Teste de rastreamento de alterações de fala para crianças***

Speech disorder screening test for children

Bárbara Niegia Garcia de Goulart*
Jair Ferreira**

*Fonoaudiologa. Doutora em Ciências da Saúde pela Universidade Federal de São Paulo - Escola Paulista de Medicina. Professora Adjunto do Curso de Fonoaudiologia da Universidade Federal do Rio Grande do Sul (UFRGS). Endereço para correspondência: R. Ramiro Barcelos, 2600 - Porto Alegre - RS - CEP 90035-003 (bgoulart@via-rs.net).

**Médico Epidemiologista. Doutor em Clínica Médica. Professor Adjunto da Faculdade de Medicina da Universidade Federal do Rio Grande do Sul.

***Trabalho Realizado com Auxílio da Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul - Hospital das Clínicas de Porto Alegre - Recursos da Fundação Instituto de Pesquisas Econômicas e da Feevale.

Artigo Original de Pesquisa

Artigo Submetido a Avaliação por Pares

Conflito de Interesse: não

Recebido em 21.01.2008.
Revisado em 27.08.2008; 13.01.2009; 18.05.2009; 27.07.2009.
Aceito para Publicação em 21.08.2009.

Abstract

Background: validation of a screening test to detect speech disorders in children. Aim: to present validation data of a new speech disorders screening test (Terdaf), developed by Brazilian researchers. Method: 2,027 children, of both genders, enrolled in the first grade of elementary public schools in Canoas (Brazil) during 2001 were selected by a probabilistic cluster sampling. In order to verify Terdaf's sensibility and specificity, 200 children were re-evaluated by an expert in speech disorders who had no information about the screening test results. Results: prevalence of speech disorders in this sample was of 26.7%. Terdaf´s sensibility was of 81.6% (95%CI 67.5 - 90.8%), specificity was of 44.4% (95%CI 36.0 - 53.2%). When children with speech disorders due to sociocultural issues were excluded from the sample with positive Terdaf results, the screening test specificity increased to 74.1%. Conclusion: the new tool for speech disorders screening has a quick and easy application format and can be used by education and health professionals. It can become an important ally in the early diagnosis of speech disorders as well as in the prevention of co morbidities associated to speech disorders. A few adjustments are necessary for the application of this test. These are discussed and presented in this article.

Key Words: Epidemiology; Speech; Speech Articulation Tests; Screening.

Resumo

Tema: validação de instrumento de rastreamento de alterações de fala em crianças. Objetivo: apresentar dados da validação de um teste de rastreamento - Terdaf, desenvolvido por pesquisadores brasileiros, para detecção de alterações de fala em crianças. Método: foram avaliadas 2.027 crianças de ambos os sexos e matriculadas na 1ª série da rede municipal de ensino de Canoas (RS) em 2001 e selecionadas por meio de amostragem aleatória por conglomerados. Para verificar a sensibilidade e especificidade do teste em estudo, 200 crianças foram submetidas à avaliação de fala por um fonoaudiólogo especialista cego para os resultados do rastreamento. Resultados: a prevalência estimada de distúrbio de fala na população estudada foi de 26,7%. O Terdaf apresentou sensibilidade de 81,6% (IC95%: 67,5 - 90,8%) e especificidade de 44,4% (IC95%: 36,0 - 53,2%). Quando se excluíram dos casos com Terdaf positivo as crianças que apresentaram alterações de fala exclusivamente por questões sócio-culturais a especificidade do teste aumentou para 74,1%. Conclusão: essa nova ferramenta de rastreamento de distúrbios de fala de fácil e rápida aplicação por profissionais da educação ou saúde pode tornar-se um importante aliado no diagnóstico precoce e prevenção das comorbidades associadas aos distúrbios de fala. Alguns ajustes para a aplicação do teste devem ser feitos e são apresentados neste artigo.

Palavras-Chave: Epidemiologia; Fala; Testes de Articulação da Fala; Diagnóstico.

Referenciar este material como:
Goulart BNG, Ferreira J. Speech disorder screening test for children (original title: Teste de rastreamento de alterações de fala para crianças - Terdaf). Pró-Fono Revista de Atualização Científica. 2009 jul-set;21(3):231-6.

Introduction

The acquisition of a language involves identifying the language's phonological system, morphology, lexicon, language syntax as well as understanding how semantic relations are established1-3. In several languages, by the age of 5, children have acquired the contrasts of the adult's phonemic system producing the language sounds properly and only in the allowed sequences2-4.

Many studies have been conducted with the purpose of improving speech and language diagnostic evaluations of disorders involving speech and language5-7. To prevent these disorders specific tests based on epidemiological characteristics of the conditions screened8-10 are recommended. There is a need for updated general guidelines and clinical protocols to guide health actions which would be based on reviewed clinical and epidemiological data on specific conditions and population groups by age, gender and/or exposure to certain risk factors in the work environment or social environment in general3,8,10-12. The validation of a sensitive screening test that is easily applicable and reproducible can help early diagnosis and thus reduce the prevalence of comorbidities associated to speech and language disorders7,10,13-14. Traces of phonological disorders, as described in DSM-IV Manual, are likely to persist during adolescence and adult age when these conditions are not treated during childhood13-16.

The objective of the present study was to present data and to describe the methods used in the validation of a screening test for detecting phonological disorders and perceptible speech deficit associated to several comorbidities.

Method

The study comprised elementary schoolchildren enrolled in the first grade of 39 public schools in the city of Canoas, metropolitan area of Porto Alegre, southern Brazil, in 2001. Of 161 school classes, 90 were randomly selected, making a total of 2,250 schoolchildren eligible to participate in the study. Of these, 2,027 were evaluated using the Screening Test for Speech Articulation Disorders (TERDAF) (Annex). Among 218 losses, 152 were children who did not attend school at the day scheduled for evaluation, dropped out of school or changed schools and 66 did not get consent from their parents/ guardians.

The study was approved by the Research Ethics Committee of Porto Alegre Clínicas Hospital (Protocol No. 01.013) on February 2001.

All children in the sample were submitted to individual testing in a classroom with background noise of up to 60 decibels. The tests were administered by university students in health who followed the TERDAF application instructions and had no prior knowledge of the children's speech disorders, apparent speech deficits or auditory complaints.

The test results were classified as normal (all answers were adequate), abnormal (some answers were inadequate) and no answer (when a child was not able to recognize a picture but otherwise provided correct answers in the test).

The test included words of easy pictorial representation that are known to children over 6 and are part of their vocabulary and are illustrative of Brazilian Portuguese phonemes with all its variants. A pilot study including 30 same-age schoolchildren with similar characteristics to the sample studied was conducted for prior adjustment of the instrument.

To estimate the test sensitivity and specificity, a subsample of randomly selected children was reevaluated by a speech therapist with clinical experience of more than 6 years in the evaluation and treatment of speech disorders who was blinded to the results of the previously applied screening test. In this evaluation children were asked to repeat words including all Brazilian Portuguese sounds and also to tell a story for the collection of a sample of spontaneous speech. The speech therapist considered that a child did not have any speech deficit when all Brazilian Portuguese phones in both spontaneous and repeat speech were adequately produced.

Based on data from the speech and language evaluations, a specialist blinded to all data estimated TERDAF sensitivity, specificity, predictive values, and 95% confidence intervals for the prevalence of speech disorders found in the study.

Results

In the sample studied, 1,076 (53.1%) schoolchildren were males and their ages ranged from 6 to 12 years old, and most children (1,421; 71.6%) were 7 or 8 years old.

Of 2.027 children submitted to TERDAF, 643 (31.7%) had normal test results; 1,168 (57.6%) had some degree of speech deficit; and 217 (10.7%), though they did not have any detectable speech deficit, were not able to recognize some pictures in the test and were thus considered "non-responders".

Among 1,168 children with abnormal test results, 721 (61.7%) had only an abnormality of speech articulation emitting fósfo, fósfro, frósfuo or frósfi instead of fósforo (match in Portuguese) and/or praca instead of placa (sign). When this abnormality was not considered a speech disorder, the number of abnormal tests fell from 1,168 to 447, accounting for 22.0% of the entire sample (2,027) or 24.7% of the remaining sample (1,810) after excluding non-responders.

Of 200 children randomly selected for reevaluation by the speech therapist blinded to TERDAF results, 114 (57.0%) showed positive results, 70 (35.0%) negative, and 16 (8.0%) were non-responders. As for the distribution of TERDAF results, there was no significant difference between the subsample and the entire sample (p = 0.36).

Comparative analyses between TERDAF and the gold-standard evaluation (speech therapist evaluation) included only data from children responders to TERDAF (N = 184).

Table 1 shows TERDAF results compared with the gold-standard evaluation when speech deficits exclusively associated to social and cultural patterns were also considered positive results.

TABLE 1. TERDAF results compared with the gold-standard (speech-language pathologist evaluation blind for Terdaf´s results).

	Speech-Language Pathologist Evaluation (Gold-Standard)		
	PO (AF) +	PO (AF) -	
Terdaf +	40	75 (*)	115
Terdaf -	9	60	69
TOTAL	49	135	184

TABLE 2. TERDAF results compared with the gold-standard (speech-language pathologist evaluation blind for Terdaf´s results).

	Speech-Language Pathologist Evaluation (Gold-Standard)		
.	PO (AF) +	PO (AF) -	
Terdaf +	40	35	75
Terdaf -	9	100 (*)	109
TOTAL	49	135	184

Legend Tables 1 and 2: Terdaf + = presence of speech disorder; Terdaf - = absence of speech disorders; GS (SLP)+ = gold-standard, speech-language pathologist evaluation positive for speech disorders; GS (SLP) - = gold-standard, speech-language pathologist evaluation negative for speech disorders ; (*) Including 40 children with speech disorders exclusively related to sociocultural variability.

Based on this criterion, TERDAF showed 81.6% sensitivity (95% CI: 67.5-90.8) and 44.4% specificity (95% CI: 36.0-53.2). The estimated prevalence of speech disorders in the subsample of the population studied was 26.6%. At this prevalence, the test positive predictive value was 34.8% (95% CI: 26.3-44.3) and the negative predictive value was 87.0% (95% CI: 76.2-93.5).

Table 2 shows the results of the screening test compared with the gold-standard evaluation when speech deficits exclusively associated to social and cultural patterns were not considered positive (abnormal) results.

Therefore, TERDAF would show 81.6% sensitivity (95% CI: 69.0-90.7) and 74.1% specificity (95% CI: 66.2-80.9). The estimate prevalence of speech disorder would remain at 26.7% (95% CI: 20.8-33.4), but the test positive predictive value would increase to 53.3% (95% CI: 41.5-64.8) and the negative predictive value would increase to 91.7% (95% CI: 84.5-95.9).

Discussion

The prevalence estimate of speech disorders in the present study was higher than 25%, which contrasts with prior studies that reported 3% to 5% prevalence1,17-18. This inconsistency may be due to a different diagnostic criterion applied in the present study; as diagnostic criteria are not clearly detailed in many studies, it makes it difficult comparisons and reproduction of the methods in other populations1,3,10,19.

To prevent potential distortions, diagnostic criteria of speech disorders were previously defined and detailed so that more accurate results could be provided and discussed by child specialists, speech therapists and others. Speech disorder was defined as any abnormality (or perceptible distortion) in consonant emission.5,7,14 Speech was considered adequate when a child was able to emit all target sounds presented in the test or in the gold-standard evaluation. A detailed description of diagnostic criteria used in the study allows further comparisons with other tests.

In TERDAF, 35.6% (N = 721) of children evaluated showed positive results due to inadequate pronunciation of consonantal encounters with liquid consonant phone [l],1,2,13 characterized by its replacement by phone [?]. This finding may be associated to social factors; in some social or cultural milieu the pronunciation of the word placa (sign) is acceptable (and understood) as praca and it is also considered a linguistic variant

and/or potential simplication6,20. As an alternative, the test could be redesigned to include linguistic variations associated to children's background and adjustments could be made to both pictures and target words in the test protocol. We currently work with instruments that are widely used in clinical speech evaluation and diagnosis, but there are no reports of adjustments made to these screening instruments by other professionals, such as teachers and pediatricians.

During TERDAF administration, we noted that the picture representing nenê (baby) was emitted by 5.1% (N = 102) of all children evaluated as bebê (baby). We thus recommend the use of facilitating sentences to prompt the intended word. Another option is replace the picture representing the phone [n] (e.g., use a picture of a banana).

The picture of a sign (placa) was not identified by 6.7% (N = 135) of the children evaluated so we recommend to replace the street sign by a car plate.

TERDAF current version does not have a picture representing the target sound [3] (such as in gelo [ice] or jóia [jewel]); however, it should be added in an upgraded version of the test by including a picture of a clock (relógio). The fact that this phoneme is not included in the test does not invalidate the study data because in our experience we found that the isolated abnormality of phoneme /3/ is rare from an epidemiological perspective even considering that palatal frontalization is very common3,6-7,14,20,25.

The replacement of the match (fósforo) and sign (placa) pictures or the inclusion of additional instructions when children under evaluation only have these abnormalities can improve the test sensitivity and specificity.

TERDAF was designed based on evidence that naming pictures is the most adequate approach of evaluating speech disorders in children because the evaluator does not provide an articulation model to those under evaluation6,19. In cases of severe speech disorders naming pictures allows the evaluator to assess the child's target word and phonemes can be balanced, ensuring that all phonemes of Brazilian Portuguese are evaluated. A 2006 study showed no difference in speech evaluation (normal or abnormal answer) in children evaluated using syllable imitation, word imitation, and naming pictures6.

TERDAF is not intended to assess whether the perceptible speech deficit is characterized by phonetic, phonological, or phonetic-phonological deviation (referred here as speech disorders) since this diagnosis is usually made by a skilled speech therapist who will clinically evaluate children with positive test results.

A good screening test has high sensitivity to identify cases in the population tested and high specificity to reduce the number of false-positive results that would require further investigation8,10,21.

TERDAF does not cause any discomfort or risks to children and the test takes five minutes to be applied and does not require any prior specific preparation of those under evaluation. It has good sensitivity to detect diseased individuals, i.e., children with perceptible speech deficits9,21.

We did not find any review on the validation of screening tests in the Brazilian population that follows the same criteria used in the present study. However, overall technology approaches used for screening and/or diagnosis related to human communication should be reassessed. Several authors claim that new technologies, techniques or equipment are not necessary more effective or can provide better input than the instruments available10,22-24.

TERDAF specificity was low (44.4%) and was associated to a high prevalence of positive test (abnormal) results because many children showed inadequate emission of words such as fósforo and/or placa. When these cases were not considered positive, the test specificity increased to 74.1%.

Spontaneous speech was evaluated in the speech and language (gold-standard) evaluation. We noted that children with difficulty in pronunciation tend to avoid words with phonemes that elicit it. Hence the comparative analysis between TERDAF and the gold-standard evaluation was based on children's repetitions of speech models that were singly prompted by the evaluator.

The clinical speech and language evaluation by a qualified specialist with prior experience in the evaluation and treatment of speech disorders, who is blinded to the instrument data under validation, is a common approach used in many studies investigating screening or diagnostic instruments when an accepted gold-standard is not available9-10,22,24-27.

TERDAF has proved to be a valuable tool that providers other than speech therapists can use for a first screening when speech disorder is suspected in children so that only detected cases will be referred to auditory and speech and language evaluation and treatment, which can help streamlining health care. Further studies with other groups of children are required especially to assess

the performance of the modified test version here proposed in children from different geographical regions of Brazil. In addition, the test pictures need to be reviewed so that regionalisms related to picture naming can be identified and any required adjustments can be made and the instrument can be validated to be used in routine evaluations of children - the population for which TERDAF was originally developed and validated.

The present study highlights the relevance of epidemiological consideration and application for improving scientific and methodological quality of diagnostic tests of human communication disorders as proposed in other studies10-11,23-24.

Conclusion

TERDAF showed test sensitivity higher than 80% and specificity around 75% when speech abnormalities exclusively associated to social and cultural patterns were not considered as positive test results. Based on this same criterion, for a prevalence slightly higher than 25%, the positive predictive value was higher than 50% and the negative predictive value was higher than 90%.

TERDAF requires further adjustments to increase its accuracy including a review of the pictures used to evaluate children of different ages and social conditions and the inclusion of a picture to evaluate phone [3].

Apêndice

Pictures List presented in Terdaf

Terdaf - Words elicited by images (cliparts) presented in Terdaf*:

scissors	little bird	cat	dog
butterfly	bunny	apple	baby*
zebra	finger)	guitar	key
leaf	shoe	gift	match*
truck	pencil	sign*	radio

* In the test review authors´suggest that the match ("fósforo" in Portuguese) clipart should be suppressed; the sign clipart ("placa" in Portuguese) should be changed by a car plate and the substitution of "nenê (baby) by the figure of a banana (target sound [b]). A watch figure ("relógio" in Portuguese, target sound [R]) must be included in Terdaf, so all phonemes in Brazilian Portuguese will be assessed by the screening test.

References

1. Smith SD, Bruce FP, Broada R, Shriberg L. Linkege of speech sound disorder to reading disability loci. J Child Psychol Psychiatry. 2005;46(10):1057-66.

2. Wertzner HF, Sotelo MB, Amaro L. Análise de distorções em crianças com e sem transtorno fonológico. Clinics. 2005;60(2):93-102.

3. Goulart BNG, Chiari BM. Prevalência de desordens de fala em escolares e fatores associados. Rev Saúde Pública. 2007;41(5):726-31.

4. Ziegler JC, Pech-Georgel C, George F, Alario FX, Lorenzi C. Deficits in speech perception predict language learning impairment. Proc Natl Acad Sci USA. 2005;102(39):14110-5.

5. Wertzner HF, Amaro L, Teramoto SS. Gravidade do distúrbio fonológico: julgamento perceptivo e porcentagem de consoantes corretas. Pró-Fono Rev. Atual. Cient. 2005;17(2):185-94.

6. Wertzner HF, Papp ACCS, Galea DES. Provas de nomeação e imitação como instrumentos de diagnóstico do transtorno fonológico. Pró-Fono Rev. Atual. Cient. 2006; 18(3):303-12.

7. Nelson HD, Nygren P, Walker M, Panoscha R. Screening for speech and language delay in preschool children: systematic evidence review for the US preventive services task force. Pediatrics. 2006;117(2):e298-e319.

8. Nobre MRC, Bernardo WM, Jatene FB. A Prática Clínica Baseada em Evidências parte III: Avaliação Crítica das Informações de Pesquisas Clínicas. Rev Assoc Med Bras. 2004;50(2):221-8.

9. Barreto ML. Comentário: tecnologias em saúde e o sempre tênue equilíbrio entre riscos e benefícios. Rev Saúde Pública. 2006;40(3):397-9.

10. Goulart BNG, Chiari BM. Testes de rastreamento x testes de diagnóstico: atualidades no contexto da atuação fonoaudiológica. Pró-Fono Rev. Atual. Cient. 2007;19(2): 223-32.

11. Goulart BNG. Contribuições da epidemiologia para a pesquisa e atuação clínica em fonoaudiologia. Fono Atual. 2002;5(21):60-3.

12. Teixeira CF. Promoção e vigilância da saúde no contexto da regionalização da assistência à saúde no SUS. Cad. Saúde Pública. 2002;18 Suppl:153-62.

13. Goulart BNG, Ferreira J. Teste de rastreamento de distúrbios articulatórios de fala em crianças de 1ª série - dados preliminares. Rev. Bras. Epidemiol. 2002;Suppl:159. NÃO ISI.

14. Nathan L, Stackhouse J, Goulandris N, Snowling MJ. Educational consequences of developmental speech disorder: Key stage 1 national curriculum assessment results in english and mathematics. Br J Educ. Psychol. 2004;74(Pt 2):173-86.

15. Naucler K, Magnusson E. Language problems in poor readers. Logoped. Phoniatr. Vocol. 2000;5(1):12-21.

16. Fox A, Dodd B, Howard D. Risk factors for speech disorders in children. Int J Lang Commun Disord. 2002;37 (2):117-31.

17. Andrade CRF. Prevalência de desordens idiopáticas da fala e da linguagem em crianças de um a onze anos de idade. Rev. Saúde Pública. 1997;31(5):495-501.

18. Shriberg LD, Tomblin JB, Mc Sweeny JL. Prevalence of speech delay in 6-year-old children and comorbidity with language impairment. J Speech Lang Hear Res 1999; 42(6):1461-81.

19. Scheuer CI, Stivanin L, Mangilli LD. Nomeação de figuras e memória em crianças: efeitos fonológicos e semânticos. Pró-Fono Rev. Atual. Cient. 2004;16(1):49-56.

20. Wertzner HF, Papp ACCS, Amaro L, Galea DES. Relação entre processos fonológicos e classificação perceptiva de inteligibilidade de fala no transtorno fonológico. Rev. Soc. Bras. Fonoaudiol. 2005b;10(4):193-200.

21. Aerts D, Alves GG, La Salvia MW, Abegg C. Promoção de saúde: a convergência entre as propostas da vigilância da saúde e da escola cidadã. Cad. Saúde Pública. 2004;20(4): 1020-8.

22. Krauss-Silva L. Avaliação tecnológica em saúde: questões metodológicas e operacionais. Cad. Saúde Pública. 2004; 20 Suppl 2:S199-S207.

23. Goulart BNG, Chiari BM. Construção e aplicação de indicadores de saúde na perspectiva fonoaudiológica - contribuições para reflexão. Rev. Soc. Bras. Fonoaudiol. 2006; 11(3):194-204.

24. Wegner L. Screening for speech and language delay in preschool children: more answers are needed. Pediatrics. 2006;117(2):533-4.

25. Law J, Boyle J, Harris F, Harkness A, Nye C. Screening for primary speech and language delay: a systematic review of the literature. Int J Lang Commun Disord. 1998;33 Suppl:21-3.

26. American Academy of Pediatrics. Developmental surveillance and screening of infants and young children. Pediatrics 2001;108(1):192-6.

27. Stott CM, Merricks MJ, Bolton PF, Goodyer IM. Screening for speech and language disorders: the reliability, validity and accuracy of the general language screen. Int J Lang Commun Disord. 2002;37(2):133-51.