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Noise speech tests in the audiological clinic - An Integrative Review

Testes de fala no ruído na clínica audiológica – Uma Revisão Integrativa

Noise speech tests in the audiological clinic - An Integrative Review

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Abstract

Introduction: Conventional audiometry is not reliable enough to predict a person's understanding in a noisy environment, so inserting speech noise tests into the audiological clinical routine can be a useful tool for detecting possible central auditory function problems. **Objective:** To conduct an integrative literature review on noise speech tests available for use in the audiological clinic. **Method:** Search for publications without temporal delimitation in the Lilacs, PubMed, Medline, IBCS and SciELO databases, using the following keywords: Noise speech test, auditory perception, auditory discrimination tests, hearing disorders, standardization, development, validation, speech reception threshold tests, hearing perception and hearing loss. There was no exclusion by publication period. The articles were searched in June and July 2017. **Results:** A total of 1200 articles were found and 39 were included in this integrative review because they met the inclusion criteria. In the selected articles, 25 different materials were used to evaluate speech in noise: syllables, words, sentences, digits and association of words and tone and words and sentences. The types of noise used were: speech spectrum, babble noise, white noise and stationary noise and these materials were developed for use in adults and / or children and subjects with and / or without hearing loss. **Conclusion:** All authors reported the importance of inserting speech tests in noise

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Authors' contributions:
APO: Study conception, data collection, analysis and interpretation; and article writing.
TMMS: Study conception and supervision, and article review;
MPC and AF: Data collection, analysis and interpretation; and article writing.

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into the clinical routine, since only conventional audiometry does not predict speech comprehension in noisy environment.

Keywords: Hearing Tests; Speech intelligibility; Noise; Speech discrimination tests; Auditory perception.

Resumo

Introdução: A audiometria convencional não é suficientemente confiável para prever a compreensão de uma pessoa num ambiente ruidoso e, desta forma, inserir testes de fala no ruído na rotina clínica audiológica pode ser uma ferramenta útil para detectar possíveis problemas da função auditiva central. **Objetivo**: Realizar uma revisão integrativa da literatura sobre testes de fala no ruído disponíveis para uso na clínica audiológica. **Método:** Busca de publicações sem delimitação temporal nos bancos de dados Lilacs, PubMed, Medline, IBCS e SciELO, utilizando-se como descritores: teste de fala no ruído, percepção auditiva, testes de discriminação auditiva, distúrbios auditivos, padronização, desenvolvimento, validação, testes do limiar de recepção da fala, percepção auditiva e perda auditiva. Não houve exclusão por período de publicação. Os artigos foram pesquisados nos meses de junho e julho de 2017. **Resultados:** Foram localizados um total de 1200 artigos e 39 foram inseridos nesta revisão integrativa por satisfazerem os critérios de inclusão. Nos artigos selecionados, foram localizados 25 materiais diferentes que utilizaram para avaliação de fala no ruído: sílabas, palavras, sentenças, dígitos e associação de palavras e tonalidade e palavras e sentenças. Os tipos de ruídos empregados foram: espectro de fala, ruído tipo *babble*, ruído branco e ruído estacionário e tais materiais foram desenvolvidos para uso em adultos e/ou crianças e sujeitos com e/ou sem perda auditiva. **Conclusão:** Todos os autores relataram a importância de inserir testes de fala no ruído na rotina clínica, já que só a audiometria convencional não prevê a compreensão de fala em ambiente ruidoso.

Palavras-chave: Testes auditivos; Inteligibilidade da fala; Ruído; Testes de discriminação da fala; Percepção auditiva.

Resumen

Introducción: La audiometría convencional no es confiable para predecir la comprensión de una persona en entorno ruidoso, por lo que insertar pruebas de ruido del habla en la rutina audiológica puede ser una herramienta útil para detectar posibles problemas de la función auditiva central. **Objetivo:** realizar una revisión integral de literatura sobre las pruebas de ruido en el habla disponibles para su uso en la clínica audiológica. **Método**: Búsqueda de publicaciones sin delimitación temporal en las bases de datos Lilacs, PubMed, Medline, IBCS y SciELO, utilizando las palabras clave: prueba de ruido, percepción auditiva, pruebas de discriminación auditiva, trastornos auditivos, estandarización, desarrollo, validación , pruebas de umbral de recepción del habla, percepción auditiva y pérdida auditiva. No hubo exclusión por período de publicación. Se buscaron los artículos en junio y julio de 2017. **Resultados:** se encontraron un total de 1200 artículos y se incluyeron 39 en esta revisión porque cumplían con los criterios de inclusión. En los artículos seleccionados, se utilizaron 25 materiales diferentes para evaluar el habla en ruido: sílabas, palabras, oraciones, dígitos y asociación de palabras y tonos y oraciones. Tipos de ruido utilizados: espectro del habla, ruido de balbuceo, ruido blanco y ruido estacionario, y estos materiales se desarrollaron para su uso en adultos y/o niños y sujetos con y/o sin pérdida auditiva. **Conclusión:** Todos los autores informaron la importancia de insertar pruebas de habla en ruido en la rutina clínica, ya que solo la audiometría convencional no predice la comprensión del habla en entornos ruidosos.

Palabras clave: Pruebas auditivas; Inteligibilidad del habla; Ruido; Pruebas de discriminación del habla; Percepción auditiva

Introduction

Complaints of difficulty in understanding speech in noisy environments are increasingly frequent, even for individuals who have normal hearing ability from the audiometric perspective. For this reason, the analysis of the relationship between audiometric thresholds and the ability to recognize speech stimuli in conditions similar to real communication situations (using speech tests to assess sentence recognition in silence and also in the presence of competitive noise) has become crucial in the audiological evaluation process. This is due to the fact that tests that use pure tone as a stimulus do not allow the assessment of the individual's social hearing.[1]

The evaluation of speech intelligibility plays an important role in audiological practice.[2] Conventional logoaudiometry does not measure or predict the ability of a person to understand speech in a noisy environment. Thus, speech in noise tests (tests that assess speech intelligibility in the presence of background noise) should be included in the battery of tests of audiologists in order to assess the central auditory function.[3]

In addition to conventional measurements, tests that reproduce situations in complex auditory environments should be included, as the performance in the speech in noise recognition cannot be predicted only by pure tone thresholds or using the speech in silence.[4] Although studies have recommended the inclusion of speech in noise tests in the audiologist's clinical routine and its importance has been recognized by many researchers,[5,6] the use of these tests is limited in clinical practice.[7]

Speech in noise tests are necessary to determine the patient's ability in everyday situations. Assessing the ability to understand speech in noisy environments is important in the evaluation and optimization of the parameter settings of electronic devices. The inclusion of speech in noise tests in the clinical practice also provides a more targeted and effective counseling and intervention based on knowledge about the individual's ability to understand speech in noise.[8]

Many methods have been proposed to measure speech intelligibility in silence and in the presence of competitive noise. These methods differ in several aspects, such as: the structure of the speech material, the application procedure of the tests, the level of presentation, the interval of the signal-to-noise ratio and the type of noise used.[9]

Given these issues, it is important to know the speech in noise tests used in audiology for the differential diagnosis of hearing disorders. Thus, this study formulated the following question: What speech in noise tests have been developed for the differential diagnosis of hearing disorders in the audiological clinic and are available?

The study aimed to conduct an integrative literature review on speech in noise tests used in audiological clinic for the differential diagnosis of hearing disorders.

Method

This is an exploratory study through an integrative literature review. The search for articles was conducted in the Latin American and Caribbean Center on Health Sciences Information (Lilacs), US National Library of Medicine (PubMed and Medline), and Information Behavior in Everyday Contexts (IBECS) databases and in the Scientific Electronic Library Online (SciELO) without delimiting the publication period of the articles.

The question of the investigation work was: What speech in noise tests have been developed for the differential diagnosis of hearing disorders in the audiological clinic and are available?

After the question was formulated, a bibliographic search was performed on the central topics of the work using the terms that best identified the studies. The structured and trilingual vocabulary - Health Sciences Descriptors (DeCS), which was developed by the Virtual Health Library (VHL) and also by the descriptors prepared by Medical Subject Headings (MeSH) was used to survey the keywords. Chart 1 shows the descriptors used in the study:

Chart 1. Keywords and terms used to search for articles

SEARCH TERMS			
No.	**PORTUGUESE**	**ENGLISH**	**SPANISH**
1	Perda Auditiva	Hearing loss	Pérdida de la audición
2	Testes de fala no ruído	Speech in noise tests	Discurso en pruebas de ruido
3	Teste do Limiar de recepção da Fala	Speech Reception Threshold Test	Prueba del Umbral de Recepción del Habla
4	Testes de Discriminação da Fala	Speech Discrimination Tests	Pruebas de Discriminación del Habla
5	Percepção auditiva	Auditory perception	Percepción auditiva
6	Distúrbios Auditivos	Auditory disorders	Transtornos auditivos
	Testes auditivos no ruído	Hearing in noise tests	Audición en pruebas de ruido
7	Padronização	Standardization	Normalización
8	Desenvolvimento	Development	Desarrollo
9	Validação	Validation	Validación

As shown in Chart 2, the strategies to find the articles were developed after adding the search terms following the same strategies in all journals. Thus, whenever there is a reference to 'number of search terms' in the results, this number will be based on the Chart 2, as follows:

Chart 2. Combination of keywords and search terms for articles

SEARCH STRATEGY	
No.	**TERMS**
1	Speech in noise tests AND Auditory perception AND Speech Discrimination Tests
2	Auditory disorders AND speech in noise tests AND Standardization
3	Speech Reception Threshold Test AND Hearing in noise tests AND speech in noise tests.
4	Development AND Speech Reception Threshold Test AND speech in noise tests.
5	Auditory perception AND hearing loss AND speech in noise tests AND validation

Inclusion criteria:

- Prospective controlled and randomized clinical studies published in the searched databases.
- Studies involving research on the development of speech in noise tests for the diagnosis of hearing disorders;

Figure 1. Order of selection of articles to be included in the Integrative Review

Figure 1 shows the order in which the studies were selected after being found in the databases, using the search terms of the strategy:

Results and discussion

In total, 1200 articles were found, which, after reading the title, resulted in 134 articles. The reading of the abstract of the 134 articles was performed and resulted in 74 articles selected to be read in full. After reading the articles, 58 articles remained to be included in the research; however, 19 of these 58 articles were removed as they were duplicated. Thus, 39 articles remained and were included in this Integrative Review. This process is shown in Figure 2 and the total number of articles by terms is shown in Chart 3.

Figure 2. Article selection process

Chart 3. Total articles found for each search term

Number of terms used	Number of articles found	Number of articles found in all databases searched				
		Title	Abstract	Reading	Duplicates	Included
1	798	40	18	12	19	39
2	15	9	3	2		
3	324	42	27	25		
4	41	35	22	16		
5	22	8	4	3		
Total	1200	134	74	58	19	39

Chart 4 shows all studies found in the 39 searches included in this integrative review. As some studies have had duplicate materials, as adaptations have been made for different languages, the chart shows only the materials developed.

Chart 4. Materials found in the Integrative Review

No.	Designed/Studied Instrument
1	DIGITS-IN-NOISE TEST - DIN
2	MATRIX SENTENCE TEST -
3	SPEECH RECEPTION IN NOISE TEST - GALKER-TEST.
4	AZBIO SENTENCE TEST
5	OLDENBURGER KINDER-SATZTEST - OLKISA
6	LISTENING IN SPATIALIZED NOISE – SENTENCES TEST (LiSN-S)
7	SENTENCE RECOGNITION FOR ENGLISH NON-NATIVE SPEAKERS
8	FOUR ALTERNATIVE AUDITORY FEATURE TEST - FAAF
9	NATIONAL HEARING TEST (NHT). EARCHECK (EC) AND OCCUPATIONAL EARCHECK (OEC). ONLINE TESTS.
10	ESTONIAN WORDS IN NOISE TEST (EWIN)
11	SPEECH PERCEPTION IN NOISE TEST (SPIN)
12	HEARING IN NOISE TEST - HINT
13	NONSENSE SYLLABLE TEST - ORCA
14	QUICK SPEECH-IN-NOISE TEST - QUICK-SIN
15	SPEECH RECEPTION IN NOISE TEST - SPRINT
16	STARR TEST
17	CANDILET-N TEST
18	MANDARIN PEDIATRIC LEXICAL TONE AND DISYLLABIC-WORD PICTURE IDENTIFIATION TEST IN NOISE (MAPPID-N)
19	PERCEPTUAIIY ROBUST ENGLISH SENTENCE TEST OPEN-SET - PRESTO
20	GERMAN SENTENCE TEST
21	MANDARIN TONE IDENTIFICATION TEST - MTIT
22	SENTENCES USING AUDITORY AND AUDITORY-VISUAL STIMULUS
23	FOUR ALTERNATIVE FORCED CHOICE - 4AFC
24	SOUTH AFRICAN DIGITS-IN-NOISE HEARING TEST.
25	PORTUGUESE SENTENCE LISTS - LSP

Chart 5 shows all the references of the 39 articles found. Of these, 25 materials were developed, as three were prepared in different versions and languages.

Chart 5. Articles found

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/Studied Instrument	Original test author (when using third party material)
1	Silverman SR, Hirsh IJ. Problems related to the use of speech in clinical audiometry. Ann Otol Rhinol Laryingol. 1956; 64:1234-44.	1956	Preparation of material from an existing material.	Digits-in-noise test DIN	Same authors.
2	Plomp R, Mimpen AM. Improving the reliability of testing the speech reception threshold for sentences. Int J Audiol. 1979; 18:43–53.	1979	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA. (1994)
3	Bilger RC, Nuetzel JM, Rabinowitz WM. Standardization of a test of speech perception in noise. J Speech Hear Res. 1984; 27:32-48.	1984	Preparation of material.	Speech Perception in Noise Test (SPIN)	Kalikow DN, Stevens KN, Elliott LL (1977).
4	Macleod A, Summerfield Q. A procedure for measuring auditory and audiovisual speech-reception thresholds for sentences in noise: Rationale, evaluation, and recommendations for use. Br J Audiol. 1990; 24:29-43.	1990	Preparation of material.	Sentences using auditory and auditory-visual stimulus	Same authors.
5	Keidser G. Computerized Measurement of Speech Intelligibility I.: Development of System and Procedures. Scand Audiol 1991, 20:147-152.	1991	Preparation of materials.	Four Alternative Forced Choice - 4AFC	Same authors.
6	Nilsson M, Soli SD, Sullivan JA. Development of the Hearing In Noise Test for the measurement of speech reception thresholds in quiet and in noise. J. Acoust. Soc. Am. 1994; 95:1085-99.	1994	Preparation of materials.	Hearing In noise Test - HINT	Same authors.
7	Costa MJ, Iorio MCM, Mangabeira-Albernaz PL. Reconhecimento de fala: desenvolvimento de uma lista de sentenças em português / Speech recognition: development of a list of sentences in Portuguese. Acta AWHO 1997; 16:164-73.	1997	Preparation of materials.	Portuguese Sentence Lists - LSP	Same authors.
8	Kollmeier B, Wesselkamp M. Development and evaluation of a German sentence test for objective and subjective speech intelligibility assessment. J. Acoust. Soc. Am. October 1997;102:2412-21.	1997	Preparation of materials.	German sentence test	Same authors.
9	Cameron S, Dillon H. Development of the Listening in Spatialized Noise-Sentences Test (LISN-S). Ear Hear. 2007;28:196-211	2007	Preparation of material from an existing material. New version - same authors.	Listening in Spatialized Noise – Sentences Test (LiSN-S)	Cameron, Dillon, Newall (2006a).
10	Killion MC, Niquette PA, Gudmundsen GI. Development of a quick speech-in-noise test for measuring signal-to-noise ratio loss in normal-hearing and hearing-impaired listeners. J. Acoust. Soc. Am. October 2004 116 (4), Pt. 1.	2004	Preparation of materials.	Quick speech-in-noise test - QUICK-SIN	Same authors.
11	Wong LLN, Soli SD. Development of the Cantonese Hearing In Noise Test (CHINT). Ear Hear. 2005; 26:276-89.	2005	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA (1994)
12	Vaillancourt V, Laroche C, Mayer C, Basque C, Nali M, Eriks-Brophy A, et al. Adaptation of the HINT (hearing in noise test) for adult Canadian Francophone populations. Int J Audiol. 2005; 44:358-69.	2005	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA. (1994)
13	Wong LL, Soli SD, Liu S, Han N, Huang MW. Development of the Mandarin Hearing in Noise Test (MHINT). Ear Hear. 2007; 28:70-74.	2007	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA. (1994)
14	Bevilacqua MC, Banhara MR, Costa EA, Vignoly AB, Alvarenga KF. The Brazilian Portuguese Hearing in Noise Test (HINT). Int J Audiol. 2008;47:364-5.	2008	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA. (1994)
15	Yuen KCP, Pang KW, Tong MCF, Hasselt CSV, Yuan M, Lee T, Soli SD. Development of the computerized Cantonese Disyllabic Lexical Tone Identification Test in Noise (CANDILET-N). Cochlear Implants Int. 2009, 10(S1):130-37.	2009	Preparation of materials.	CANDILET-N Test	Same authors.

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/Studied Instrument	Original test author (when using third party material)
16	Yuen KCP, Luan L, Li H, Wei C, Cao K, Yuan M, Lee T, Development of the computerized Mandarin Pediatric Lexical Tone and Disyllabic-word Picture Identification Test in Noise (MAPPID-N). Cochlear Implants Int. 2009;10(S1):138-47.	2009	Preparation of materials.	Mandarin Pediatric Lexical Tone and Disyllabic-Word Picture Identification test in Noise (MAPPID-N)	Same authors.
17	Kuk F, Lau C, Korhonen P, Crose B, Peeters H, Keenan D. Development of the ORCA Nonsense Syllable Test. Ear Hear. 2010;31:779-95.	2010	Preparation of materials.	Nonsense Syllable Test - ORCA	Same authors.
18	Leensen MCJ, Laat JAPM, Dreschler WA. Speech-in-noise screening tests by internet, Part 1: Test evaluation. Int J Audiol. 2011;50:823-34.	2011	Use of third party materials.	National Hearing Test (NHT). Earcheck (EC) and Occupational Earcheck (OEC). Online tests.	National Hearing Test (NHT) - Smits et al (2006). Earcheck (EC) - Albrecht et al (2005), e Occupational Earcheck (OEC) - Ellis et al (2006). Online tests.
19	Nielsen JB, Dau T. The Danish hearing in noise test. Int J Audiol. 2011; 50:202-08.	2011	Preparation of material from an existing material.	Hearing In Noise – HINT	Nilsson M, Soli SD, Sullivan JA (1994)
20	Calandruccio L, Smiljanic R. New Sentence Recognition Materials Developed Using a Basic Non-Native English Lexicon.J Speech Lang Hear Res. 2012; 55:1342-55.	2012	Preparation of materials.	Sentence Recognition For English Non-Native Speakers	Same authors.
21	Hochmuth S, Brand T, Zokoll MA, Castro FZ, Wardenga N, Kollmeier B. A Spanish matrix sentence test for assessing speech reception thresholds in noise. Int J Audiol.2012;51:536-44.	2012	Preparation of material from an existing material. New version.	Matrix Sentence Test – consisting of a fixed syntactic structure, semantically unpredictable, with low redundancy and a word cannot be predicted based on the context.	This material was prepared in other versions. However, this version was designed by the author mentioned. Original developed by Hagerman (1982).
22	Neumann K, Baumeister N, Baumann U, Sick U, Euler HA, gerber TWB. Speech audiometry in quiet with the Oldenburg Sentence. Int J Audiol. 2012;51: 157-63	2012	Use of third party materials.	Oldenburger Kinder-Satztest - OlKiSa	Wagener K., Kühnel V. e Kollmeier B. 1999.
23	Schafer EC, Pogue J, Milrany T. List Equivalency of the AzBio Sentence Test in Noise for Listeners with Normal-Hearing Sensitivity or Cochlear Implants. J Am Acad Audiol.2012;23:501-09.	2012	Use of third party materials.	AzBio Sentence Test	Spahr et al, 2012
24	Smits C, Goverts ST e Festen JM. The digits-in-noise test: Assessing auditory speech recognition abilities in noise. J. Acoust. Soc. Am. March 2013 133 (3).	2013	Use of third party materials.	Digits-in-noise test - DIN -	Same authors.
25	Gilhert JL, Tamatit TN, Pisoni DB.Development, Reliability, and Validity of PRESTO: A New High-Variability Sentence Recognition Test. J Am Acad Audiol. 2013;24:26-36.	2013	Preparation of materials.	Perceptually Robust English Sentence Test Open-set - PRESTO	Same authors.
26	Xu J, Cox RM. Recording and Evaluation of an American Dialect Version of the Four Alternative Auditory Feature Test. J Am Acad Audiol. 2014;25:737-45 .	2014	Preparation of material from an existing material. New version.	Four Alternative Auditory Feature Test - FAAF	Foster and Haggard (1987).
27	Zhu S, Wong LLN, Chen F. Development and validation of a new Mandarin tone identification test. Int J Pediatr Otorhinolaryngol. 2014; 78:2174-2182.	2014	Preparation of materials.	Mandarin Tone Identification Test - MTIT	Same authors.
28	Houben R, Koopman J, Luts H, Wagener KC, Wieringen AV, Verschuure H, et al. Development of a Dutch matrix sentence test to assess speech intelligibility in noise. Int J Audiol. 2014; 53: 760-63.	2014	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
29	Dietz A, Buschermöhle M, Aarnisalo AA, Vanhanen A, Hyyrynen T, Aaltonen O, et al. The development and evaluation of the Finnish Matrix Sentence Test for speech intelligibility assessment. Acta Oto-Laryngol. 2014;134:728-37.	2014	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
30	Lauritsen MG, Kreiner S, Soderstrom M, Jens Dorup J, Lous J. A speech reception in noise test for preschool children (the Galker-test): Validity, reliability and acceptance. Int J Pediatr Otorhinolaryngol. 2015;79:1694-701.	2015	Preparation of material from an existing material. New version.	Speech Reception in Noise Test - Galker-test.	This material was prepared in other versions. However, this version was designed by the author mentioned.

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/Studied Instrument	Original test author (when using third party material)
31	Veispak A, Jansen S, Ghesquière P e Wouters J. Speech audiometry in Estonia: Estonian words in noise (EWIN) test. Int J Audiol. 2015;54:573-78.	2015	Preparation of material from an existing material. New version.	Estonian words in noise test (EWIN)	Bosman (1989);
32	Warzybok A, Zokoll M, Wardenga N, Ozimek E, Boboshko M, Kollmeier B. Development of the Russian matrix sentence test. Int J Audiol. 2015; 54:35-43.	2015	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
33	Zokoll MA, Fidan D, Türkyılmaz D, Hochmuth S, Ergenç I, Sennaroğlu G, Kollmeier B.Development and evaluation of the Turkish matrix sentence test. Int J Audiol. 2015; 54:51- 61.	2015	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
34	Puglisi GE, Warzybok A, Hochmuth S, Visentin C, Astolfi A, Prodi N, et al. An Italian matrix sentence test for the evaluation of speech intelligibility in noise. Int J Audiol. 2015; 54:44- 50.	2015	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
35	Wardenga N, Batsoulis C, Wagener KC, Brand T, LenarzT, Maier H. Do you hear the noise? The German matrix sentence test with a fixed noise level in subjects with normal hearing and hearing impairment. Int J Audiol. 2015; 54:71-9.	2015	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982)
36	Myhrum M, Tvete OE, Heldahl MG, Moen I, Soli SD. The Norwegian Hearing in Noise Test for Children. Ear Hear. 2016;37:80-92.	2016	Preparation of material from an existing material.	Matrix Sentence Test	Hagerman B. (1982).
37	D'Alessandro HD, Ballantyne D, Seta ED, Musacchio A, Mancini P. Adaptation of the STARR test for adult Italian population: A speech test for a realistic estimate in real-life listening conditions. Int J Audiol. 2016; 55:262-67.	2016	Preparation of material from an existing material. New version.	STARR test	Cutugno et al. (2000).
38	Potgieter J, Swanepoel DW, Myburgh HC, Hopper TC, Smits C. Development and validation of a smartphone-based digits-in noise hearing test in South African English. Int J Audiol. 2016;55: 405-11.	2016	Preparation of materials.	South African digits-in-noise hearing test.	Same authors.
39	Brungart DS, Walden B, Cord M, Phatak S, Theodoroff SM, Griest S, Grant KW. Development and validation of the Speech Reception in Noise (SPRINT) Test. Hear Res. 2017;349:90-7.	2017	Preparation of material from an existing material. New version.	Speech Reception in Noise Test - SPRINT	Cord, Walden e Atack (1992)

Chart 6 shows the analysis of the articles selected to the Integrative Literature Review on speech in noise tests available for use in the audiological clinic.

Chart 6. Selected articles

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/ Studied Instrument	Original test author (when using third party material)	Material format	Primary test objective	What is the target audience of the material?	Does the material have standardization?	Does the article clarify whether the material is available for use?	Were other versions of the same material found in this data search?	Does the article clarify whether there are adaptations of the material in other languages?	Was an adaptation for Brazilian Portuguese found in this search?
1	23.Bilger RC, Nuetzel JM, Rabinowitz WM. Standardization of a test of speech perception in noise. Journal of Speech and Hearing Research March 1984. Volume 27, 32-48,	1984	Preparation of materials.	Speech Perception in Noise Test (SPIN)	Kalikow DN, Stevens KN e Elliott LL (1977).	The test consists of 50 sentences spoken by a person and a Babble speech noise. The listener is required to repeat the final word, which is always a monosyllabic noun, for each sentence.	To allow a separate assessment of the listener's ability to use acoustic and linguistic information.	People with hearing loss.	Yes	Yes	No	Not specified in the study.	No
2	27. Macleod A, Summerfield Q. A procedure for measuring auditory and audiovisual speech--reception thresholds for sentences in noise: Rationale, evaluation, and recommendations for use. British Journal of Audiology 1990, 24:1, 29-43.	1990	Preparation of materials.	Sentences using auditory and auditory-visual stimulus	Same authors.	The test consists of 10 lists with 15 short sentences each, phonetically balanced and equivalent to each other. A headphone and a computer are used and the sentences are performed with white noise, in an auditory and auditory--visual way.	To evaluate speech recognition through sentences in the presence of noise, using auditory and auditory-visual stimuli.	Adults with and without hearing loss.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
3	32. Keidser G. Computerized Measurement of Speech Intelligibility I.: Development of System and Procedures. Scand Audiol 1991, 20: 147-152.	1991	Preparation of materials.	Four Alternative Forced Choice - 4AFC	Same authors.	The test uses words and sentences in the presence of a speech-spectrum noise. The subject must listen with a headset and then must select the correct answer on the computer (4 answer options are provided).	To evaluate speech recognition through sentences in the presence of noise.	Adults with and without hearing loss.	Yes	Not specified in the study.	No	Not specified in the study.	No
4	11. Nilsson M, Soli SD, Sullivan JA. Development of the Hearing In Noise Test for the measurement of speech reception thresholds in quiet and in noise. J. Acoust. Soc. Am. February 1994, 95 (2).	1994	Preparation of materials.	Hearing In noise Test - HINT	Same authors.	The test uses sentence lists for training and clinical use, and is applied with a speech--spectrum noise.	To measure the intelligibility of sentences in silence and noise.	Adults with and without hearing loss.	Yes	Yes	Yes, six additional versions: Norwegian: Myhrum et al (2015); Danish - Nielsen e Dau (2011); Brazilian: Bevilacqua et al (2008), Canadian: Vaillancourt et al (2005); Cantonese: Wong Soli (2005); Chinese: Wong et al (2007).	Each article reports on their own version based on the original American version of Nilson, Soli and Sullivan (1994). Versions found: Norwegian, Danish, Brazilian, Canadian, Cantonese and Chinese.	Yes
5	28. Costa MJ, Iorio MCM, Mangabeira-Albernaz PL. Reconhecimento de fala: desenvolvimento de uma lista de sentenças em português / Speech recognition: development of a list of sentences in Portuguese. Acta AWHO 1997; 16(4): 164-73.	1997	Preparation of materials.	Portuguese Sentence Lists - LSP	Same authors.	Lists of phonetically balanced sentences are presented with a speech-spectrum noise, with the ascending-descending strategy, which allows determining the speech recognition threshold - SRT.	To evaluate the ability of individuals with hearing disorder to recognize speech in a noisy environment.	Adults with hearing loss.	Yes	Yes	No	Not specified in the study.	Yes

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/ Studied Instrument	Original test author (when using third party material)	Material format	Primary test objective	What is the target audience of the material?	Does the material have standardization?	Does the article clarify whether the material is available for use?	Were other versions of the same material found in this data search?	Does the article clarify whether there are adaptations of the material in other languages?	Was an adaptation for Brazilian Portuguese found in this search?
6	26. Kollmeier B, Wesselkamp M. Development and evaluation of a German sentence test for objective and subjective speech intelligibility assessment. J. Acoust. Soc. Am. October 1997, 102 (4).	1997	Preparation of materials.	German sentence test	Same authors.	The test consists of 20 lists with 10 short sentences each, which are presented with speech Babble noise.	To assist in the assessment of sentence recognition as a clinical practice and in the adaptation of PSAPs;	People with and without hearing loss.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
7	21. Cameron S, Dillon H. Development of the Listening in Spatialized Noise--Sentences Test (LISN--S). EAR & HEARING, April 2007. VOL. 28 NO. 2,	2007	Preparation of material from an existing material. New version - same authors.	Listening in Spatialized Noise – Sentences Test (LiSN-S)	Cameron, Dillon e Newall (2006a).	Sentences applied with a headset in a three-dimensional way. The output levels are directly controlled by the software through an external USB sound card. The sentences are applied with the speech Babble noise.	To evaluate the children's ability to understand speech in the presence of Babble noise.	Children 6 to 11 years old with hearing loss or suspected Central Auditory Processing Disorder.	Yes	Yes	Yes	The authors mention in the article that there is an Australian and American version.	No
8	3. Killion MC, Niquette PA, Gudmundsen GI. Development of a quick speech-in--noise test for measuring signal-to-noise ratio loss in normal-hearing and hearing-impaired listeners. J. Acoust. Soc. Am. October 2004 116 (4), Pt. 1.	2004	Preparation of materials.	Quick speech-in-noise test - QUICK-SIN	Same authors.	Lists of six sentences with five target words per sentence are presented in the presence of the noises of four people talking (Babble noise). The following SNRs are used: 25, 20,15, 10, 5 and 0, covering performance from normal noise to severely impairment.	To provide a quick way for professionals to measure the subject's ability to understand speech in the presence of noise; To assist professionals in choosing the appropriate amplification and other supporting technology; To provide a large number of equivalent test lists for use in clinical and research work;	People with hearing loss.	Yes	Yes	No	Not specified in the study.	No
9	17. Yuen KCP, Pang KW, Tong MCF, Hasselt CSV, Yuan M, Lee T, Soli SD. Development of the computerized Cantonese Disyllabic Lexical Tone Identification Test in Noise (CANDILET--N). Cochlear Implants Int. 2009, 10(S1), 130–137.	2009	Preparation of materials.	CANDILET-N Test	Same authors.	Disyllabic word pairs are used in Cantonese in the presence of speech-spectrum noise and are simultaneously presented. The words differ from each other according to their lexical tone. In 15 pairs, the first syllable of the pairs is equal, but the second syllable is different. The reverse occurs in the other 15 pairs.	To evaluate the speech recognition ability in noise. For clinical use and diagnosis.	People with hearing loss.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
10	31. Yuen KCP, Luan L, Li H, Wei C, Cao K, Yuan M, Lee T, Development of the computerized Mandarin Pediatric Lexical Tone and Disyllabic-word Picture Identification Test in Noise (MAPPID-N). Cochlear Implants Int. 2009, 10(S1), 138-147.	2009	Preparation of materials.	Mandarin Pediatric Lexical Tone and Disyllabic-Word Picture Identification test in Noise (MAPPID-N)	Same authors.	Closed-set computerized test composed of two subtests: 1) The subtest of disyllabic words “DI-WORD” (consisting of three test sets: everyday objects, body parts/clothing items and animals). The software randomly plays the audio of the sets and the pictures are provided on the screen, then children need to click on what they heard. 2) Lexical tone subtest (TONE) (six sets of monosyllable items that differ by lexical tone and have the same phonetic composition, but produce different meanings). The application is performed with the speech--spectrum noise.	To evaluate the speech recognition skills in noise in children who speak Mandarin, through disyllabic words and lexical tones with monosyllables.	Children with hearing loss	Not specified in the study.	In the end, the authors conclude that further studies are required with this material; therefore, it is not available for use.	No	Not specified in the study.	No

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/ Studied Instrument	Original test author (when using third party material)	Material format	Primary test objective	What is the target audience of the material?	Does the material have standardization?	Does the article clarify whether the material is available for use?	Were other versions of the same material found in this data search?	Does the article clarify whether there are adaptations of the material in other languages?	Was an adaptation for Brazilian Portuguese found in this search?
11	30. Kuk F, Lau C, Korhonen P, Crose B, Peeters H, Keenan D. Development of the ORCA Nonsense Syllable Test. Ear & Hearing 2010;31;779–795.	2010	Preparation of materials.	Nonsense Syllable Test - ORCA	Same authors.	115 syllables in female and male voice recording, in the format consonants-vowels--consonants-vowels-consonants were created in an open phoneme identification format. The material is applied in the presence of speech-spectrum noise.	Speech perception test to be used as a tool for bottom-up and quantitative analysis of the effects of signal processing algorithms (especially those that impact high frequencies) in the identification of phonemes.	People with hearing loss.	Yes	Yes	No	Not specified in the study.	No
12	14. Leensen MCJ, Laat JAPM, Dreschler WA. Speech-in-noise screening tests by internet, Part 1: Test evaluation. International Journal of Audiology 2011; 50: 823-834.	2011	Use of third party materials.	National Hearing Test (NHT). Earcheck (EC) and Occupational Earcheck (OEC). Online tests.	National Hearing Test (NHT) - Smits et al (2006). Earcheck (EC) - Albrecht et al (2005), e Occupational Earcheck (OEC) - Ellis et al (2006). Online tests.	The material consists of adaptive online tests of speech in stationary noise. These tests are applied on a computer, with headphones or in the field.	'NHT' test: To measure the ability to understand speech in noise. 'Eartheck (EC)' test: To evaluate difficulties in high frequency. 'Occupational Earcheck' test: To monitor the hearing ability of employees in noisy occupations.	NHT - young people between 12 and 24 years old, in order to raise awareness on the risks of exposure to loud music in this population. 'Occupational Earcheck' test: workers in noisy jobs.	Not specified in the study.	Yes	No	Not specified in the study.	No
13	22.Calandruccio L, Smiljanic R. New Sentence Recognition Materials Developed Using a Basic Non--Native English Lexicon. Journal of Speech, Language, 1342 and Hearing Research. October 2012 Vol. 55, 1342–1355.	2012	Preparation of materials.	Sentence Recognition For English Non-Native Speakers	Same authors.	It includes 25 sentences, with 4 keywords each, which are applied in the presence of noise (white noise).	Sentences based on a basic non-native lexicon to be used to test the speech recognition ability of various hearing people (native and non-native English speakers).	Native and non-native English speaking adults.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
14	10. Hochmuth S, Brand T, Zokoll MA, Castro FZ, Wardenga N, Kollmeier B. A Spanish matrix sentence test for assessing speech reception thresholds in noise. International Journal of Audiology 2012; 51: 536-544.	2012	Preparation of material from an existing material. New version.	Matrix Sentence Test – consisting of a fixed syntactic structure, semantically unpredictable, with low redundancy and a word cannot be predicted based on the context.	This material was prepared in other versions. However, this version was designed by the author mentioned. Original developed by Hagerman (1982).	The material consists of a basic matrix of ten different sentences, but with the same syntactic structure. Each sentence includes a name, verb, number, object and adjective. The sentences are applied in the presence of speech--spectrum noise.	To evaluate the speech recognition ability in the speech-spectrum noise. For clinical use and diagnosis.	Adults with and without hearing loss.	Yes	Yes	Yes - 7 additional versions: Polish: Ozimek, Warzybok, Kutzner (2010); Finnish: Dietz et al (2014); Russian: Warzybok et al (2015); German: Wardenga et al (2015); Dutch: Houben et al (2014); Turkish: Zokoll et al (2015); Italian: Puglisi et al (2015).	Each article reports on their own version based on the original version of Hagerman (1982). Versions of articles found: Spanish, Polish, Finnish, Russian, German, Dutch, Turkish and Italian.	No
15	20. Neumann K, Baumeister N, Baumann U, Sick U, Euler HA, gerber TWB. Speech audiometry in quiet with the Oldenburg Sentence. International Journal of Audiology 2012; 51: 157-163	2012	Use of third party materials.	Oldenburger Kinder-Satztest - OlKiSa	Wagener K., K ü hnel V. e Kollmeier B. 1999.	Sentences formed by noun, adjective and number, which are applied in silence and with background noise. The article does not report the type of noise.	To determine the language comprehension threshold in children from 4 years old.	Children with hearing loss	Yes	Yes	No	Not specified in the study.	No

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/ Studied Instrument	Original test author (when using third party material)	Material format	Primary test objective	What is the target audience of the material?	Does the material have standardization?	Does the article clarify whether the material is available for use?	Were other versions of the same material found in this data search?	Does the article clarify whether there are adaptations of the material in other languages?	Was an adaptation for Brazilian Portuguese found in this search?
16	19. Schafer EC, Pogue J, Milrany T. List Equivalency of the AzBio Sentence Test in Noise for Listeners with Normal-Hearing Sensitivity or Cochlear Implants. J Am Acad Audiol 2012 23:501–509.	2012	Use of third party materials.	AzBio Sentence Test	Spahr et al, 2012	The material consists of 15 sentences with a Babble noise of 10 people speaking.	Set of sentence lists to be used in the assessment of the speech perception ability of people with hearing loss and users of cochlear implants (CI).	People with hearing loss and users of cochlear implants (CI).	Yes	Yes	No	Not specified in the study.	No
17	8. Smits C, Goverts ST e Festen JM. The digits--in-noise test: Assessing auditory speech recognition abilities in noise. J. Acoust. Soc. Am. March 2013 133 (3).	2013	Use of third party materials.	Digits-in-noise test - DIN -	Same authors.	24 triple digits presented in monaural, diotic and dichotic form, with stationary noise and/or modulated noise.	To evaluate the speech recognition ability in noise. For clinical use and diagnosis.	Adults with and without hearing loss.	Yes	Yes	Yes - Smits et al (2016)	Dutch (NL DIN) and American (US DIN) versions.	No
18	25. Gilhert JL, Tamatit TN, Pisoni DB.Development, Reliability, and Validity of PRESTO: A New High--Variability Sentence Recognition Test. J Am Acad Audiol 2013, 24:26-36.	2013	Preparation of materials.	Perceptually Robust English Sentence Test Open-set - PRESTO	Same authors.	Highly variable sentences are presented in the presence of speech Babble noise.	To assist in the evaluation of the recognition of perceptually robust sentences in the presence of speech Babble noise.	People with and without hearing loss.	Yes	Not specified in the study.	No	Not specified in the study.	No
19	13. Xu J, Cox RM. Recording and Evaluation of an American Dialect Version of the Four Alternative Auditory Feature Test. J Am Acad Audiol 2014 25:737-745 .	2014	Preparation of material from an existing material. New version.	Four Alternative Auditory Feature Test - FAAF	Foster and Haggard (1987).	Monosyllabic word test, with 80 keywords along with a consistent carrier sentence. Several types of noise were used: modulated noise, speech-spectrum noise and Babble noise.	To assess the performance of speech recognition in the presence of noise and assist in the use of PSAPs.	People with hearing loss and users of cochlear implants (CI).	Yes	Yes	No	There is the original UK version and the American version.	No
20	18. Zhu S, Wong LLN, Chen F. Development and validation of a new Mandarin tone identification test. International Journal of Pediatric Otorhinolaryngology 2014, 78, 2174–2182.	2014	Preparation of materials.	Mandarin Tone Identification Test - MTIT	Same authors.	Monosyllabic words are presented through pictures, in silence and noise, with different tones. White and speech--spectrum noise were used.	To assess the ability to recognize tones in silence and noise in children with and without hearing loss.	Children with and without hearing loss.	Yes	Not specified in the study.	No	Not specified in the study.	No
21	12. Lauritsen MG, Kreiner S, Soderstrom M, Jens Dorup J, Lous J. A speech reception in noise test for preschool children (the Galker-test): Validity, reliability and acceptance. International Journal of Pediatric Otorhinolaryngology 2015, 79 1694–1701.	2015	Preparation of material from an existing material. New version.	Speech Reception in Noise Test - Galker-test.	This material was prepared in other versions. However, this version was designed by the author mentioned.	Computerized audiovisual image test, which uses mono, bi or trisyllabic words presented by a visible female speaker, allowing reading lips. The words are displayed in a white noise background, with a signal-to-noise ratio of -2 dB.	To evaluate the speech recognition ability in white noise in children.	The material was developed for preschool children from 3 to 6 years old, with suspected hearing loss and difficulty understanding speech in noise.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
22	15. Veispak A, Jansen S, Ghesquière P e Wouters J. Speech audiometry in Estonia: Estonian words in noise (EWIN) test. International Journal of Audiology 2015; 54: 573-578.	2015	Preparation of material from an existing material. New version.	Estonian words in noise test (EWIN)	Bosman (1989);	Lists of monosyllables are presented with a background speech-spectrum noise.	To diagnose hearing loss and quantify speech intelligibility.	People with hearing loss.	Yes	Yes	No	There are the Dutch and Estonian versions.	No

No.	Reference	Year	Article for material elaboration or use of third party material?	Designed/ Studied Instrument	Original test author (when using third party material)	Material format	Primary test objective	What is the target audience of the material?	Does the material have standardization?	Does the article clarify whether the material is available for use?	Were other versions of the same material found in this data search?	Does the article clarify whether there are adaptations of the material in other languages?	Was an adaptation for Brazilian Portuguese found in this search?
23	24. D'Alessandro HD, Ballantyne D, Seta ED, Musacchio A, Mancini P. Adaptation of the STARR test for adult Italian population: A speech test for a realistic estimate in real--life listening conditions. International Journal of Audiology 2016; 55: 262-267.	2016	Preparation of material from an existing material. New version.	STARR test	Cutugno et al. (2000).	The material uses 200 sentences organized in 10 lists with 20 sentences each, which are applied in the presence of speech-spectrum noise.	To assess the performance of speech recognition in the presence of noise and assist in the use of PSAPs.	People with hearing loss who use a Personal Sound Amplification Product	Yes	Yes	No	Yes, in the original format.	Yes
24	29. Potgieter J, Swanepoel DW, Myburgh HC, Hopper TC, Smits C. Development and validation of a smartphone-based digits-innoise hearing test in South African English. International Journal of Audiology 2016, 55: 405-411.	2016	Preparation of materials.	South African digits-in-noise hearing test.	Same authors.	A smartphone application was developed based on South African English, using triple digits in the presence of white noise. Any type of headset can be used.	To provide hearing screening in urban and rural areas for people of different socioeconomic levels.	South Africans with and without hearing loss.	Not specified in the study.	Not specified in the study.	No	Not specified in the study.	No
25	16. Brungart DS, Walden B, Cord M, Phatak S, Theodoroff SM, Griest S, Grant KW. Development and validation of the Speech Reception in Noise (SPRINT) Test. Hearing Research 2017, http://dx.doi.org/10.1016/j.heares.2017.01.008	2017	Preparation of material from an existing material. New version.	Speech Reception in Noise Test - SPRINT	Cord, Walden e Atack (1992)	A list of 200 monosyllabic words is presented with a background noise of six people speaking - Babble noise. The gross score on the SPRINT is the number of words that the patient correctly identified in the list of 200 words.	To evaluate and distinguish the impact of the hearing loss degree in the speech understanding	Members of the U.S. Army with hearing loss.	Yes	Not specified in the study.	No	Not specified in the study.	No

Materials analysis

In total, 39 articles were analyzed. The first of these selected articles was published in 1984, while the most recent was published in 2017. As shown in Chart 6, 25 different materials associated with speech in noise were found. Among these, the materials that had their standardization in different countries were the Sentence Matrix Test (MATRIX), with eight standards found, and the Hearing in Noise Test (HINT), with seven standards found in this study. Among the selected materials, eight use words, 13 use sentences, two use digits, one uses syllables, one uses words and tone, and one uses words and sentences.

As for the type of noise used in the materials, nine materials use the speech-spectrum noise, seven use the speech Babble noise, four use the white noise, one uses two types of noise in the same material (white and speech-spectrum noise), one uses two types of noise in the same material (speech-spectrum and Babble noise), two materials use stationary noise and one article did not specify the type of noise used in the material. Regarding the target audience of the material, seven articles were directed to adults, five to children, 10 to all ages, one material for young people aged 12 to 24 years, one was designed for members of the US army and one for South Africans. Of the 39 articles, 12 were written for people with hearing loss, 11 for people with and without hearing loss and two for people without hearing loss. Of the 25 materials found, 11 were made from other versions[10-21].

The speech in noise intelligibility assessment is crucial for diagnoses of audiology, auditory rehabilitation, room acoustics and the telecommunications industry.[22] Hearing tests that use speech in noise are better than a test that uses only pure tones. As in addition to confirming hearing loss and providing diagnostic and prognostic information, which are not provided by the audiogram, speech in noise tests also provide a direct approach to everyday hearing. [23] In addition, the ability to understand speech in the presence of another sound is one of the most important communication skills. These considerations suggest an accurate assessment of the communication difficulty, so that the clinical treatment of hearing loss is more efficient.[24]

The number of materials that use sentences found in this review is in line with that reported by Cervera, González-Alvarez[2]. As sentences are more representative of real everyday communicative situations than words or syllables, the use of sentences to test speech intelligibility has many benefits over other types of speech stimuli. As for the most reported materials, the search highlight the Matrix Sentence Test with 7 additional versions (Polish,[25] Finnish,[26] Russian,[27] German,[28] Dutch,[29] Turkish[30] and Italian[31]), the Hearing In Noise Test - HINT, with six additional versions (Norwegian,[32] Danish,[33] Brazilian,[34] Canadian,[35] Cantonese[36] and Chinese[37]) and the Digits-in-noise test - DIN, with another version[21]. On the one hand, the HINT uses important daily sentences[38] and, although they are efficient for the diagnosis for having accurate SRT estimates, they also have a high degree of redundancy, thus limiting their use when retesting is required[5]. On the other hand, the Matrix Sentence Test consists of sentences that are semantically unpredictable, so they have low redundancy and a word cannot be predicted based on the context[22]. As for DIN, its new version was designed by the same authors as the original version.[21]

The number of materials in this review that used words was also significant. According to Wilson, McArdle[4], the use of words in the clinical practice assists the professional in directing rehabilitation, as the performance in the speech in noise recognition cannot be predicted by conventional audiometry, only assessed by pure tone thresholds or by the performance in speech recognition in silence.

The Speech-Spectrum was the most reported noise. The spectral and temporal properties of the speech signal assist in diagnosis, in the results of a speech in noise intelligibility tests. Using a noise with the same speech spectrum eliminates the differences between the speech signal and the noise, and allows an intense intelligibility function for the test.[39]

Then the babble noise was the most reported, which is the combination of several people talking, reproducing an environment like a coffee shop. With the use of this type of noise, the assessment approaches the everyday reality of the subjects, ensuring the assessment of communication effectively. [40] As the speech noise is the most found by the subjects, the use of this type of noise makes the assessment closer to reality.[41]

Davis[41] reported that, of 26% of adults who reported hearing difficulties in a noisy environment, only 16% of them had changes in audiometric thresholds. It occurs as noise levels generally bring challenges for listeners in everyday communication

environments, even without hearing loss, so it is necessary to assess this population.

This review also found speech materials designed for children. Hearing loss in children may affect speech, language and psychosocial development and, later, academic performance.[42] While listening to a conversation, the child uses numerous acoustic, linguistic and contextual cues to understand the message. Since all of these factors can hardly be addressed in a test in silence, the development of speech in noise tests directed at children must be a concern of audiologists.[43]

Subjects with the same speech recognition skills in silence can have different results in noisy environments. When the evaluation is conducted in noise, several auditory mechanisms are required to achieve the same level of speech recognition, indicating that more detailed sensory information is necessary in conditions of difficult listening.

Conclusion

All authors indicate the importance of including speech in noise tests in clinical practice. However, there are only two tests in Brazil: HINT, which was designed based on the adaptation of existing material and whose use at the moment is restricted to studies; and the Sentence Recognition List, which has been developed, validated and is available for use. Therefore, it is necessary to develop tests in Brazilian Portuguese for inclusion in clinical practice that will provide numerous benefits for the evaluation and rehabilitation process of children and adults.

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