Editorial Board

Editors

Journal Development Team

Editor-in-Chief

- James F. Lynch, Woods Hole Oceanographic Institution

ASA Publications Staff

- Liz Bury, ASA Publications Senior Managing Editor
- Ambri Phillips, ASA Publications Business Administrator
- Kelly Quigley, *JASA* Manuscript Manager
- Kat Setzer, ASA Publications Editorial Associate

Associate Editors

General Linear Acoustics

- Agnés Maurel, Institut Langevin
- Andi G. Petculescu, University of Louisiana, Lafayette
- Olga Umnova, University of Salford
- Sean F. Wu, Wayne State University

Nonlinear Acoustics

- Michel Destrade, National University of Ireland, Galway

- Lixi Huang, University of Hong Kong

Atmospheric Acoustics and Aeroacoustics

- Philippe Blanc-Benon, Ecole Centrale de Lyon
- Xun Huang, Peking University
- Kai Ming Li, Purdue University
- Vladimir E. Ostashev, University of Colorado Boulder
- Keith Wilson, US Army Engineer Research and Development Center (ERDC)

Underwater Sound

- *Julien Bonnel, Woods Hole Oceanographic Institution<*
- Nicholas P. Chotiros, University of Texas
- John A. Colosi, Naval Postgraduate School (Coordinating Editor, Acoustical Oceanography)
- Stan E. Dosso, University of Victoria
- Timothy F. Duda, Woods Hole Oceanographic Institution
- D. Benjamin Reeder, Naval Postgraduate School
- Stephen P. Robinson, National Physical Laboratory
- William L. Siegmann, Rensselaer Polytechnic Institute (Coordinating Editor, Underwater Acoustics)
- Hee-Chun Song, Scripps Institution of Oceanography
- Aaron M. Thode, Scripps Institution of Oceanography
- Beatrice Tomasi, L@BISEN, ISEN Yncrea Ouest
- Thomas C. Weber, University of New Hampshire
- Jie Yang, University of Washington

Ultrasonics and Physical Acoustics

- Badreddine Assouar, Université de Lorraine
- Michael R. Haberman, University of Texas at Austin
- Mark F. Hamilton, University of Texas at Austin
- Timothy G. Leighton, Institute for Sound and Vibration Research, Southampton
- Julian D. Maynard, Pennsylvania State University
- Roel K. Snieder, Colorado School of Mines
- Martin D. Verweij, Delft University of Technology
- Likun Zhang, University of Mississippi (Coordinating Editor, Physical Acoustics)

Transduction, Acoustical Measurements, Instrumentation, Applied Acoustics

- Mingsian R. Bai, National Tsing Hua University, Taiwan
- Daniel Costley, US Army Engineer Research and Development Center (ERDC; Coordinating Editor, Engineering Acoustics)
- D.D. Ebenezer, Cochin University of Science and Technology, India
- Wonkyu Moon, Pohang University of Science and Technology
- David E. Scarborough, Auburn University
- *Joseph F. Vignola, The Catholic University of America*
- Michael J. White, US Army Engineer Research and Development Center - Construction Engineering Research Laboratory (ERDC-CERL)
- Robert D. White, Tufts University

Structural Acoustics and Vibration

- Li Cheng, Hong Kong Polytechnic University
- Nicole J. Kessissoglou, University of New South Wales (Coordinating Editor, Structural Acoustics and Vibration)
- Laurent Maxit, INSA Lyon
- Marcel C. Remillieux, Los Alamos National Laboratory
- Franck C. Sgard, Quebec Occupational Health and Safety Research Center

Noise: Effects and Control

- Anurag Agarwal, University of Cambridge
- Francesco Aletta, The Bartlett, University College London
- Jordan Cheer, Institute of Sound and Vibration Research, University of Southampton
- Sanford Fidell, Fidell Associates
- Kirill V. Horoshenkov, University of Sheffield (Coordinating Editor, Noise)
- Yun Jing, Pennsylvania State University
- David S. Michaud, Health Canada
- William J. Murphy, National Institute for Occupational Safety and Health
- Alan T. Wall, Air Force Research Laboratory

Architectural Acoustics

- Brian F. G. Katz, Sorbonne Université
- Siu-Kit Lau, National University of Singapore
- Francesco Martellotta, Politecnico di Bari
- Lauri Savioja, Aalto University
- Shiu-Keung Tang, The Hong Kong Polytechnic University
- Michael Vorländer, RWTH Aachen University
- Ning Xiang, Rensselaer Polytechnic Institute (Coordinating Editor, Architectural Acoustics)

Acoustic Signal Processing

- Julien de Rosny, Institut Langevin - CNRS - ESPCI
- Efren Fernandez-Grande, Technical University of Denmark
- Peter Gerstoft, University of California, San Diego (Coordinating Editor, Signal Processing in Acoustics)
- Jianlong Li, Zhejiang University
- Zoi-Heleni Michalopoulou, New Jersey Institute of Technology
- Haiqiang Niu, Chinese Academy of Sciences
- Karim G. Sabra, Georgia Institute of Technology

Physiological Acoustics

- Hari M. Bharadwaj, Purdue University
- Bastian Epp, Technical University of Denmark
- Philip X. Joris, KU Leuven
- Colleen G. Le Prell, University of Texas at Dallas
- H. Heidi Nakajima, Harvard University
- Sunil Puria, Harvard University
- Christopher A. Shera, University of Southern California
- G. Christopher Stecker, Vanderbilt University (Coordinating Editor, Psychological and Physiological Acoustics)
- Sarah Verhulst, Ghent University

Psychological Acoustics

- Joshua G. W. Bernstein, Walter Reed National Military Medical Center
- Leslie R. Bernstein, University of Connecticut Health Center
- Jonas Braasch, Rensselaer Polytechnic Institute
- Emily Buss, University of North Carolina at Chapel Hill
- Matthew J. Goupell, University of Maryland - College Park
- Karen S. Helfer, University of Massachusetts Amherst
- Laurie M. Heller, Carnegie Mellon University
- Christian Lorenzi, Ecole normale superieure, Université Paris Sciences & Lettres

Speech Production

- Susanne Fuchs, Leibniz-Centre General Linguistics
- Ewa Jacewicz, Ohio State University
- Jianjing Kuang, University of Pennsylvania
- Anders Lofqvist, Lund University
- Zhaoyan Zhang, University of California, Los Angeles (Coordinating Editor, Speech Communication)

Speech Perception

- Melissa M. Baese-Berk, University of Oregon
- Deniz Başkent, University Medical Center, Groningen
- Jody Kreiman, University of California, Los Angeles
- Megha Sundara, University of California, Los Angeles
- Benjamin V. Tucker, University of Alberta

Speech Processing

- Paavo Alku, Aalto University
- John H. L. Hansen, University of Texas at Dallas
- B. Yegnanarayana, International Institute of Information Technology, Hyderabad

Musical Acoustics

- Psyche Loui, Northeastern University
- Thomas R. Moore, Rollins College (Coordinating Editor, Musical Acoustics)
- Andrew Morrison, Joliet Junior College
- Tamara Smyth, University of California, San Diego

Biomedical Acoustics

- Charles C. Church, University of Mississippi
- Libertario Demi, University of Trento
- Guillaume Haïat, National Center for Scientific Research (CNRS)
- Julien Meaud, Georgia Institute of Technology
- Tyrone M. Porter, University of Texas at Austin, (Coordinating Editor, Biomedical Acoustics)
- Bradley E. Treeby, University College London
- Juan Tu, Nanjing University
- Keith A. Wear, Food and Drug Administration
- Yuk Wang Yoon, Sungkyunkwan University

- Xiaoming Zhang, Mayo Clinic

Animal Bioacoustics

- Mark A. Bee, University of Minnesota
- Brian Branstetter, National Marine Mammal Foundation
- Robert J. Dooling, University of Maryland
- Rebecca A. Dunlop, University of Queensland
- Darlene R. Ketten, Woods Hole Oceanographic Institution
- Klaus Lucke, JASCO Applied Sciences
- Arthur N. Popper, University of Maryland (Coordinating Editor, Animal Bioacoustics)
- Colleen Reichmuth, University of California, Santa Cruz
- Joseph A. Sisneros, University of Washington
- Kathleen J. Vigness-Raposa, INSPIRE Environmental

Computational Acoustics

- John B. Fahnline, Pennsylvania State University
- Nail A. Gumerov, University of Maryland
- Ying-Tsong Lin, Woods Hole Oceanographic Institution
- Steffen Marburg, Technical University of Munich
- Assad Oberai, University of Southern California
- Nickolas Vlahopoulos, University of Michigan
- Kuangcheng Wu, Naval Surface Warfare Center-Carderock (Coordinating Editor, Computational Acoustics)

Education in Acoustics

- Victor W. Sparrow, Pennsylvania State University
- Preston S. Wilson, University of Texas at Austin

Reviews and Tutorials

- James F. Lynch, Woods Hole Oceanographic Institution

Forum and Acoustical Notes

- James F. Lynch, Woods Hole Oceanographic Institution

Acoustical News

- Elaine Moran, Acoustical Society of America

Book Reviews

- Philip L. Marston, Washington State University

Patent Reviews

- Sean A. Fulop, California State University, Fresno

ASA Publications' Engagement Advisory Board

- Sarabeth Mullins, Sorbonne Université, CNRS (chair)
- Colby W. Cushing, Applied Research Laboratories, University of Texas at Austin
- Kent L. Gee, Brigham Young University
- Kathi Mestayer, Hearing Loss Association of America
- Andrew Morrison, Joliet Junior College
- Edward Richards, University of California Santa Cruz
- Prakaiwan Vajrabhaya, Rakuten Mobile, Inc.

General Information

ABOUT

CONTACT

HELP

PRIVACY POLICY

TERMS OF USE

FOLLOW AIP PUBLISHING:

Table of Contents

Volume 146,

ISSUE 4

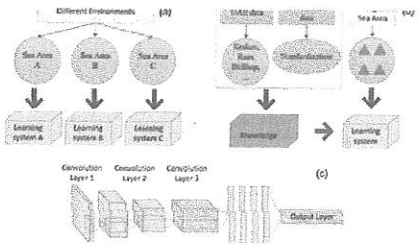
October 2019

< PREV NEXT >

Filter By Section

DISPLAY: 20 50 100 all

JASA EXPRESS LETTERS



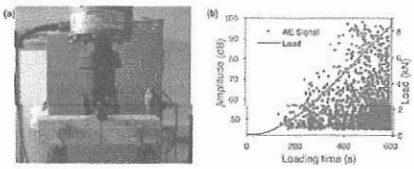
Open . October 2019

Deep transfer learning for source ranging: Deep-sea experiment results

Wenbo Wang, Haiyan Ni, Lin Su, Tao Hu, Qunyan Ren, Peter Gerstoft and Li Ma

The Journal of the Acoustical Society of America 146, EL317 (2019); https://doi.org/10.1121/1.5126923

SHOW ABSTRACT



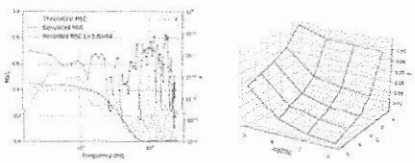
Open . October 2019

Passive monitoring of nonlinear relaxation of cracked polymer concrete samples using acoustic emission

Xiaoyang Yu, Mourad Bentahar, Charfeddine Mechri and Silvio Montrésor

The Journal of the Acoustical Society of America 146, EL323 (2019); https://doi.org/10.1121/1.5127519

SHOW ABSTRACT



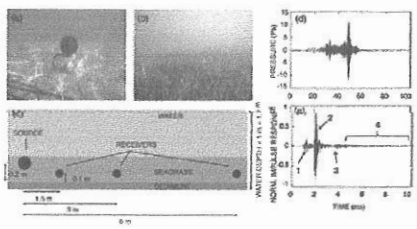
Open . October 2019

Analysis of spherical isotropic noise fields with an A-Format tetrahedral microphone

Andres Perez-Lopez and Nikolaos Stefanakis

The Journal of the Acoustical Society of America 146, EL329 (2019); https://doi.org/10.1121/1.5127736

SHOW ABSTRACT



Open . October 2019

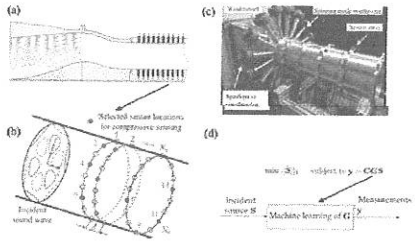
Broadband sound propagation in a seagrass meadow throughout a diurnal cycle

Kevin M. Lee, Megan S. Ballard, Gabriel R. Venegas, Jason D. Sagers, Andrew R. McNeese, Jay R. Johnson, Preston S. Wilson and Abdullah F. Rahman

BROWSE VOLUMES

The Journal of the Acoustical Society of America 146, EL335 (2019); https://doi.org/10.1121/1.5127737

SHOW ABSTRACT



Open . October 2019

A tutorial example of duct acoustics mode detections with machine-learning-based compressive sensing

Xun Huang

The Journal of the Acoustical Society of America 146, EL342 (2019); https://doi.org/10.1121/1.5128399

SHOW ABSTRACT

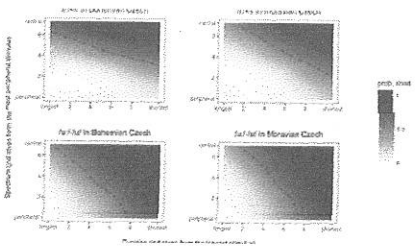
Open . October 2019

Calculation of acoustic radiation modes by using spherical waves and generalized singular value decomposition

Jiawei Liu, Yangfan Liu and J. Stuart Bolton

The Journal of the Acoustical Society of America 146, EL347 (2019); https://doi.org/10.1121/1.5128139

SHOW ABSTRACT



Open . October 2019

Spectrum as a perceptual cue to vowel length in Czech, a quantity language

Václav Jonáš Podlipský, Kateřina Chládková and Šárka Šimáčková

BROWSE VOLUMES

SHOW ABSTRACT

Free . October 2019

Validation of the whisper test modified by distance as a screening test of hearing impairment for young adults

Nyilo Purnami, HMS Wiyadi, Rosa Falerina, Ainun Nadiroh, Dhany Arifianto and Puguh S. Nugroho

The Journal of the Acoustical Society of America 146, 2834 (2019); https://doi.org/10.1121/1.5136824

SHOW ABSTRACT

Free . October 2019

The multisensory benefit of informative sound in visual task performance

Alexandra L. Bruder, Judy Edworthy, Joseph Schlesinger and Clayton Rothwell

The Journal of the Acoustical Society of America 146, 2834 (2019); https://doi.org/10.1121/1.5136825

SHOW ABSTRACT

Free . October 2019

A study on the ASMR effect of reed wind sound

Ik-Soo Ann and Myungjin Bae

The Journal of the Acoustical Society of America 146, 2834 (2019); https://doi.org/10.1121/1.5136826

SHOW ABSTRACT

Free . October 2019

Autism?

Robert H. Cameron

The Journal of the Acoustical Society of America 146, 2835 (2019); https://doi.org/10.1121/1.5136827

SHOW ABSTRACT

BROWSE VOLUMES

Proceedings of Meetings on Acoustics

Volume 39 http://acousticalsociety.org/

178th Meeting of the Acoustical Society of America

San Diego, California

2-6 December 2019

Psychological and Physiological Acoustics: Paper 2aPP18

Validation of the whisper test by distance as a screening test of hearing impairment for young adults

Nyilo Purnami, Manshur Shidiq Wiyadi, Rosa Falerina and Puguh Setyo Nugroho
Department of Otorhinolaryngology Head and Neck Surgery, Airlangga University Faculty of Medicine: Universitas Airlangga Fakultas Kedokteran, Surabaya, East Java, 60231, INDONESIA; nyilo@fk.unair.ac.id; wiyadi@fk.unair.ac.id; rosafalerina husain@yahoo.com; puguh-s-n@fk.unair.ac.id

Ainun Nadiroh
Department of Engineering Physics, Sepuluh Nopember Institute of Technology Faculty of Industrial Technology and Systems Engineering: Institut Teknologi Sepuluh Nopember Fakultas Teknologi Industri dan Rekayasa SistemSurabaya, East Java, 60111, INDONESIA; ainun12@mhs.ep.its.ac.id

Dhany Arifianto
Department of Engineering Physics, Institut Teknologi Sepuluh Nopember, Surabaya, East Java, 60111, INDONESIA; dhany@ep.its.ac.id

Pure-tone audiometry as a gold standard is difficult to do in several places in Indonesia due to problems related to access, referral systems, and costs. Therefore, the examiner relies on the whisper test as a screening test. In this study, we evaluated the method of the whisper test by modifying the distance in order to make the procedure practical, simple and easy to perform in a smaller room with large groups. A cross-sectional study between the modified whisper test and the reference test (pure-tone audiometry) was conducted on 618 selected participants. Based on diagnostic and screening test evaluation, it was known that sensitivity and specificity of the modified-distance whispered voice test were 13.43% and 99.27%, respectively. While the test yielded high PPV (69.23%) and NPV (90.41%) for a screening test. The likelihood ratio results were 18.50 for positive and 0.87 for negative. The other parameter results were 21.22 (DOR), 89.97% (diagnostic effectiveness), 10.03% (misclassification rate), and 0.13 (Youden's Index). This hearing screening method will help identify more hearing impairments for a considerable population, helping in referral planning.

Published by the Acoustical Society of America

 https://doi.org/10.1121/2.0001522

INTRODUCTION

According to recent World Health Organization (WHO) data, disabling hearing loss has increased worldwide with approximately 466 million people, over 5% of the world's population affected. It is estimated that by 2050 over 900 million people or one in every ten people will have disabling hearing loss [1]. More than 9 million Indonesians are estimated to be among them, with an average of 150,000 cases each year in the country [2]. Hearing loss can have negative impacts on the social and emotional functioning of an individual if not detected and treated well [3] [4]. Based on national health guidelines, pure-tone audiometry is a gold-standard method used to assess the degree of hearing impairment, which is determined based on the average value of the hearing threshold across a specified frequency range (Pure Tone Averages) [5]. However, this method is challenging to do in several places in Indonesia due to problems of access, referral systems, and costs. Therefore, many audiology societies suggested using whispered voice tests for hearing impairment screening as an integral part of overall health assessment [6]. Moreover, the test is the best alternative screening method because it is quite fast and simple to do. This method is not only non-invasive, but comfortable to both children and adults, as well [7] [8].

The conventional whispered voice test is typically carried out in a quiet room (about 40 dB_A or below) where the whispered voice (using residual air) is conducted with a distance of 12 feet between the trained ENT doctor (henceforth, the examiner) and patients [9]. Several studies also demonstrate that the whispered voice test is reliable up to 3 m (about 10 feet), using a method where the distance was reduced stepwise ifthe patients failed to respond, until a response was obtained [10] [11]. However, often the examination rooms are smaller than 12-feet in length [9], therefore, this paper proposed a distance reduction from the examiner to the patient to two feet. Theproposed method was validated for use in screening hearing loss in elementary school children [12]. This study aimed to evaluate the performance of the modified-distance whispered voice test to screen young adults' (freshman college students) hearing sensitivity level.

METHODS

A cross-sectional study was used to evaluate the hearing ability of participants who were freshman college students. The research was conducted in two adjacent examination rooms by five of our staff members. The first room was used to perform the first step of ear examination consisting of otoscopy and a modified-distance whispered voice test. In the other room, pure tone audiometric air conduction test using a clinical audiometer (GRASON STADLER, GSI Arrow Clinical Audiometer, VIASYS Healthcare Inc., 3B Audiometer) was conducted to obtain an audiogram at frequencies between 250 and 8000 Hz for each ear.

A. PARTICIPANTS

The recruited subjects were 618 freshman student volunteers (male = 179, female = 439) from various departments. The participants were aged 16 - 45 years (M = 18.3; SD = 2.31) and were Indonesian native speakers enrolled in Universitas Airlangga, Surabaya. This group of students was chosen as they were felt to represent young adults. Participants underwent an audiological evaluation between April – September 2018 and agreed to be a part of the study by signing an informed consent form.

B. MEASUREMENTS

The modified-distance whispered voice test was conducted in a small examination room with an average background noise level of 45.99 dB_A (range 42.72 – 48.98 dB_A). We measured the room reverberation time to ensure that the whisper did not echo. The examiner sat behind the participant at a distance of 2 feet from the participant (see Figure 1). Tragal Rubbing in the non-test ear was used as masking and each ear was tested separately. Whisper was delivered by positioning their mouth in line with non-test ear. The examiner whispered ten words randomly selected from the Indonesian bisyllabic word list (see Table 1) [13]. The words in the list are common usage words in daily conversation and easily understood by normal native Indonesians 7 years or older. The participant was asked to repeat every word clearly and loudly, after the examiner uttered one word. If the participant correctly repeated 80% or more of whispered words, then the trial was a pass. During the trial, the whisper level (dB_A) of the examiners was measured in order to maintain consistency in the sound pressure level (dBA) of the examiners. The sound level meter (ONOSOKKI, Sound Level Meter Class 1, Ono Sokki Technology, Inc., LA-7500) was positioned next to the examiner's mouth at a distance of

30 cm. The modified-distance whispered voice test itself took about four to five minutes to examine both ears. This was about a one-third time reduction compared to the conventional audiometry, excluding the preparation time.

Figure 1. Staff conducted the modified-distance whispered voice test on a participant in an examination room at Universitas Airlangga Hospital.

Table 1. Indonesian bisyllabic word list [13].

MATA	KUDA	PIRING	BAKMI	RAMBUT
PINTU	MALAM	KAPAL	KACA	KURSI
RUMAH	TIKUS	BULAN	DINDING	SAMA
SUSU	LAMPU	GARAM	BANGKU	PIPA
SAPI	GIGI	SAPU	MINUM	GULA
MEJA	BAWANG	IBU	SAWAH	HIDUNG
KAKI	ROTI	SENDOK	SUSAH	BECAK
MAKAN	SUKAR	BUKU	PAPA	ORANG
GORENG	BASAH	SIKAT	KUE	APA
BABI	MERAH	BAWAH	SODA	LIDAH
KAPAL	SAPI	KURSI	BAWANG	RODA
SIKAT	MEJA	LIDAH	KUDA	BANGKU
SENDOK	RUMAH	SAMA	MERAH	KACA
BUKU	KAKI	RAMBUT	GIGI	MINUM
NAMA	GORENG	BECAK	MALAM	PAPAN
PIRING	SUSU	APA	TIKUS	DINDING
BULAN	PINTU	GULA	LAMPU	BAKMI
IBU	BABI	ORANG	SUKAR	SAWAH
GARAM	MATA	PAPA	ROTI	KUE
SAPU	MAKAN	HIDUNG	BASAH	SUSAH

C. VALIDITY

To confirm the presence and absence of hearing loss, a diagnosis test from 2 × 2 contingency tables was used in this study. It was used to evaluate the comparative diagnostic accuracy and feasibility of the modified-distance whispered voice test in comparison to the gold standard (puretone audiometry). In other words, this part was conducted to observe how the modified-distance whispered voice test recognized the distinction between participants with normal hearing and hearing loss. It could be measured by calculating the sensitivity and specificity, the positive and negative predicative values (PPV, NPV), the positive and negative likelihood ratios, the diagnostic odds ratio (DOR), the diagnostic accuracy & misclassification rate and the Youden's index [14]. Participants were assigned to four groups, namely, when participants passed both the modified-distance whispered voice test and audiometry (True Negative - TN), when participants passed the modified-distance whispered voice test and failed audiometry (False Negative - FN), when participants failed both the modified-distance whispered voice test and audiometry (True Positive - TP), and when participants did not pass the modified-distance whispered voice test but passed audiometry (False Positive - FP) (see Table 2).

Table 2. Evaluation of the modified-distance whispered voice test in relation to the gold standard.

		Puretone Audiometry		**Total**
		Participant with Hearing Loss	Participant with Normal Hearing	
Modified-distance Whispered Voice Test	Positive	TP	FP	TP + FP
	Negative	FN	TN	FN + TN
	Total	TP + FN	FP + TN	TP + TN + FP + FN

RESULTS

A. GENERAL CHARACTERISTICS OF THE STUDY PARTICIPANTS

General characteristics of participants undergoing the gold standard test and the modified-distance whispered voice test are depicted in Table 3. From the modified-distance whispered voice test, it can be seen that 605 participants had normal hearing (97.9%), 12 participants had a unilateral hearing impairment, and the others had a bilateral hearing impairment (0.2%). It is also known from the audiometry test results that 551 participants did not have a hearing impairment (89.2%), 55 participants had a unilateral hearing impairment (8.9%), and 12 participants had a bilateral hearing impairment (1.9%).

Table 3. General characteristics of the study participants (n = 618).

	Characteristics	**Data (n)**	**Percentage (%)**
Modified Whispered Voice Test	Normal	605	97.9
	Unilateral	12	1.9
	Bilateral	1	0.2
	Total	**618**	**100.0**
Hearing Impairment (Audiometry Result)	Normal	551	89.2
	Unilateral	55	8.9
	Bilateral	12	1.9
	Total	**618**	**100.0**

Aside from the gold standard test and the proposed technique, physical ear examinations were also conducted (see Table 4). A total of 519 participants did not have cerumen (84.0%), 42 participants had

cerumen in both ears (6.8%), and the others had cerumen in only one ear (9.2%). Moreover, 616 participants did not have otitis media (99.7%), and two participants had unilateral otitis media (0.3%). No participants in this study had bilateral otitis media. Medical records indicated that 40 participants had a medical history (6.5%) while 578 participants (93.5%) had no medical history. This was necessary for further validation of the results of both tests.

Table 4. Physical ear examination's result of the study participants (n = 618).

	Characteristics	Data (n)	Percentage (%)
Cerumen	Normal	519	84.0
	Unilateral	57	9.2
	Bilateral	42	6.8
	Total	**618**	**100.0**
Otitis Media	Normal	616	99.7
	Unilateral	2	0.3
	Bilateral	0	0.0
	Total	**618**	**100.0**
Medical History	Yes	40	6.5
	No	578	93.5
	Total	**618**	**100.0**

B. SOUND PRESSURE LEVEL

Figure 2 shows the results of the average whisper level of the examiners (dBA) during the trial. The individual differences in sound pressure level were identical with levels less than 3 dBA, respectively. Within digit variability across the examiners was similar, at 1 – 2 dBA. Note that a change in sound level of 3 dB is just perceptible to the normal ear. It means the participants generally had received a similar level of whispers.

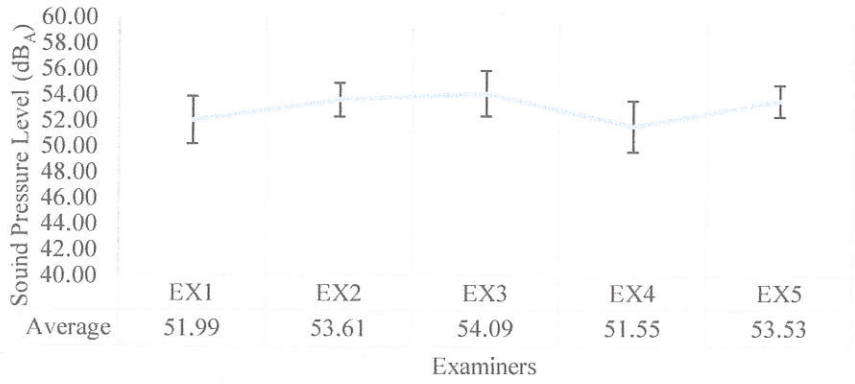


Figure 2. Average sound pressure level (dB_A) across the five examiners showing ± 2 SD.

C. SCREENING TEST EVALUATION

Relationship between the modified-distance whispered voice test and gold standard and parameters of the diagnostic test were shown in Table 5 and 6. The sensitivity and specificity of the modified-distance whispered voice test had been calculated, which had values of 13.43% and 99.27%, respectively. Sensitivity of 13.43% shows that the modified-distance whispered voice test correctly identified 9 participants out of 605 who have the hearing loss. Specificity of 99.27% refers to the ability of the modified-distance whispered voice test to

correctly identify participants who have normal hearing (do not have hearing problems). While, positive predictive value of 69.23% refers to the proportion that a positive test result indicates the presence of the hearing loss. Negative predictive value of 90.41% refers to the proportion that a negative test result indicates the absence of the hearing loss. The positive likelihood ratio of the modified-distance whispered voice test 18.50 indicates that with a positive result a participant is 18.50 times more likely to be truly positive than negative, as determined by the gold standard. The negative likelihood ratio of 0.87 indicates that with a negative result a participant is 0.13 times as likely to be positive than negative, as determined by the gold standard. Diagnostic odds ratio of 21.22 for the modified-distance whispered voice test indicates that, the odds for positivity among participants with disease (hearing loss) is 21.22 times higher than the odds of positivity among the participants without disease (hearing loss). The diagnostic accuracy, misclassification rate and the Youden's index which was used to assess the predictive ability of the ability of the modified-distance whispered voice test had values of 89.97%, 10.03%, and 0.13, respectively. The diagnostic effectiveness (accuracy) 89.97% of the modified-distance whispered voice test is expressed as the proportion of participants correctly categorized by this test, in relation to gold standard. The compliment of diagnostic accuracy (misclassification rate) 10.03% shows a proportion of participants, who were incorrectly classified by this test, in relation to the gold standard. The Youndex's index of 0.13 is another measure of the diagnostic accuracy of the modified-distance whispered voice test.

Table 5. Results of the relationship between the modified-distance whispered voice test and gold standard.

			TRUE CONDITION	
			Puretone Audiometry	**Total**
			Participant with Hearing Loss	Participant with Normal Hearing	
PRED. CONDITION	**Modified-distance Whispered Voice Test**	Positive	9	4	13
		Negative	58	547	605
		Total	67	551	618

Table 6. The calculated values of diagnostic test parameters

Parameters	**Value**	
Sensitivity (true positive rate) = TP/TP+FN	0.13	13.43%
Specificity (true negative rate) = TN/TN+FP	0.99	99.27%
Positive predictive value (PPV) = TP/TP+FP	0.69	69.23%*
Negative predictive value (NPV) = TN/FN+TN	0.90	90.41%*
Likelihood ratio for positive test (LR+)	18.50	
Likelihood ratio for negative test (LR-)	0.87	
Diagnostic Odds Ratio (DOR)	21.22	
Diagnostic effectiveness (Accuracy)*	89.97%	
Misclassification Rate	10.03%	
Youden's Index	0.13	

(*) These values were dependent on disease prevalence of 10.84%

DISCUSSION AND CONCLUSION

The results of the modified-distance whispered voice test show that 13 students had hearing loss. This result was lower than the audiometry test result indicates that 67 students had hearing loss (see Table 3). The results of physical ear examination also show that not many participants had any inflammation of the middle air (see Table 4) that might be explained then contribute the different results of hearing loss presence of both tests. So, the environmental noise condition during the test might be the reason why the value is different. Pure-tone audiometry requires a quiet testing environment with low levels of background noise [15], which in this reference, the background noise level is 35 dB_A. In this study, the modified-distance whispered voice test was conducted at a noise level that higher than the audiometry test, namely with an average of 45,99 dB_A. The previous study explained in order to be heard above the noise level; we must raise the intensity of the voice above that level that also applied in a whispered voice [16]. In this case, then, the noise level might be giving an impact on the resulting test, but it does not mean the modified-distance whispered voice test is not suitable for an alternative hearing screening method.

Therefore, to demonstrate the performance of the modified-distance whispered voice test, statistical analysis with 2×2 contingency tables was done to validate the method with the pure-tone audiometry test as a reference method. The purpose of the examinations was to assess the test validity of the modified whisper test relative to performance on the gold standard. The results present that the sensitivity and specificity of the modified-distance whispered voice test were 13.43% and 99.27%, respectively. Based on the previous study [6] [7] [8] [11] [17], a highly sensitive test is useful which in these cases people do not want to miss a disease in the early phase of diagnostic workup and in screening the population for the target disorder [14]. However, for this study, the presence of hearing loss was expected to occur in small quantities. Therefore, a sensitive test is most convenient if it is negative. Whereas to spot the proportion of participants who do not have hearing loss that is the true negatives, a specific test was used and its result of 99.24% was expressed as the proportion of correctly classified as true negatives among the total normal hearing. A highly specific test is useful if false positives are nil or rare and to confirm a diagnosis that the condition fits with this study (see Table 5).

For predictive values both positive and negative, the PPV and NPV were used as tools to know how the modified-distance whispered voice test is doing since in actual condition we do the new test first and we do not have results of the gold standard available. When the screening test in this study has a high PPV, there is a high chance that a participant has the hearing loss being investigated when the participant has a positive test. While, when the test has a high NPV, there is a high chance that a participant does not have hearing loss being investigated when the participant has a negative test [18]. In this study, the PPV was 69.23%, and the NPV was 90.41%, according to the results of the modified-distance whispered voice test among 618 participants (Table 6). The results of predictive values depend on the prevalence of the disease in the population. If the prevalence of the disease is high in a given population, PPV increases and NPV decreases. Thus, the results of predictive values are not fixed characteristics of this new proposed test [19].

Based on the likelihood ratio results, the modified distance whisper speech test seems to be an ideal hearing screening fair method [20]. The positive likelihood ratio (LR [+]) indicates a higher probability of correctly identifying individuals with hearing loss. The higher value of LR [+] means more likelihood of someone suffering from the disease, which in this case, is patients with hearing loss (the possibility of a valuable correct diagnosis is more). A good diagnostic test has a LR (+) value greater than 10, so the chance of proper diagnosis is even higher. The negative likelihood ratio (LR [-]) is usually small because the prevalence of hearing loss is lower than that of normal hearing, and the value of LR [-] is small indicates better test results.

The DOR can be read as the ratio of the odds of hearing loss in test positives relative to the odds of hearing in test negatives. The higher value of DOR indicates better discriminatory test performance [21]. From Table 6, it can be seen that the modified-distance whispered voice test discriminates between participants with hearing loss and those without it. The values of diagnostic effectiveness (accuracy) and misclassification rate also interprate the modified-distance whispered voice test as a good screening test. While for a test with poor diagnostic accuracy, Youden's index equals 0, and in a perfect test Youden's index equals 1. Nevertheless, Youden's index is not sensitive for differences in the sensitivity and specificity of the test, which is its main disadvantage [22].

In addition, the reliability of the modified whisper test was also initially measured in this study (see Figure 2). The result is consistent with a previous study [6], which said that standardization of reproducibility of the whispered voice test was a concern for further research. A study published by Oxford University Press reported that the whisper test was good for an experienced examiner but not for an inexperienced examiner due

to the probability of whispering being too quiet. The study also indicated that the loudness of the examiners had to be standardized [23]. Thus, for this research, even though the deviation level and sound pressure level of each examiner were measured through this study, it is necessary to observe the advanced statistical calculation of the result in order to evaluate the standardization of the new proposed test.

In summary, in this study, we had the advantage of getting research data in a short time to determine the prevalence of hearing loss in a specific place. Therefore, further research needs to be done to determine the relationship between several related factors and how they affect the modified-distance whispered voice test. Finally, the modified-distance whispered voice test can be further improved to obtain a better hearing screening method that is standardized.

ACKNOWLEDGMENTS

This study was a part of the internal research program "Penelitian Unggulan Fakultas 2019," funded by Universitas Airlangga, Surabaya, Indonesia. Dhany Arifianto was funded in part by Kemenristek DIKTI PPUPT 2018 – 2020 research grant.

REFERENCES

[1] WHO, "Newsroom: Deafness and hearing loss," World Health Organization, 20 March 2019. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss. [Accessed 05 October 2019].

[2] C. Mathers, A. Smith and M. Concha, "Global burden of hearing loss in the year 2000," World Health Organization, Geneva, 2000.

[3] M. I. Wallhagen, W. J. Strawbridge, S. J. Shema, J. Kurata and G. A. Kaplan, "Comparative impact of hearing and vision impairment on subsequent functioning," *J Am Geriatr Soc,* vol. 49, pp. 1086-92, 2001.

[4] W. J. Strawbridge, M. I. Wallhagen, S. J. Shema and G. A. Kaplan, "Negative consequences of hearing impairment in old age: a longitudinal analysis," *Gerontologist,* vol. 40, pp. 320-6, 2000.

[5] "Recommended procedures for pure-tone audiometry using a manually operated instrument," *Br J Audiol,* vol. 15, no. 3, pp. 213-6, 1981.

[6] S. Pirozzo, T. Papinczak and P. Glasziou, "Whispered voice test for screening for hearing impairment in adults and children: systematic review," *BMJ,* vol. 327, pp. 1-5, 2003.

[7] J. A. Eekhof, G. H. de Bock, J. A. de Laat, R. Dap, R. Schaapveld and M. P. Springer, "The whispered voice: the best test for screening for hearing impairment?," *Br J Gen Pract,* vol. 46, no. 409, pp. 473-4, 1996.

[8] G. J. Macphee, J. A. Crowther and C. H. McAlpine, "A simple screening test for hearing impairment in elderly patients," *Age Ageing,* vol. 17, no. 5, pp. 347-51, 1988.

[9] M. Maqbool and S. Maqbool, Textbook of ear, nose and throat diseases, eleventh ed., New Delhi: Jaypee Brothers Medical Publishers (P) Ltd., 2007.

[10] J. J. Groen, "Pure tone audiometry and whispered voice test," *ORL,* vol. 35, pp. 65-70, 1973.

[11] R. F. Uhlmann, T. S. Rees, B. M. Psaty and L. G. Duckert, "Validity and reliability of auditory screening tests in demented and non-demented older adults," *J Gen Intern Med,* vol. 4, pp. 90-6, 1989.

[12] N. Purnami, "The modified whispered test for screening of hearing impairment in children at the elementary school," in *Regional Conference on Acoustics and Vibration 2017*, Bali, 2018.

[13] H. Soewito, "Penyusunan kata dan pembakuannya sebagai bahan tes bisik untuk anak sekolah," Universitas Gadjah Mada, Yogyakarta, 1984.

[14] S. A. Shaikh, "Measures derived from a 2 x 2 table for an accuracy of a diagnostic test," *J Biomet Biostat,* vol. 2, no. 5, pp. 1-4, 2011.

[15] T. Frank, J. D. Durrant and J. M. Lovrinic, "Maximum permissible ambient noise levels for audiometric test rooms," *AJA,* pp. 33-7, 1993.

[16] "The value of conversation and whispering tests. details," *Acta Otolaryngol,* vol. 27, pp. 51-69, 1939.

[17] I. R. Swan and G. G. Browning, "The whispered voice as a screening test for hearing impairment," *J R Coll Gen Pract,* vol. 35, no. 273, p. 197, 1985.

[18] W. W. LaMorte, "Screening for disease: Positive and negative predictive value," Boston University School of Public Health, 5 July 2020. [Online]. Available: https://sphweb.bumc.bu.edu/otlt/MPH-Modules/EP/EP713_Screening/EP713_Screening5.html. [Accessed 1 September 2021].

[19] R. Parikh, A. Mathai, S. Parikh, G. C. Sekhar and R. Thomas, "Understanding and using sensitivity, specifi city and predictive values," *Indian J Ophthalmol,* vol. 56, no. 1, pp. 45-50, 2008.

[20] A. K. Akobeng, "Understanding diagnostic tests 1: sensitivity, specificity and predictive values," *Acta Paediatr,* vol. 96, no. 3, pp. 338-41, 2007.

[21] H. C. Kraemer, Risk ratios, odds ratio, and the test QROC. In: Evaluating medical test, Newbury Park, CA: SAGE Publications, Inc., 1992.

[22] M. Bovbjerg, "Foundations of epidemology: Screening and diagnostic testing," Oregon State University, [Online]. Available: https://open.oregonstate.education/epidemiology/chapter/screening-and-diagnostic-testing/. [Accessed 1 September 2021].

[23] F. Dick, "The whisper test and speech recognition tests," *Occup Med,* vol. 68, pp. 488-489, 2018.

Source details

Journal of the Acoustical Society of America

Scopus coverage years: from 1929 to 2021

Publisher: Acoustical Society of America

ISSN: 0001-4966 E-ISSN: 1520-8524

Subject area: Arts and Humanities: Arts and Humanities (miscellaneous) Physics and Astronomy: Acoustics and Ultrasonics

Source type: Journal

CiteScore 2020
3.3

SJR 2020
0.619

SNIP 2020
1.107

View all documents > Set document alert Save to source list Source Homepage

CiteScore CiteScore rank & trend Scopus content coverage

Improved CiteScore methodology

CiteScore 2020 counts the citations received in 2017-2020 to articles, reviews, conference papers, book chapters and data papers published in 2017-2020, and divides this by the number of publications published in 2017-2020. Learn more >

CiteScore 2020

$$3.3 = \frac{11{,}113 \text{ Citations 2017 - 2020}}{3{,}364 \text{ Documents 2017 - 2020}}$$

Calculated on 05 May, 2021

CiteScoreTracker 2021

$$3.5 = \frac{11{,}309 \text{ Citations to date}}{3{,}204 \text{ Documents to date}}$$

Last updated on 05 January, 2022 • Updated monthly

CiteScore rank 2020

Category	Rank	Percentile
Arts and Humanities		
— Arts and Humanities (miscellaneous)	#71/306	76th
Physics and Astronomy		
— Acoustics and Ultrasonics	#12/43	73rd

View CiteScore methodology > CiteScore FAQ > Add CiteScore to your site

Journal of the Acoustical Society of America

COUNTRY

United States

Universities and research institutions in United States

SUBJECT AREA AND CATEGORY

Arts and Humanities
└ Arts and Humanities (miscellaneous)

Physics and Astronomy
└ Acoustics and Ultrasonics

PUBLICATION TYPE

Journals

ISSN

00014966, 15208524

SCOPE

The journal serves physical scientists, life scientists, engineers, psychologists, physiologists, architects, musicia communication specialists. Subjects include: Linear and nonlinear acoustics Aeroacoustics Underwater sound a Ultrasonics and quantum acoustics Architectural and structural acoustics and vibration Speech, music, and nois of hearing Engineering acoustics, sound transducers, and measurements Bioacoustics, animal bioacoustics, an

Join the conversation about this journal

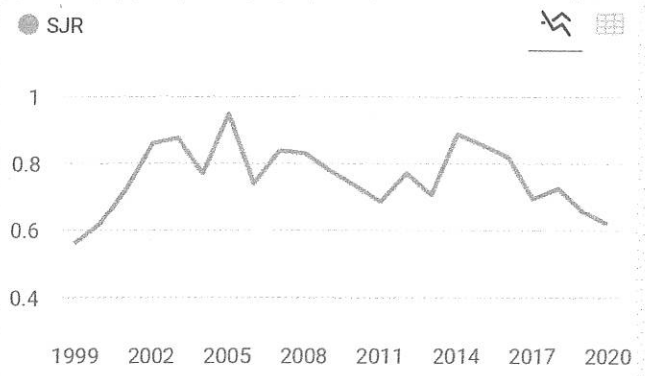
Quartiles

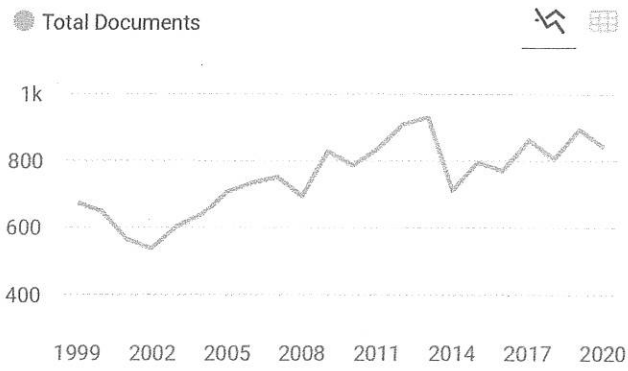
FIND SIMILAR JOURNALS

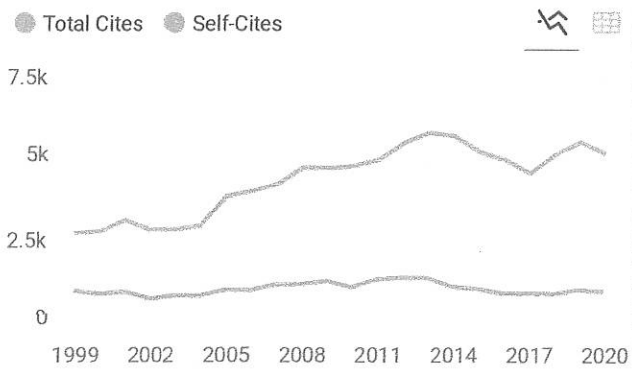
1
Shengxue Xuebao/Acta Acustica
CHN
79%

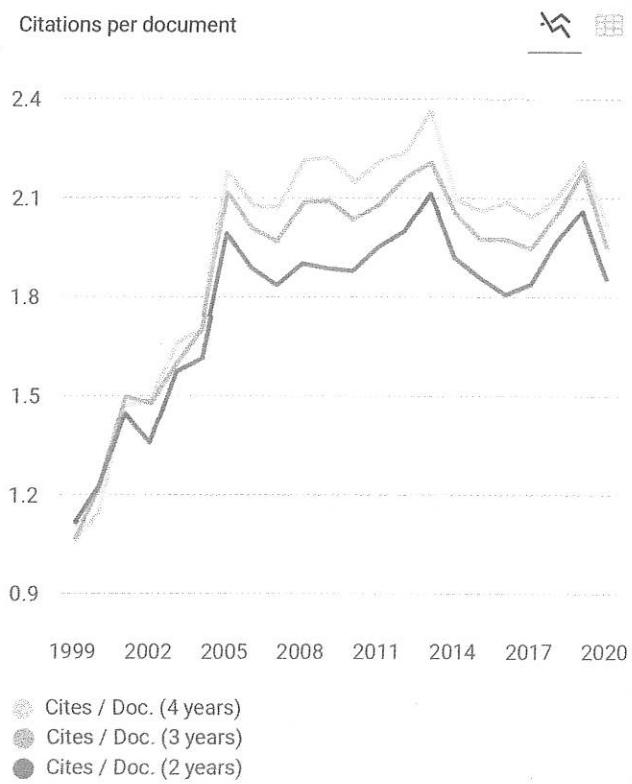
2
Acta Acustica united with Acustica
DEU
69%

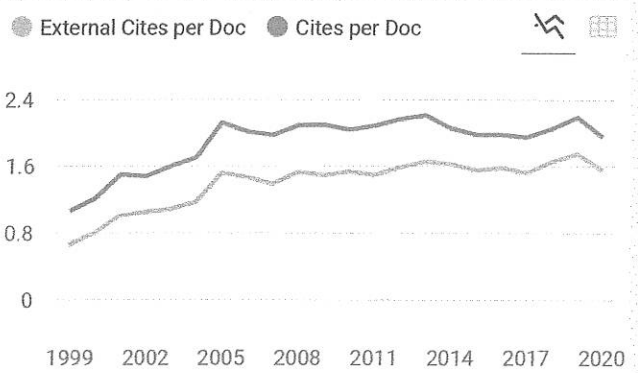
3
JARO - Journal of the Association for Research in
USA
59%

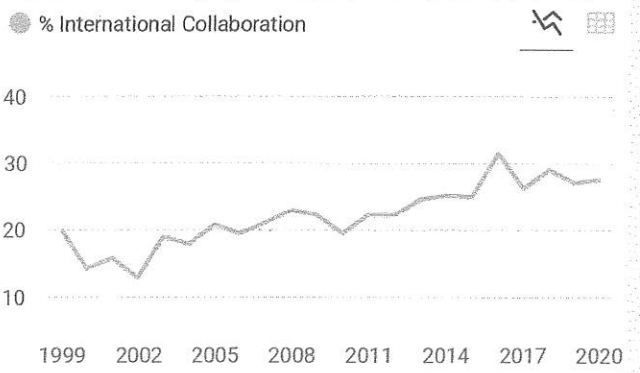


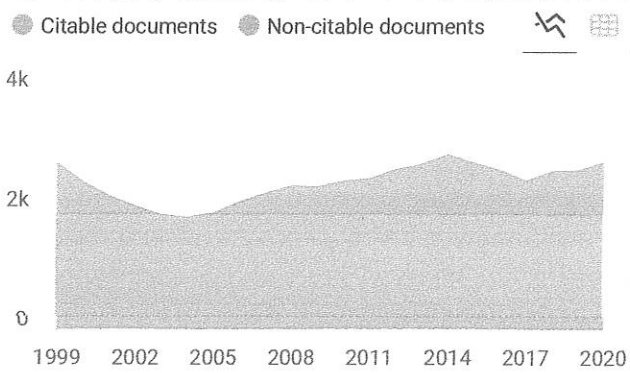


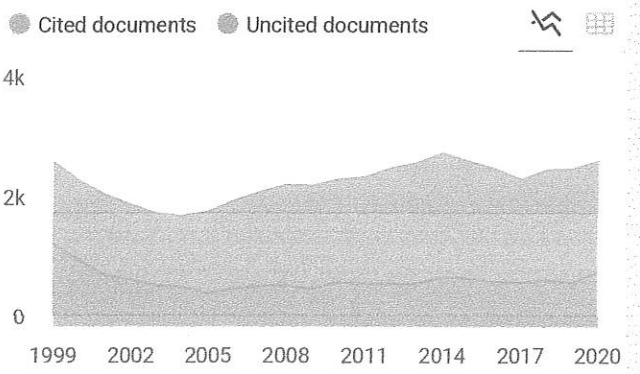


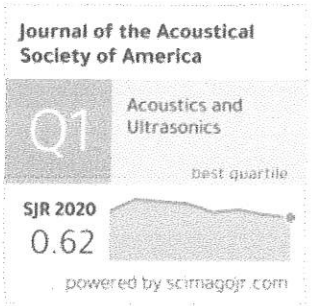












← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scima