scholastic abilities.

METHODS

The project was approved by the Research Ethics Committee of the Bauru School of Dentistry of Universidade de São Paulo (protocol number 088/2008). All criteria of Resolution 196/96 have been fulfilled. The parents/guardians signed the Term of Free and Informed Consent.

Five children diagnosed with myelomeningocele, with lumbar sacral injury, three males and two females, aged between 9 years and 10 months and 11 years and 7 months between 3rd and 5th grades (G1), and five children with typical development, without history of delay of the neuropsychomotor development (G2), who had been paired to G1 in regards to age, gender and level of schooling. The chronological age, in order to be considered pairing, could not exceed five months of difference between the children.

All the participants were public school students and the children were paired to someone who was in the same classroom. We point out that all children went through hearing and intellectual level assessments, with results within normal standards. In regards to visual acuity, 60% of G1 made use of corrective lenses.

Parents/guardians answered an interview containing information about the past history of general health (G1 and G2) and of the myelomeningocele (G1), from gestation to present. The questions referred to the development, treatments, and academic history of the child. All the children in G1 underwent surgical procedure for closing of the neural tube in the first month of life and still presented hydrocephalia, undergoing surgical procedures by the third month of life. The delay in the neuropsychomotor development occurred in 100% of the participants in G1, being that all presently made use of wheelchairs since they are unable to walk independently. Moreover, 100% of the relatives in G1 indicated learning disabilities and difficulty to follow academic activities. All children in G1 attended physical therapy sessions regularly, but had never attended speech therapy sessions.

We characterized the referring cohort in G1 and G2 in regards to the chronological age (CA), grade they were in (GR) and gender (Chart 1).

The following procedures were applied:

- Illinois Test of Psycholinguistic Abilities (ITPA). Subtests: Auditory reception (AR); Visual reception (VR), Auditory Sequential Memory (ASM); Visual Sequential Memory (VSM); Auditory Association (AA); Visual association (VA); Auditory Closure (AC); Visual Closure (VC); Manual expression (ME); Verbal expression (VE); Grammatical Closure (GC); Sounds Combination (SC) in regards to the Psycholinguistic Age (PLA). The analysis followed the norms described in the Test's Manual[25] (Brazilian adaptation).
- Scholastic Performance Test (SPT)[26]. Reading, Arithmetic, and Writing subtests were applied and the total score was observed (sum of gross scores on the three subtests) in the SPT from the table of standardization supplied on test itself. Participants had been classified in three levels of scholastic performance: poor, average or high, according to the school level presented.

Chart 1. Characterization of the cohort of children in G1 and G2 regarding age, gender and educational level

Subject	G1			Subject	G2		
	CA	G	Gender		CA	G	Gender
1	9y10m	4th	Male	1	9y11m	4th	Male
2	10y7m	4th	Male	2	10y10m	4th	Male
3	10y3m	3rd	Male	3	10y4m	3rd	Male
4	11y3m	5th	Female	4	11ym	5th	Female
5	11y2m	5th	Female	5	11y1m	5th	Female

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; CA = chronological age; G = grade; y = years; m = months

- Reading Speed Test (RST)[27]. Its objective was to verify the reading speed, in milliseconds, associate to the understanding. A text for oral reading was applied (*As travessuras de Afonsinho*). We observed if the reading was within expected level for the chronological age and school level. We timed five minutes at the beginning of the oral reading and requested that the participant indicate which had been the last word read. We verified if the number of words read was compatible with the age and the school level and if the participant had been capable of understanding the content read.
- Rapid Automatized Naming Test – RAN[28]. It consists of four subtests of nomination: colors, digits, letters and objects. The child's answers and the time taken (in seconds) in each activity were recorded in specific protocol. The analysis was carried out in accordance with the instructions contained in the test's manual.

The treatment of the data consisted of descriptive analysis by means of the minimum and maximum values, median, standard deviation, and for the application of the Mann-Whitney test, we considered $p \leq 0.05$ the significance value.

RESULTS

The data referring to the comparison between G1 and G2, all the subtests of the ITPA presented differences, except for AC. In regards to the minimum and maximum value, it was possible to verify that G1 presented modest index of correct answers and the maximum value obtained by this group corresponded approximately to the minimum value obtained by G2, confirming the difference between the groups. In regards to proof of closure, the participants in G1 presented greater difficulty in the GC (Table 1).

In the reception tests, both auditory and visual, it was possible to verify that the PLA obtained by G1 corresponds to scores lower than those pertaining to school age group of 7 years (except for subject 4 in the RV subtest) (Table 2).

Taking into consideration the Scholastic Performance Test (SPT), all participants in G1 presented inferior classification. In G2, one participant obtained average classification and four obtained high. Analyzing minimum and maximum values, it is possible to verify that G1 presented indexes considered inferior on the reading tests, writing and arithmetic. The maximum value reached by this group corresponded approximately to the minimum value of G2, confirming the difference between the groups (Table 3).

In the reading speed test, checking the minimum and maximum values, the results show that the maximum value reached by the G1 is less than the minimum value of G2, confirming the difference between the groups (Table 4).

The results obtained by the participants of G1 and G2, in the Rapid Automatized Naming Test (RAN), had shown that G1 presented a higher maximum value than the minimum value obtained by G2, confirming the difference between the groups. In relation to the subtests, G1 presented better scores in the rapid automatized naming test of objects, digits, letters and colors, respectively (Table 5).

DISCUSSION

The reception of stimuli involves complex processes initiated through mechanisms of attention. Several are the implications of the difficulties in the receptive process; among them we find the difficulty to learn information and to associate them with other stimuli, or even to learn verbal and not verbal concepts[12,21,24]. The same can be observed for the abilities of AA, VA and GC. These tests relate to the performance of the perceptive abilities. The perceptive development depends on the quality of the sensory motor experiences lived by the child,

Table 1. Comparison between G1 e G2 regarding the results obtained in the ITPA subtest

Tasks	G1			G2			p-value
	Min	Max	Mean	Min	Max	Mean	
PLA-AR	56	107	73.20	116	132	127.00	0.007*
PLA-VR	24	131	61.80	132	132	132.00	0.007*
PLA-ASM	39	131	88.20	114	132	128.00	0.035*
PLA-VSM	39	131	88.20	120	132	129.60	0.015*
PLA-AA	34	72	52.60	132	132	132.00	0.007*
PLA-VA	32	48	37.60	132	132	132.00	0.007*
PLA-AC	72	124	100.4	117	124	122.60	0.095
PLA-VC	48	131	112.2	132	132	132.00	0.007*
PLA-GC	40	60	48.80	126	132	128.40	0.007*
PLA-VE	30	102	62.40	120	132	129.20	0.007*
PLA-ME	40	131	110.6	132	132	132.00	0.007*
PLA-SC	36	126	85.80	117	138	129.00	0.005*

* Significant values ($p \leq 0.05$) – Mann-Whitney test

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; PLA = psycholinguistic age; AR = auditory reaction; VR = visual reception; ASM = auditory sequential memory; VSM = visual sequential memory; AA = auditory association; VA = visual association; VC = visual closure; VE = verbal expression; GC =grammatical closure; ME = manual expression; AC = auditory closure; SC = sound combination; Min = minimum values; Max = maximum values

Table 2. Distribution of results regarding the psycholinguistic age of the subjects in G1 and G2 in the ITPA subtests

ITPA		Subjects				
		1	2	3	4	5
AR	G1	3y 11m	6th	4y8m	6y3m	4y8m
	G2	9y11m	10y10m	10y5m	>11y	>11y
VR	G1	4y	5y6m	5th	10y11m	2y
	G2	>11y	>11y	>11y	>11y	>11y
ASM	G1	7y	4y8m	9y9m	8y11m	3y3m
	G2	9y10m	10y11m	10y11m	>11y	>11y
VSM	G1	3y3m	7y9m	9y	7y11m	5y
	G2	10y	>11y	>11y	>11y	>11y
AA	G1	3y2m	3y11m	6y	6y	2y10m
	G2	>11y	>11y	>11y	>11y	>11y
VA	G1	2y8m	2y11m	4y	2y10m	3y3m
	G2	>11y	>11y	>11y	>11y	>11y
AC	G1	6y	8y9m	9y9m	10y4m	7y
	G2	9y9m	10y4m	10y4m	10y4m	10y4m
VC	G1	4y	9y	10y	10y4m	10y11m
	G2	>11y	>11y	>11y	>11y	>11y
ME	G1	3y4m	10y11m	10y11m	10y11m	10y
	G2	>11y	>11y	>11y	>11y	>11y
VE	G1	2y6m	5y	4y8m	8y6m	4y
	G2	10y	10y11m	10y11m	>11y	>11y
GC	G1	4y	4y	5y10m	4y	3y4m
	G2	>11y	>10y6m	>10y6m	>10y6m	>11y
SC	G1	3y	4y	>10y6m	>10y6m	7y9m
	G2	9y9m	>11y	>10y6m	>11y6m	>11y

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; AR = auditory reception; VR = visual reception; ASM = auditory sequential memory; VSM = visual sequential memory; AA = auditory association; VA= visual association; VC = "visual closure"; VE = verbal expression; GC = "grammatical closure"; ME = manual expression; AC = "auditory closure"; SC = sound combination; y = years; m = months

Table 3. Comparison between G1 and G2 regarding the total gross result of the Scholastic Performance Test (SPT)

Ability	Min	Max	Mean	Median	p-value
Writing					
G1	7	28	16	11.7	0.0033*
G2	30	36	32.4	33	
Reading					
G1	33	65	53.4	54	0.00147*
G2	64	70	68.6	70	
Arithmetic					
G1	3	18	11.4	15	0.0026*
G2	17	33	31	40	

* Significant values (p≤0.05) – Mann-Whitney test

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; Min = minimum values; Max = maximum values

Table 4. Comparison between G1 and G2 regarding the results of speed of the oral reading test

Group	Min	Max	Mean	SD	p-value
G1	21	68	46.1	36.3	0.002*
G2	76	133	98.2	88.4	

* Significant values (p≤0.05) – Mann-Whitney test

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; Min = minimum values; Max = maximum values; SD = standard deviation

of its elaboration and organization, in addition to, obviously, the anatomo-functional aspects of the nervous system[1,5,6,10,14,29]. In this sense, the child with myelomeningocele, presenting alterations in the central nervous system and damages in their development, can have deficits in the abilities that involve the reception, the integration and the expression of the stimuli.

We observed influence of the attention control in the activities, i.e., the participants of G1 demonstrated more distraction and lack of attention. We should point out that this is a complaint common to all the participants of G1 in their schools, that also is described in the literature[5,14,18]. Studies[5,7] have shown that the success in academic activities is potentially dependent on the family environment, on the development of the language and the specific perceptive abilities that they will promote learning of strategies used in the learning process.

Table 5. Results of the Rapid Automatized Naming Test for G1 and G2

Task	G1				G2				p-value
	Min	Max	Mean	SD	Min	Max	Mean	SD	
Colors	0.41'	2.11	1.01	0.68	0.17	0.43	0.24	0.10	0.002*
Digits	0.26	1.09	0.48	0.34	0.16	0.27	0.20	0.04	0.001*
Objects	0.25	0.47	0.36	0.09	0.20	0.36	0.29	0.05	0.001*
Letters	0.25	1.02	0.52	0.29	0.17	0.25	0.20	0.03	0.002*

Values in seconds

* Significant values (p≤0.05) – Mann-Whitney test

Note: G1 = group of subjects with myelomeningocele; G2 = group of subjects with typical development; Min = minimum values; Max = maximum values; SD = standard deviation

The orientation of the attention for a determined location or stimulus is generally followed by movements of the eyes, the head and/or the body, producing what is called orientation behavior or exploratory behavior. This behavior allows the central nervous system to identify the source of stimulus, with the goal of making the organism react to it[30]. In reality, attention is essential to learning; therefore, it corresponds to the selection or prioritization of the processing of categories of information. Thus, the system of information processing must select, from a variety of stimuli present in the environment, those that will receive more intense processing and that will eventually control the actions of the organism. A study indicated[9] that two attention systems exist: a posterior one, which is responsible for the directed stimuli, guiding and focusing independent of the directed attention, and an anterior one, involved in the voluntary maintenance, in monitoring, and sustained attention. Still on the subject, authors[6] concluded that children with myelomeningocele present greater alterations in the posterior system. Moreover, a study indicated that children with myelomeningocele are slower in accomplishing activities and make more errors in tasks that involve sustained attention[9].

In the visual association test, the child must relate the visually received stimuli by means of understanding its meaning and make analogies that require notions of different concepts, such as functional associations, strengthening its use, that is, related to the pragmatic. Literature[18] confirmed that individuals with myelomeningocele present poor performance in tests that require the integration of different cognitive processes.

The grammatical subtest describes the ability to make use of the redundancies of oral language in the acquisition of the syntax and grammatical inflections. In fact, literature points to such difficulties, indicating that individuals with myelomeningocele can present serious deficits in speech abilities and flexibility in the use of the language[3,11-14] .

The VC subtest evaluates the ability to identify a common stimulus, from an incomplete visual presentation, recognizing a visual whole through an incomplete visual stimulation. This can indicate difficulties in integrating individual parts in an image[10]. The AC test evaluates the ability to complete blank parts of a word, captured by means of the auditory presentation. In this test it is inferred that the participants have had influence of scholastic procedures and, moreover, there is the participation of the lexical access, favoring the recognition of the target word. In the auditory and visual memory tests, the participants of G1 presented deficits. Failures in memory tasks interfere with learning, problem resolution and academic performance. Studies[2,5,11,20] presented similar data to the ones obtained here, that is, individuals with myelomeningocele presented altered performance in the tests involving memory.

One study[17] concluded that individuals with myelomeningocele presented better performance in decoding than in understanding, what was also observed in this study. Complementing the reading activities, in the rapid reading test, we also observed that the individuals in G1 presented difficulties related to the decoding of the graphic symbols in regards to the understanding of the content read. These abilities were not in agreement with the grade level they were in, confirming the complaints of their families and their school in regards to the difficulties in the process of alphabetization and learning of scholastic contents. For the writing abilities, expert knowledge of orthography is expected and, in this sense, some perceptive processes are necessary, for example, refined motor coordination, hand-eye coordination, visuospacial, visuoperceptual abilities, sustained attention, discrimination, memory, among others. These abilities are generally compromised in individuals with myelomeningocele and hydrocephalia, as indicated in the literature[1,2,9,11,12,17,18,21].

Studies[17,19,22] have related alterations in reading, writing and Arithmetic in individuals with myelomeningocele and hydrocephalia, informing that they tend to present problems in school. Although the nomination and the spelling of words usually present no problems, reading comprehension, written expression and mathematical abilities are typically poor[2,8,10,19,21,24,25]. A study[2] showed that individuals with myelomeningocele present poor scholastic abilities demonstrated by perceptive deficits, visuomotor and visuospatial difficulties, alteration of the visual and attention working memory. Researchers[19], studying the processing of arithmetic in individuals with myelomeningocele , related that failures found are related to the cognitive and neuropsychologic alterations, involving verbal and visual working memory, difficulties in visuospatial abilities and alterations in reading in the decoding of problems.

Authors suggested that the ability to process visual symbols rapidly also plays an important role in the learning of reading and writing in an alphabetical orthography, and that a disorder in this ability can constitute in deficit in the phoneme awareness, in the phoneme/grapheme relation[4,22].

In regards to the Rapid Automatized Naming Test of objects

we concluded that the participants of G1 presented lexical access, with interference of signifier and the signified. In the nomination of letters, digits and colors we concluded that the ability in the processing of visual stimuli is necessary for the accomplishment of text reading, once that for understanding of the stimuli, there must be a relation between the ability to recognize them fast and successively, which demands the use of cognitive resources such as attention, discrimination and short-term memory.

The speed of lexical access is directly related to the ability of the speech processing, that must be measured by means of activity that not only verifies the abilities of identification and decoding of words, but also the abilities of reading comprehension. That requires the use of strategies that verify the processing of recognition and nomination of colors, digits and objects, as well as of criteria that can measure the time per minute and the number of errors in the reading of words, paragraphs and texts. This will not only guarantee the accurate verification of the speech processing, but also of perceptive processes - visual and mnemonic processes. A study showed that children with myelomeningocele and hydrocephalia present deficits in tests that require rapid answers[11].

Perceptive alterations, compromised control of the sustained attention, discrimination, association, closure and memory intervene with the learning processes. Such alterations added to poor visuospatial, visuoperceptual and constructive abilities, in addition to difficulties in tasks that require serial learning and rapid answers in sensorial and motor abilities, intervene with the scholastic performance, as indicated in the literature[1,2,4,8,9,11-13,19,20].

The development of academic learning of individuals with myelomeningocele is a process that demands constant follow up. In this perspective, considering the influence of the psycholinguistic abilities in the development of the oral language and in the alphabetization, programs to assist the individuals with myelomeningocele in the areas that they demonstrate difficulties are necessary.

The evaluations used in this study indicate important reflections in the direction of the recognition of academic problems in individuals with myelomeningocele. Although the cohort is small, there was control of important variables such as age, gender, school level, and school environment. There were no analyses considering anatomophysiologic, what it is an indication for future studies.

CONCLUSION

Individuals with myelomeningocele presented alterations in the psycholinguistic abilities, involving reception, sequential memory, association and closure, both auditory and visual, combination of sounds and verbal expressions. In the academic performance test these individuals demonstrated inferior classification in the reading, writing, and arithmetic tests. The speed of verbal reading was reduced. In the rapid automatized naming test the individuals with myelomeningocele presented deficits. Such findings justify the complaints in regards to academic learning.

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