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The effect of age in a task of stressed vowels identification in Brazilian Portuguese

O efeito da idade em uma tarefa de identificação das vogais tônicas do Português Brasileiro

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ABSTRACT

Purpose: Investigate the effect of age in stressed vowels identification in Brazilian Portuguese in children. **Methods:** The hearing-perceptual performance of 155 children, between 5 and 9 years old (divided in 2 groups: G1 and G2) was evaluated with the use of a software named Perception Evaluation Auditive & Visuelle (PERCEVAL), in a task of stressed vowels identification in Brazilian Portuguese. Acoustic and visual stimuli were presented, asking a child to choose the corresponding picture according to the word listened, between two possibilities of images shown on a computer screen. The presentation time of the stimuli and the children's reaction were calculated, automatically, by the software. **Results:** The group of older children (G2) presented a better hearing-perceptual accuracy, comparing to the accuracy of the younger children's group (G1). As to the reaction time, the G1 has always presented a higher reaction time comparing to the children in G2, for both the mistakes and successes. As to the standard of mistakes, generally, the groups didn't differ. The analysis of correlation between age and accuracy showed that the children from G1 presented a positive correlation with the age. However, it didn't happen with the children from G2. **Conclusion:** The hearing-perceptual ability, concerning the identification of vocalic contrasts, seems to occur gradually and stabilizes at 9 years old.

Keywords: Auditory perception; Evaluation; Speech; Phonetics; Child

RESUMO

Objetivo: Investigar o efeito da idade na identificação das vogais tônicas do Português Brasileiro em crianças. **Métodos:** Avaliou-se, com o uso do *software Perception Evaluation Auditive & Visuelle* (PERCEVAL), o desempenho perceptivo-auditivo de 155 crianças, entre 5 e 9 anos de idade (divididas em 2 grupos, G1 e G2), em uma tarefa de identificação das vogais tônicas do Português Brasileiro. Foram apresentados os estímulos acústico e visual, solicitando-se à criança a escolha da gravura correspondente à palavra apresentada auditivamente, dentre duas possibilidades de imagens dispostas na tela do computador. O tempo de apresentação dos estímulos e de reação das crianças foi computado, automaticamente, pelo *software*. **Resultados:** O grupo de crianças mais velhas (G2) apresentou melhor acurácia perceptivo-auditiva, quando comparada à acurácia do grupo de crianças menores (G1). Quanto ao tempo de reação, o G1 sempre apresentou um tempo de reação superior ao das crianças do G2, tanto para os acertos, quanto para os erros. Quanto ao padrão de erros, de um modo geral, os grupos não se diferenciaram. A análise da correlação entre idade e acurácia mostrou que as crianças do G1 apresentaram correlação positiva com a idade. No entanto, isso não ocorreu para as crianças do G2. **Conclusão:** A habilidade perceptivo-auditiva, no que diz respeito à identificação de contrastes vocálicos, parece ocorrer de forma gradativa e se estabilizar aos 9 anos de idade.

Descritores: Percepção auditiva; Avaliação; Fala; Fonética; Criança

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INTRODUCTION

It is well established in the literature that the ability of speech perception goes through reorganization during the first year of life, highlighting a change of sensibility to discriminate the phonic contrasts, in this period.

In general, it's reported that the child loses the sensibility to non-native contrasts and increases the sensibility to his/her own language contrasts, due to the increase of age[1-4].

The speech perception, in turn, has been understood as a capacity that involves both the discrimination abilities and the categorization[5].

The discrimination ability is defined as a capacity to perceive the difference between two sounds, in which the listener is not obliged to assign a significant to the sound in question, while the categorization is seen as an ability in which the listener must, not only discriminate acoustic patterns, but also organize these patterns consistently, in their appropriate phoneme categories[6].

Several studies, mainly international, have been searching for investigating the discrimination and categorization abilities considering different age groups.

In these studies[7,8], we can find some evidences that the categorization of the acoustic properties in the samples of each phonetic category is better defined according to the increase in the child's age. In addition, other investigations[5,6] point to the fact that, at 12 years old, the children still don't present a consistent categorization, such as the one that is presented by adults, once, at this age group, the phoneme boundary and the decline of the classification functions are still stabilizing. But, the period that the phoneme categorization of a child reaches the same performance as the adult, hasn't been established[9] yet. What one can observe, regarding to the categorization ability, is an increasing enhancement in the children's hearing-perceptual performance, based on an increase in age[1,3,4,7,8,10-12].

Therefore, it is possible to clearly deduce from the literature consulted, that the age seems to influence the process of phonological acquisition, from the hearing-perceptual view, and that, although there is an indication of how this influence happens, it's not well explored yet, the way this ability develops in children, in the course of time.

It is still observable that the existing studies aimed, mostly, to investigate the development of the hearing-perceptual ability, comparing the performance between groups of very distinct ages. Besides, the studies involved a small number of participant subjects that emphasized the influence of acoustic tracks for the task of identification and they investigated the way that the perceptual identification of these acoustic tracks can develop according to the age increase.

So, the objective of the present study was to investigate the age effect in stressed vowels identification in Brazilian Portuguese with children, comparing the hearing-perceptual accuracy of two groups of children, the reaction time and the mistakes pattern, as well as correlate the age with the hearing-perceptual accuracy.

It's believed that the proposed research can lead to scientific earnings, like: contribute to the comprehension of the hearing-perceptual acquisition of vocalic contrasts; provide subsidies for future theories about hearing-perceptual acquisition; provide subsidies for speech practice, both for evaluation (offering normative information about the hearing-perceptual acquisition), and in therapy.

METHODS

Sample

It is a transversal and prospective study.

The sample was established by two groups of children, from different age groups: Group 1 (G1) – children between 5 and 7 years old; Group 2 (G2) – children between 7 and 9 years old. After being approved by the Research Ethics Committee (CEP) of *Universidade Estadual Paulista* "Júlio de Mesquita Filho" (UNESP), Protocol 132/2010, data from 155 children were collected at the school they attended Profº Antônio Gomes de Oliveira Elementary School, in the city of Marilia, distributed as follows:

- G1: 76 children of 5 years and 4 months old to 7 years and 5 months old (an average age of 76 months and 8 days old), that attended the First and Second Grade of Elementary School;
- G2: 79 children of 7 years and 6 months old to 9 years old (an average of 77 months and 8 days old), that attended the Third and Fourth Grade of Elementary School.

Among the participants of G1, 41 were female and 35 were male; among the participants of G2, 39 were female and 40 were male.

The inclusion criterion was: the children should not present any otological and/or audiological problems, neurological and about language. The exclusion criterion was: all the children that presented more than 80% of hits in the survey stage of the performed experiment.

Those responsible for all the participant children of this research allowed, in writing, their participation, from the clarifications in the Informed Consent Form.

Material and experimental procedure

The assessment tool in speech perception (PERCEFAL)[13-16] was used and the same experimental procedure of a previous study[17] was replicated.

In general, the experimental procedure consisted in three distinct stages: recognition of the words in the experiment (survey), training and test phase.

The identification procedure was performed with each child, individually, in a silent room at the elementary school

they attended at the time of the data collection.

The experiment total time did not exceed 15 minutes with each child.

Analysis criteria

The following criteria for analysis had been used: (a) hearing-perceptual accuracy (percentage of mistakes, hits and non-response); (b) reaction time of mistakes and hits; (c) mistake pattern in the identification of contrast between stressed vowels; (d) correlation between age and accuracy.

The analysis of mistake pattern was organized according to the following parameters: (1) vowel height (subclassified in high, medium and low); (2) forward/backward direction (subclassified in front, central (vowel /a/) and back); (3) mistake direction within the vocalic space, i.e., if the mistake was from a central vowel to a peripheral vowel, or in the reverse direction.

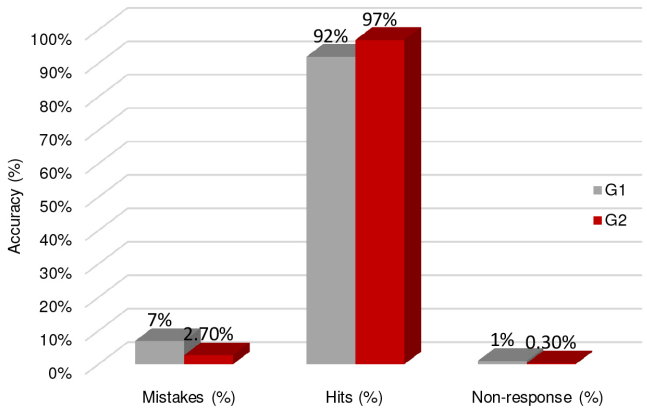
In the statistical analysis, the following tests were used: the chi-square test, in accuracy comparison in function of groups; T-test, in comparison with the mistakes and hits reaction time; Spearman's linear correlation coefficient between the variables "age" and "hearing-perceptual accuracy".

It is important to note that the correlation is a measure of relation between two or more variables. Its coefficient may vary from -1.00 to + 1.00, and 1.00 represents a perfect negative correlation, while +1.00 represents a perfect positive correlation. The 0.00 value indicates lack of correlation. A significance level of $\alpha<0.05$ and a confidence interval of 95% were established.

RESULTS

Comparing the hearing-perceptual accuracy between G1 and G2, it was found that the group of older children (G2) presented a better hearing-perceptual accuracy (chi-square = 71.15, p>0.00) than the group of younger children (Figure 1).

Sequentially, considering the reaction time used by children, for decision making in the identification task, the reaction time

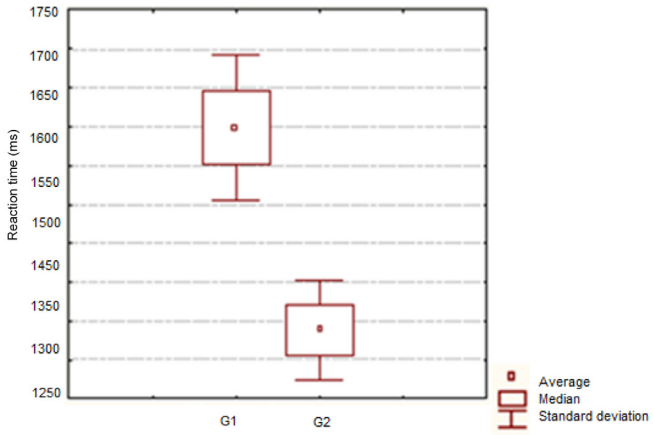


Note: G1 = Group 1; G2 = Group 2

Figure 1. Perceptual auditory Performance G1 and G2

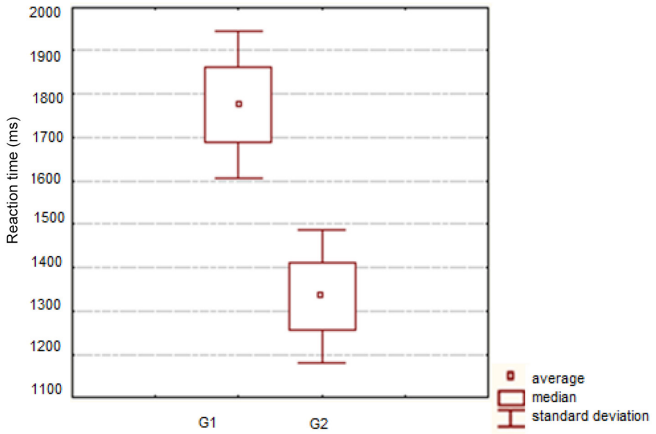
average for G1, relating to the mistakes, was 1780.335 ms, while the reaction time average for hits was 1594.454 ms. At the same time, for G2, the reaction time average for mistakes was 1354.596 ms, while the reaction time average for hits was 1350.772 ms.

A difference in the reaction time between G1 and G2 was observable, for both the reaction time of hits (t=4.54, p>0.00), and the reaction time of mistakes (t=3.51, p>0.00). The children from G1 presented a reaction time always higher than the children from G2 (Figures 2 and 3).



Note: G1 = Group 1; G2 = Group 2

Figure 2. Comparison of the hits reaction time between hits G1 and G2



Note: G1 = Group 1; G2 = Group 2

Figure 3. Comparison of the mistakes between the reaction time between G1 and G2

The mistakes pattern performed by children in the identification task was organized according to the proposal parameters (Table 1). In general, the groups did not distinguish about the observed mistakes pattern, except the mistakes involving the parameter "height". Specifically, analyzing the mistakes direction within the vocalic space, there was a prevalence of mistakes in the less peripheral direction to the more peripheral one, in both groups.

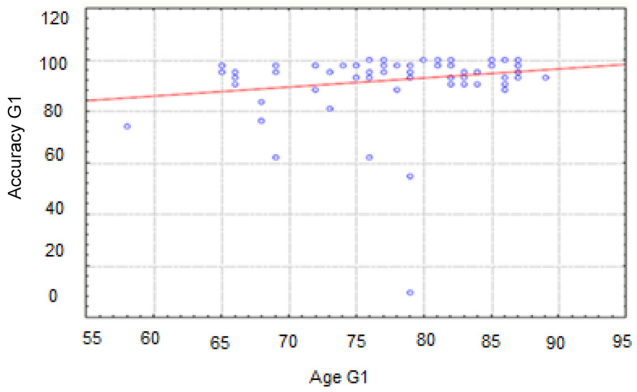
Finally, when performing the correlation between age and

Table 1. Characterization of mistakes performed by groups G1 and G2

Mistake pattern	Groups		Statistic analysis	
	G1	G2	X^2	p-value
High vowels	24% (54/223)	40.66% (37/90)	8.77	0.0031*
Medium vowels	63% (140/223)	40.66% (37/90)	13.3	0.0003*
Low vowels /a/	13% (29/223)	18.68% (16/90)	1.75	0.1862
Front vowel	45% (100/223)	46% (42/90)	0	0.8945
Central vowel /a/	13% (29/223)	19% (17/90)	1.75	0.1862
Back vowels	42% (94/223)	35% (31/90)	1.18	0.277
More peripheral – less peripheral	25.18% (56/223)	23.08% (21/90)	0.18	0.6736
Less peripheral – more peripheral	74.82% (167/223)	76.92% (69/90)	0.18	0.6736

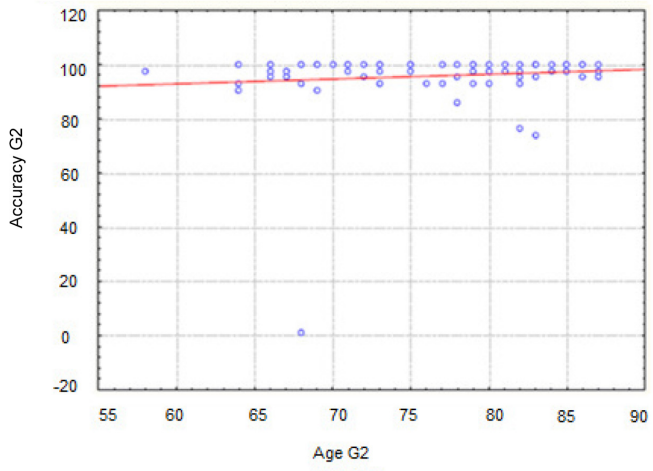
Significant values (p≤0.05) – Chi-square test

accuracy, it is observable that children from G1 presented a positive correlation about age (Spearman R=0.25, p=0.02), i.e., the older the child is, the higher the accuracy is. However, it did not happen with children from G2 (Spearman R=0.11, p=0.30) (Figures 4 and 5).



Note: G1 = Group 1

Figure 4. Correlation between age and accuracy for the G1



Note: G2 = Group 2

Figure 5. Correlation between age and accuracy for G2

DISCUSSION

In relation to the hearing-perceptual accuracy, there was a better performance from G2 (97%) comparing to G1 (92%). This result corroborate the data of a previous study[17], that searched the hearing-perceptual performance in a group of younger children. These children presented a lower hearing-perceptual performance, according to the data of this present study, suggesting a better performance as a function of increased age. Comparatively to the study referred, the higher rate of accuracy for the vowel class, to the group of older children, can be explained by the fact that the perception of acoustic properties from samples of each phonetic category becomes clearer with the increase of child's age [9,10].

Concerning the response time obtained by the groups, the G1 presented a higher reaction time than the children from G2, i.e., the younger children needed a longer time for decision making, during the linguistic process. Some authors[18] emphasize that the interrelation between the brain maturation and the linguistic experience, where the functional properties of temporal higher level brain areas and the connectivity to other brain regions (like the motor and the visual), help in learning languages and work as a reinforcement to the linguistic representation and the development of the native language. This way, we can infer that the children from G2 had a shorter time of neurolinguistic processing due to a longer time of neuromaturation and linguistic experience during the development, comparing to the group of younger children. In other words, the relation between these factors work as a booster of linguistic representation, what may influence the decrease or the increase of necessary time for decision making, for the subjects.

In relation to the mistake pattern performed by the two groups, we can make some highlights. The first one refers to the fact that the parameter "height" presents higher percentage of mistake by G2, while the parameter "anterior-posterior" did not show any statistic difference between the groups. This data can be explained from a study[19] that suggests the model called Natural Referent Vowel (NRV) to explain the asymmetries in

vowels perception, that is, the existence of different degrees of hearing-perceptual similarity between vowels[17].

The NRV model refers that the vowels with extreme acoustic articulatory properties (peripherals in the vocalic space) act as vowels of natural reference, that attract the children's attention because of the formant convergence, or what the authors call "targeting" and provide ways of more stable language perception for the children[19].

Based on the NRV model, it seems that the younger children would be more anchored in the vowels called targeted (vowels from the edge of vocalic space), than the older children, justifying the lower number of mistakes involving the high vowels like /i/ e /u/.

Another issue to be discussed is that both groups present major difficulties of identification, towards a less peripheral direction from the vowel triangle to the most peripheral, i. e., both groups of children seem to support themselves in acoustic-articulatory parameters of the peripheral vowels /a/, /i/ e /u/. According to a study[20], the authors also found the presence of directional asymmetries (from the most peripheral to the less peripheral) on their data. The authors stated that the directional asymmetries seem to be a strong and predictable characteristic in a child perception of vowels, due to the peripheral vowels provide a perceptual standard table and stable for a child's perception. This way, we can infer that, when the stimuli target involves less prominent acoustic -articulatory characteristics, the children present major difficulties of identification, answering, thus, as a peripheral vowel. In light of this, it seems that the characteristics of less peripheral vowels – high-mid vowels and low-mid ones – are more difficult to be identified.

Finally, note that, on one hand, the positive correlation between the age and the accuracy for G1 and, on the other hand, the non-correlation between the accuracy and the age of children from G2. This data suggests that, although there is an improvement in the accuracy according to the age, until 7 years old, there is a stabilization of vowel class acquisition from children in the second group, children of 9 years old. From the literature, we observed the description about a gradual acquisition from the auditory perception view[20,21]. According to one of these authors[20], in contrast to the speech production view, the criterion to a receptive phonological acquisition is the capacity to link a sound and a distinction of meaning. The others[21], point to a receptive acquisition of a gradient character and conclude assuring that the acquisition of auditory perception is complex and that its performance gets stable slower.

In short, our data contribute to point the gradual acquisition of stressed vowels, from the auditory-perceptive view and suggests that its stabilization seem to occur around 9 years old. So, the hearing care professional, when working with the acquisition of vocalic contrasts, must take into consideration, not only the age of the child when evaluating the perception of vocalic contrasts, but also the nature of the mistake. In other words, there are more predictable mistakes in the development, like those that occur with the non-peripheral vowels.

CONCLUSION

The results suggest an improvement of the performance in the identification task of stressed vowels in function of the increase in age. The group of older children (G2) presented a better hearing-perceptual accuracy, when compared to the accuracy of the younger children group (G1).

The reaction time of G1always showed higher than the children from G2, both for the hits and the mistakes.

Referring to the mistake pattern, in general, the groups did not have any difference, except for the mistakes involving the height parameter.

The analysis of correlation between age and accuracy showed that the children from G1 presented a positive correlation with the age. However, it didn't happen with children from G2.

The hearing-perceptual ability, referred to the identification of vocalic contrasts, seems to occur gradually and gets stable at 9 years old.

REFERENCES

1. Werker JF, Tees RC. Cross-language speech perception: evidence for perceptual reorganization during the first year of life. Infant Behav Dev. 1984;7(1):49-63. http://dx.doi.org/10.1016/S0163-6383(84)80022-3
2. Werker JF, Lalonde CE. Cross-language speech perception: initial capabilities and developmental change. Dev Psychobiol. 1988;24(5):672-83. http://dx.doi.org/10.1037/0012-1649.24.5.672
3. Polka L, Werker JF. Developmental changes in perception of nonnative vowel contrasts. J Exp Psychol Hum Percept Perform. 1994;20(2):421-35. http://dx.doi.org/10.1037/0096-1523.20.2.421
4. Best CT, McRoberts GW, Sithole NM. Examination of perceptual reorganization for nonnative speech contrasts: zulu click discrimination by english-speaking adults and infants. J Exp Psychol Hum Percept Perform. 1988;14(3):345-60. http://dx.doi.org/10.1037/0096-1523.14.3.345
5. Penido FA, Rothe-Neves R. Percepção da fala em desenvolvimento: uma retrospectiva. Verba Volant. 2013;4(1):117-40
6. Hazan V, Barrett S. The development of phonemic categorization in children aged 6-12. J Phonetics. 2000;28(4):377-96. http://dx.doi.org/10.1006/jpho.2000.0121
7. Flege JE. Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language. J Acoust Soc Am. 1991;89(1):395-411. http://dx.doi.org/10.1121/1.400473
8. Walley AC, Flege JE. Effect of lexical status on children's and adult's perception of native and non-native vowels. J Phonetics. 1999;27(3):307-32. http://dx.doi.org/10.1006/jpho.1999.0098
9. Flege JE, Eefting W. The production and perception of English stops by Spanish learners of English. J Phonet. 1987;15:67-83.
10. Berti LC, Falavigna AE, Santos JB, Oliveira RA. Desempenho

perceptivo- auditivo de crianças na identificação de contrastes fonológicos entre as oclusivas. J Soc Bras Fonoaudiol. 2012;24(4):348-54. http://dx.doi.org/10.1590/S2179-64912012000400010

11. Werker JF, Tees RC. Developmental changes across childhood in the perception of non-native speech sounds. Can J Psychol. 1983;37(2):278-86. http://dx.doi.org/10.1037/h0080725
12. Nittrouer S, Miller ME. Developmental weighting shifts for noise componentes of fricative-vowel syllables. J Acoust Soc Am. 1997;102(1):572-80. http://dx.doi.org/10.1121/1.419730
13. Berti LC. PERCEFAL: instrumento de percepção de fala. In: Perspectivas interdisciplinares em fonoaudiologia. I Simpósio Internacional do Grupo de Pesquisa "Avaliação da Fala e da Linguagem"; 29 set – 1 out 2011; Marília.
14. Andre C, Ghio A, Cave C, Teston B. Perceval: perception evaluation auditive & visuelle (versão 5.0.30) [Programa de computador]. Aix-en-Provence; 2009.
15. Mota HB. Pares mínimos: os contrastes do português brasileiro. Pro Fono. 2001;13(1): 98-106.
16. Boersman P, Weenink D. Praat: doing phonetics by computer (Version 5.0.30). [citado nov 2009]. Disponível em: http://www.praat.org/
17. Berti LC, Roque LMR. Desempenho perceptivo-auditivo de crianças na identificação de contrastes fonológico entre as vogais tônicas. CoDAS. 2013;25(6):534-41. http://dx.doi.org/10.1590/S2317-17822013000600534
18. Dehaene-Lambertz G, Hertz-Pannier L, Dubois J. Nature and nurture in language acquisition: anatomical and functional brain-imaging studies in infants. Trends Neurosci. 2006;29(7):367-73. http://dx.doi.org/10.1016/j.tins.2006.05.011
19. Polka L, Bohn OS. Natural Referent Vowel (NRV) framework: an emerging view of early phonetic development. J Phonetics. 2010;39(4):467-78.
20. Pater J, Stager C, Werker J. The perceptual acquisition of phonological contrasts. Language. 2004;80(3):384-402. http://dx.doi.org/10.1353/lan.2004.0141
21. Chacon L, Vaz S. Relações entre aquisição da percepção auditiva e aprendizagem da ortografia: consoantes soantes em questão. Linguagem em (Dis)curso, Tubarão. 2013;13(3):695-719.