COMPARISON OF VISUAL AND AUDITORY SKILLS IN DIPLEGIC CEREBRAL PALSY

Comparação das habilidades auditivas e visuais em paralíticos cerebrais diplégicos

Dionísia Aparecida Cusin Lamônica[1] Cora Sofia Takaya Paiva[2], Deisiane Marcos Message[3], Jamile Cazarin Lozano[4], Plínio Marcos Pinto Ferraz[5]

ABSTRACT

Purpose: to compare the performance of auditory and visual psycholinguistic abilities of children with CP-D. **Methods:** a total of ten children with CP-D, classified using the Gross Motor Function Measure System (GMFMS) scale, aged between four years and one month to five years and six months. The clinical assessment consisted of interviews with responsible, analysis of medical records and application of auditory and visual subtests of the Illinois Test of Psycholinguistic Abilities (ITPA). Statistical analysis consisted of descriptive analysis and application of the Wilcoxon test (significance level was $p \leq 0.05$). **Results:** the tests that presented the lowest scores were in auditory sequential memory and visual sequential memory. When comparing between the auditory and visual abilities there were only statistically significant differences in the subtests of reception and association. The group behaved unevenly. This study aims to draw attention to this issue because it believes that these skills are extremely important for the development of linguistic and communication skills that should be thought in rehabilitations programs of these individuals. **Conclusion:** there were statistically significant differences in the subtests of auditory and visual reception and association in this population.

KEYWORDS: Child Language; Language Development Disorders; Cerebral Palsy; Language Development; Child

INTRODUCTION

The term Cerebral Palsy (CP) describes a group of developmental disorders related to movement and posture, causing activity limitations attributed to non-progressive disorders that occur during the development of fetal or infant brain. The motor disorders in cerebral palsy are often followed by disorders of sensation, perception, cognition, communication, behavior, seizures and secondary musculoskeletal problems[1,2].

Spastic diplegia cerebral palsy (D-CP), by definition, is characterized by bilateral impairment of the four limbs, predominantly the lower limbs, with primary expectation changes involving pelvic girdle and activities related specifically to the gait. In this perspective, the neuropsychomotor development, despite potential change, offers the best conditions for the acquisition of head and trunk control, favoring the use of hands and the possibility of better interactive and manipulative skills[3].

There is a strong correlation between the occurrence of D-CP and prematurity due to the high possibility of hemodynamic and respiratory instability of the premature newborn resulting in periventricular

(1) Department of Speech and Language Pathology, School of Dentistry of Bauru, University of São Paulo – FOB/USP. Bauru, SP, Brazil.

(2) Department of Speech and Language Pathology, School of Dentistry of Bauru, University of São Paulo - FOB/USP, Bauru, SP, Brazil.

(3) Department of Speech Pathology, School of Dentistry of Bauru, University of São Paulo – FOB/USP, Bauru, SP, Brazil.

(4) APAE, Bauru, SP, Brazil.

(5) Division of Mental Health, Municipal Health Department Bauru, Psychosocial Care Center for Children and Adolescents - CAPS i, Bauru, SP, Brazil.

Funding: CNPq

Conflict of interest: non-existent

leukomalacia (PVL)[4-6]. In PVL, the pyramidal tract is affected, featuring an ischemic damage in the periventricular region, limited to the dorsal and lateral tracts, along the lateral ventricles. The impact is generally on the descending motor fibers of the association cortex and association fibers of the visual, auditory and somesthesic functions, with possibility of affecting the development of sensory perception skills, interfering with the development of psycholinguistic skills[4, 7]. The newborn affected will reflect the results of this complex sequel.

A review study[8] presented several papers that establish a correlation between visuoperceptive, visuospatial and visuoconstructive deficits and neuroimaging findings in individuals with D-CP and PVL. The consequence of this association can interfere with the oculomotor coordination, complex visual cognitive functions, showing a close relation between the degree of motor impairment and the extent of PVL[9-11]. Studies have shown that presence of epilepsy, learning difficulties and/or vision impairment correlate with the severity of motor impairment[6,12,13].

Conductive and/or sensorineural hearing loss may occur in D-CP bringing impact to the development of language, cognition and psychosocial performance[14-17].

Studies have shown the relation between PVL and losses in processing visual and auditory information[8-11,14,15].

Information processing refers to a series of operations the auditory and visual systems must perform to receive, detect, answer, recognize, relate and integrate the stimuli that will be involved in the learning process and, based on these operations, organize and plan to respond to environment demands[18].

Although individuals with D-CP form a heterogeneous group regarding performance of skills, the nature of perceptual deficits and the impact on the lives of these individuals require further understanding[7,9-11,15,16,19,20].

Given the above, this study aims to compare the performance of auditory and visual psycholinguistic skills in children with D-CP.

METHODS

The project was approved by the Ethics Committee of the institution where the study was conducted (Protocol Number: 120/2009). We met all the criteria of Resolution 196/96. The legal guardians of the participants signed the Consent Form.

This is a cross-sectional study. For sample selection the following inclusion criteria were considered: present spastic diplegia cerebral palsy confirmed by medical report; hearing within normal limits; visual and intellectual skills that allow the tests proposed, age range 48-72 months; no seizures or West Syndrome.

Relatives responsible for the participants answered an interview protocol with information about pregnancy, birth, overall health, neuropsychomotor and communicative development. We conducted a review of the medical records of participants in their respective Rehabilitation Centers.

The assessment tool to compare auditory and visual skills consisted of the following subtests of the Illinois Test of Psycholinguistic Abilities (ITPA): 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), considering the Psycholinguistic Age (PLA). The analysis followed the guidelines outlined in the Test Guide[21].

Sample

The sample included 10 children diagnosed with spastic diplegia, 80% male and 20% female, age ranging from 49 months to 66 months (56.8 months average). All participants had a history of prematurity, motor development delay and diagnosis of cerebral palsy before 15 months. Participants are enrolled in a Rehabilitation Center and are monitored in the areas of speech therapy, physiotherapy, occupational therapy and psychology. According to the records of this center, participants belong to lower middle class (60%) and lower class (40%). They present intelligence scores above 70. As to the degree of motor impairment, classified through Gross Motor Function Measure System - GMFMS[22], 70% of sample were classified level II, 20% level III and 10% level I. All participants are enrolled in public schools and attend preschool.

As for hearing, all children in this sample have normal hearing, but for 50% of them the guardians reported, during the interview, recurrent otitis. All patients underwent ophthalmologic evaluation and 50% do continuous monitoring due to visual changes (myopia, strabismus, hyperopia) and make use of corrective lenses. All participants in this sample make use of oral communication.

The statistical description consisted of descriptive analysis by Mean, Median, Minimum and Maximum Values and Standard Deviation and the application of the Wilcoxon test. Significance level was $p \leq 0.05$.

RESULTS

Table 1 shows the distribution, according to descriptive measures, of Mean, Median, Minimum

and Maximum values and Standard Deviation (SD) for the values obtained in the subtests of the Illinois Test of Psycholinguistic Abilities (ITPA), considering Psycholinguistic Age (PLA).

The result of the Wilcoxon test to compare the psycholinguistic ages in the auditory and visual subtests of the Illinois Test of Psycholinguistic Abilities (ITPA), considering the Psycholinguistic Age (PLA) of the Auditory Reception and Visual Reception subtest (PLA - AR & PLA - VR); Auditory Association and Visual Association subtest (PLA - AA & PLA – VA); Auditory Closure and Visual Closure subtest (PLA - AC & PLA – VC) and Auditory Sequential Memory and Visual Sequential Memory subtest (PLA - ASM & PLA – VSM) is presented in Table 2.

Table 1 - Distribution of the scores obtained in each ITPA subtest as to Mean, Median, Minimum Value, Maximum Value and Standard Deviation.

Variable	Mean	Median	Minimum	Maximum	SD
PLA-AR	34.9	30.5	24	60	12.5
PLA-VR	48.5	31.5	26	78	30.5
PLA-AA	29.2	25.5	23	46	8.3
PLA-VA	35.2	34	23	48	7.9
PLA-AC	34.5	32.5	23	56	12.4
PLA-VC	42.4	37	23	66	21.8
PLA-ASM	26	23	23	34	4.6
PLA-VSM	30	24.2	23	44	12.3

Legend: Psycholinguistic Age = PLA; AR = Auditory Reception; VR = Visual Reception; AA = Auditory Association; VA = Visual Association; AC = Auditory Closure; VC = Visual Closure; ASM = Auditory Sequential Memory; VSM = Visual Sequential Memory.

Table 2 – Results of the Wilcoxon test in the comparison of the auditory and visual subtests, considering PLA

Variables	N	T Value	Z Value	P Value
PLA-AR & PLA–VR	10	5	2.073221	0.038 #
PLA-AA & PLA-VA	10	1.5	2.310462	0.021 #
PLA-AC & PLA-VC	10	8	1.014185	0.311
PLA-ASM & PLA-VSM	10	1	1.069045	0.285

Legend: Psycholinguistic Age = PLA; AR = Auditory Reception; VR = Visual Reception; AA = Auditory Association; VA = Visual Association; AC = Auditory Closure; VC = Visual Closure; ASM = Auditory Sequential Memory; VSM = Visual Sequential Memory; **#** = statistically significant for p≤ 0.05.

DISCUSSION

In CP, motor limitation causes damages that may result in delay of the child's global development, i.e. in the presence of motor impairment the child may miss opportunities to enable their linguistic repertoire, as the perceptive development occurs by integrated actions of the body to the psychomotor dispositions, impacting the maturational process and, consequently, the development of the visual, auditory and somesthesic information processing. Thus, the motor condition impacts the relations the child establishes with the environment[5,8-11,13,19,20].

PC is characterized by heterogeneity of motor, cognitive and behavioral manifestations, in addition to significant difficulty to form homogeneous groups[1,4], even for those who receive the same classification as to topography of the area of brain injury, limbs affected and degree of functionality. It is worth mentioning the terminology used in the classification of D-CP. As noted in studies[1,2], the term diplegia should be used with caution, because determining the intensity of the limbs involved can be a challenge, since limbs perform different functions and evaluation criteria include subjective criteria. However, as reported by authors[2], if the term spastic diplegia is used, it is necessary to determine exactly

what it means and what features it describes. Having considered that, we used this terminology relying also on the GMFMS[22] classification to determine the motor performance of participants.

The after-effects of D-CP damages will feature several motor, sensory, perceptual and cognitive combinations[1-4]. It is likely the consequence of focal or diffuse damage can cause simultaneous damages in projection, associative and/or commissural areas that topographically cross the periventricular area[5].

In the presence of PVL and D-CP changes involving hearing, vision and perceptual processes occur and, if the CP-individual presents perceptual disorders, these will certainly impact substantially the general learning and the interpretation of information from the environment, causing them difficulties to judge environment information in a constructive way[11].

Literature shows[2] that perception can be defined as the ability to incorporate and interpret sensory and/or cognitive information and that, in CP, failures can be attributed to primary and/or secondary damages as a consequence of the limitations that restrict the learning and development of perceptual experiences. There seems to be a dynamic self-organization system in which perception and action are closely related, forming a circular phenomenon where structures operate in parallel, with increasing complexity interactions[9].

Stimuli reception involves complex processes triggered by attention mechanisms. Driving attention to a particular location or stimulus is usually followed by eye, head and/or body movements, producing what is called orientation or exploratory behavior, allowing the central nervous system to identify the source of stimulation in order to make the body respond to it[18], integrating information and allowing the individual to express according to their potential.

Observing the auditory and visual skills (Table 1) it is possible to conclude, by analyzing the maximum values, mean and median, that participants had higher scores on visual tests when compared to auditory scores, and the tests that presented the lowest scores were the tests involving sequential memory. Analyzing the minimum and maximum values and standard deviation it is possible to see a heterogeneous behavior in this group.

Literature shows that D-CP individuals may present visual[4,5,7-9,11-13,17-20] and auditory[11,14,16,17] changes both sensory and perceptual, influencing the information processing.

It is worth highlighting that 50% of this sample reported change of visual acuity, and 50% reported recurrent otitis. As for vision, acuity failures interfere with the input and processing of stimuli, but individuals are expected to improve this ability with the use of corrective lenses and stimulation. As for hearing, no participant had sensorineural loss, but conductive hearing loss, even mild losses, may lead to muffled sounds, hurting children's hearing quality, which may cause them difficulty to realize all the details brought by the sound. It is inferred that these facts may have interfered with the receptive processes, at a time of full maturation of the central nervous system, in addition to delayed motor development.

Memory refers to the use of mechanisms of information storage through actions of the nervous system[18]. Studies involving memory in D-CP report these individuals tend to have losses[7,11,15] and the incidence of visuoperceptive, visuospatial and visuoconstructive changes is high[5-8,11,12,15], which may interfere with the storage of information.

The influence of these variables is difficult to quantify in child performance, because if on the one side they are extremely important in the maturational process, on the other side the diagnosis and early intervention process can lead to improved child performance. As pointed out in a study, environmental factors such as integration of professional staff, family and school, early entry in programs of stimulation and social integration can contribute to the full development of children with CP[20]. This sample reported professional monitoring and early school entry, which may have contributed to the scores obtained by participants in the subtests.

Table 2 shows there were statistically significant differences between visual and auditory subtests as regards reception and association.

A study focusing on the processing of auditory information in D-CP individuals demonstrated they tend to fail in tests of auditory function involving location and lateralization of sounds, discrimination, analysis and synthesis, among others[11], also reflecting in psycholinguistic processes. Studies focusing on the visual skills demonstrated that visuospatial, visuoperceptive and visuoconstructive deficits may be present, interfering with the analytical capacity of visual stimuli and their integration[6,8,9,17,19,20].

In the ITPA[21] subtests of association, the purpose of AA is to check skills to relate concepts presented orally through verbal analogies, and the purpose of VA is to check skills to deal with visual analogies, describing the ability to relate visually received stimuli through the understanding of their meaning. Analogies require understanding of different concepts, such as: part-to-whole associations and vice versa, similarity, actions, among others.

Failures in these abilities will impact communication performance and, the greater the demands,

the greater the difficulties may be, influencing learning, especially school learning.

Even considering this too small a sample to generalize these findings, this study aims to draw attention to this issue because the visual and auditory skills are regarded as extremely important for the development of linguistic and communication skills that should be considered in the (re)habilitation programs of these individuals.

CONCLUSION

In the comparison between the performance of auditory and visual psycholinguistic skills in children with D-CP there was statistically significant difference for the auditory and visual subtests of reception and association.

RESUMO

Objetivo: comparar o desempenho das habilidades psicolinguísticas auditivas e visuais de crianças com PC-D. **Métodos:** participaram dez crianças com PC-D, classificados por meio da escala Gross Motor Function Measure System (GMFMS), de idade entre quatro anos e um mês a cinco anos e seis meses. A avaliação fonoaudiológica constou de entrevista com responsável, análise de prontuário e aplicação dos subtestes auditivos e visuais do Teste de Illinois de Habilidades Psicolinguísticas (ITPA). O tratamento estatístico constou de análise descritiva e aplicação do teste de Wilcoxon (nível de significância foi p≤ 0,05). **Resultados:** os subtestes que obtiverem os menores escores foram na memória sequencial auditiva e memória sequencial visual. Na comparação entre as habilidades auditivas e visuais somente houve diferenças estatisticamente significante nos subtestes de recepção e associação. O grupo se comportou de forma heterogênea. Este estudo pretende chamar atenção para esta questão, pois se considera que estas habilidades são de extrema importância para o desenvolvimento das habilidades linguísticas e comunicativas que devem ser pensadas nos programas de reabilitação destes indivíduos. **Conclusão:** houve diferenças estatisticamente significantes nos subtestes auditivos e visuais de recepção e associação nesta população.

DESCRITORES: Linguagem Infantil; Transtornos do Desenvolvimento da Linguagem; Paralisia Cerebral; Desenvolvimento da Linguagem; Criança

REFERENCES

1. Bax M, Goldstein M, Rosenbaum P, Leviton A, Paneth N. Proposed definition and classification of cerebral palsy, April, 2005. Dev Med Child Neurol. 2005;47(8):571-6.

2. Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M. A report: definition and classification of cerebral palsy April 2006. Dev Med Child Neurol Suppl. 2007;109:8-14.

3. Bataglia M, Russo E, Bolla A, Chiusso A, Bertelli S, Pelegri A, et al. International Classification of Functioning, Disability and Health in a cohort of children with cognitive, motor and complex disabilities. Dev Med Child Neurol. 2004;46:98-106.

4. Tang-Wai R, Webster RI, Shevell MI. A clinical and etiologic profile of spastic diplegia. Pediatric Neurology. 2006;34(3):212-8.

5. Resic, B. Tomasovi M, Kuzmanié-Samija R, Lozié M, Resic S. Solac M. Neurodevelopmental outcome in children with periventricular leukomalacia. Coll. Antropol. Split. 2008;32(1):143-7.

6. Himmelmann K, Uvebrant P. Function and neuroimaging in cerebral palsy: A population –based study. Dev Med Child Neurol. 2011;53(6):516-21.

7. Downie AL, Frisk V, Jakobson LS. The impact of periventricular brain injury on reading and spelling in the late elementary and adolescent years. Child Neuropsychol. 2005;11(6):479-95.

8. Pueyo-Benito R, Vendrell-Gómez P. Neuropsicología de la parálisis cerebral. Rev Neurol. 2002;34(11):1080-7.

9. Bonifacci P. Children with low motor abilities have lower visual motor integration abilities but unaffected perceptual skills. Human Mov Sci. 2004;23(2):157-68.

10. Pirila S, Mere J, Pentikainen T, Ruusu-Niemi P, Korpela R, Kilpinen J, et al. Language and motor speech skill in children with cerebral palsy. J. Commun Disorders. 2007;40(2):116-28.

11. Lamônica DAC, Ferraz PMDP. Leucomalácia periventricular e diplegia espástica: implicações nas habilidades psicolinguísticas. Pró-Fono R. Atual. Cient. 2007;9(4):357-62.

12. Venkateswaran D, Shevell MI. Comorbitidies and clinical determinants of outcome in children with spastic quadriplegic cerebral palsy. Dev Med Child Neurol. 2008;50(3):216-22.

13. Pueyo R. Junqué C, Vendrell P, Narberhaus A, Segarra D. Neuropsychologic impairment in bilateral cerebral palsy. Pediatr Neurol. 2000;40(1):19-26.

14. Reid SM, Modak MB, Berkowitz RG, Reddihough DS. A population-based study and systematic review of hearing loss in children with cerebral palsy. Dev Med Child Neurol. 2011;53(11):1038-45.

15. Crespo-Eguiláz N, Narbona J. Habilidades neurocognitivas de niños con leucomalácia periventricular: resultados preliminares em 15 sujetos. Rev Neurol. 2004;38(Suppl 1):S80-4.

16. Lamônica DAC, Chiari BM, Pereira LD. Avaliação do processamento auditivo central em paralíticos cerebrais por meio do teste Pediatric Speech Inteligibility (PSI). Pró-Fono Rev Atual Cient. 2001;13(1):13-26.

17. Shevell MI, Dagenais L, Hall N. REPACQ Consortium. Comorbidities in cerebral palsy and their relationship to neurologic subtype and GMFCS level. Neurology. 2009;16;72(24):2090-6.

18. Lent R. Às portas da percepção: as bases neurais da percepção e da atenção. In: Lent R. Cem bilhões de neurônios: conceitos fundamentais de neurociência. São Paulo: Atheneu; 2001. p. 556-86.

19. Gagliardi C, Tavano A, Turconi AC, Pozzoli U, Borgatti R. Sequence learning in cerebral palsy. Pediatric Neurol. 2011;44(3):207-13.

20. Aisen MLI, Kerkovickd D, Mast J, Mulroy S, Wren TA, Kay RM et al. Cerebral palsy: clinical care and neurological rehabilitation. Lancet Neurol. 2011;10(9):844-52.

21. Bogossian MADS, Santos MJ. Manual do examinador: teste Illinois de habilidades psicolinguísticas. Rio de Janeiro: EMPSI; 1977.

22. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol. 1997;39(4):214-23.

Received on: May 24, 2012
Accepted on: December 20, 2012

Mailing address:
Dionísia Aparecida Cusin Lamônica
Departamento de Fonoaudiologia
Alameda Octávio Pinheiro Brisolla 9-75 - Vila Universitária
Bauru - São Paulo
CEP: 17012901
E-mail: dionelam@uol.com.br