Binaural detection with spectrally nonoverlapping signals and maskers

Citation for published version (APA):

Heijden, van der, M. L., Trahiotis, C. T., Kohlrausch, A. G., & Par, van de, S. L. J. D. E. (1996). Binaural detection with spectrally nonoverlapping signals and maskers. *Journal of the Acoustical Society of America*, 99(4), 2515-2516. <https://doi.org/10.1121/1.415734>, <https://doi.org/10.1021/ja00450a019>

DOI:

[10.1121/1.415734](https://doi.org/10.1121/1.415734)

[10.1021/ja00450a019](https://doi.org/10.1021/ja00450a019)

Document status and date:

Published: 01/01/1996

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

tions. In the experiments two primary waves were produced by focused transducers. One of the primary frequencies was kept constant at 2.25 MHz; another was changed. Thus the difference frequency was varied from 30 to 320 kHz, which corresponds to the resonant bubble radii from 109 to 10 μ m. For the bubble clouds produced in a laboratory tank by

electrolysis- and slit-type bubble makers, the bubble densities were well estimated with the present nonlinear acoustic method, respectively. [This work was done at the Acoustic Research Lab. of Sung Kyun Kwan Univ. under support of STEPI, Republic of Korea, and supported, in part, by RFBR (Grant 94-05-16755), Russia.]

WEDNESDAY MORNING, 15 MAY 1996

REGENCY B, 8:00 A.M. TO 12:00 NOON

Session 3aPP

Psychological and Physiological Acoustics: Binaural Hearing and Hearing Impairment

Frederic L. Wightman, Cochair

Waisman Center, University of Wisconsin, 1500 Highland Avenue, Madison, Wisconsin 53706

Marjorie R. Leek, Cochair

Audiology and Speech Center, Walter Reed Army Medical Center, Washington, DC 20307-5001

Contributed Papers

8:00

3aPP1. Effects of source spectrum irregularity and uncertainty on sound localization. Ewan A. Macpherson (Waisman Ctr., Univ. of Wisconsin—Madison, 1500 Highland Ave., Madison, WI 53705-2280)

Localization performance has been shown to deteriorate when source spectra are variable, but the few studies investigating this have confounded trial-to-trial variability with spectral irregularity present in each stimulus. In this experiment these factors were varied independently. Blindfolded listeners seated in an anechoic chamber reported the apparent locations of wideband noise bursts having either smoothly sloping spectra or 1/3-oct scrambled spectra. The spectra were either varied from trial to trial or held constant throughout an experimental session. Localization performance was compared to that obtained in a baseline condition using flat-spectrum stimuli. Despite trial-to-trial uncertainty, performance with the smoothly varying spectra was equivalent to baseline. The responses to the majority of the scrambled spectrum stimuli were similar to baseline, but pronounced bias and elevated variability were observed at certain pairings of source spectrum and location that varied between listeners. The degree of uncertainty had no substantial effect on performance with these stimuli. The results suggest that source spectrum familiarity cannot effectively compensate for the interference of spectral irregularity with the processing of spectral localization cues. However, this processing appears to be surprisingly immune to such interference over much of auditory space. [Work supported by NIDCD]

8:15

3aPP2. Observer weighting of interaural differences of time in different regions of intracranial space. Mark A. Stellmack (Waisman Ctr., Univ. of Wisconsin—Madison, 1500 Highland Ave., Madison, WI 53705) and Raymond H. Dye, Jr. (Parmly Hearing Inst., Chicago, IL 60626)

Weights that listeners placed on interaural differences of time (IDT's) were computed for two pure tones that had different mean IDT's. As a cue on each trial, the target (753 Hz) was presented in isolation at its mean IDT. Then, the target and distractor (553 Hz) were presented simultaneously with IDT's selected from Gaussian distributions ($\sigma = 50 \mu$ s). The listener indicated whether the target in the test interval appeared to have moved to the left or right of its cued position. The weights were the correlations between the IDT of each component and the listener's left/right response. In one condition, the mean target and distractor IDT's were of equal magnitude (0, 25, 50, 100, and 200 μ s) but opposite sign. Large individual differences in weights and percent correct were observed. In a second condition, the mean target IDT was 0 μ s and the mean distractor

IDT was 0, 50, 100, or 200 μ s. Here, target weights and percent correct generally increased for all listeners as the mean distractor IDT increased. Results are attributed to increased target weight as the difference between target and distractor IDT increased, and decreased sensitivity to changes in IDT as mean IDT increased. [Work supported by a Program Project Grant from NIDCD.]

8:30

3aPP3. Dichotic pitches as illusions of binaural unmasking. John F. Culling (Univ. Lab. of Physiol., Parks Rd., Oxford OX1 3PT, UK), Quentin Summerfield (M.R.C. Inst. of Hearing Res., University Park, Nottingham NG7 2RD, UK), and David. H. Marshall (M.R.C. Inst. of Hearing Res., University Park, Nottingham NG7 2RD, UK)

Dichotic pitches are binaural perceptual phenomena which occur when broadband noise with specific interaural phase/time relationships is presented simultaneously to the two ears. Four dichotic pitches have been described: Huggins' pitch; the binaural edge pitch; the Fourcin pitch; the dichotic repetition pitch (DRP). This paper shows that the perceived pitch and timbre of the first three dichotic pitches are correctly predicted using a model of binaural unmasking [Culling and Summerfield, *J. Acoust. Soc. Am.* **98**, 785–797 (1995)]. The model detects across-frequency variations in interaural correlation; the resulting central spectrum shows peaks which correspond to the frequencies listeners hear. These pitches are probably, therefore, illusions produced by the mechanism of binaural unmasking. The DRP is not predicted by the model. The DRP could be produced through binaural cross talk, but experiments using insert earphones which produce minimal cross-talk confirmed that the phenomenon persists when cross talk is effectively eliminated. The DRP is probably, therefore, produced by a separate mechanism from the other dichotic pitches.

8:45

3aPP4. Binaural detection with spectrally nonoverlapping signals and maskers. Marcel van der Heijden, Constantine Trahiotis [Surgical Research Ctr., Dept. of Surgery (Otolaryngol.) and Ctr. for Neurol. Sciences, Univ. of Connecticut Health Ctr., Farmington, CT 06030], Armin Kohlrausch, and Steven van de Par (Inst. for Perception Res., NL-5600 MB Eindhoven, The Netherlands)

Thresholds were measured for diotic tonal signals masked by interaurally delayed bands of Gaussian noise. When the signal frequency was 525 Hz, the spectrum of the masker was either below (highest frequency, 450 Hz) or above (lowest frequency, 600 Hz) the frequency of the signal. With a 450-Hz signal, the spectrum of the masker was always above the signal

frequency (lowest frequency, 600 Hz). Signals had a 250-ms duration and were temporally centered within 300-ms-long maskers. The spectrum level of the maskers was 60 dB. Masked thresholds obtained in all three conditions varied sinusoidally with the interaural delay of the masker. The periodicities within the data were close to, but not identical with, the periodicities of the *signals* (not the maskers). This outcome is discussed in terms of (1) auditory distortion products stemming from interactions within the masking bands of noise [cf. van der Heijden and Kohlrausch, *J. Acoust. Soc. Am.* **98**, 3125–3134 (1995)], and (2) binaural models incorporating internal delay mechanisms. It is shown that using such spectrally nonoverlapping signals and maskers can help test interesting hypotheses concerning binaural models. [Work supported by Grant No. 5 RO1 DC00234-13 from the National Institute of Deafness and other Communication Disorders, NIH.]

9:00

3aPP5. Lateral position of dichotic pitches can be substantially affected by interaural intensive differences. Anthony N. Grange and Constantine Trahiotis (Surgical Res. Ctr., Dept. of Surgery (Otolaryngol.) and Ctr. for Neurol. Sciences, Univ. Ctr. of Connecticut Health Ctr., Farmington, CT 06030)

Three listeners used an acoustic pointer to match the intracranial position of dichotic pitches presented with interaural intensive differences (IIDs). Unlike data reported previously [Raatgever, "Binaural time processing and time-intensity trading," in *Psychophysics, Physiology, and Behavioural Studies in Hearing*, edited by G. van den Brink and F. A. Bilsen (Delft U.P., Delft, The Netherlands, 1980), pp. 425–453], the intracranial position of the dichotic image was moved substantially by IIDs. Large effects of IIDs were found in a variety of stimulus conditions, including one investigated by Raatgever. When the dichotic stimuli were not pulsed, but were presented continuously and turned off only when the acoustic pointer was presented, one of the listeners produced data like those previously reported by Raatgever. It appears that intracranial images produced by stimuli which support dichotic pitches, like images produced by other binaural stimuli, *can* be affected substantially by IIDs. Consequently, in terms of lateralization, it does not appear necessary to maintain a theoretical cleavage between images produced by dichotic pitches (previously thought to be influenced only by ITDs) and images produced by other binaural stimuli. [Work supported by Grant No. 5 RO1 DC00234-13 from the National Institute on Deafness and other Communication Disorders, NIH.]

9:15

3aPP6. Localization and speech perception in noise by aging listeners. Robert C. Bilger (Dept. Speech and Hearing Sci., Univ. of Illinois, 901 S. Sixth St., Champaign, IL 61820), Chien Yeh Hsu (Inst. for Information Industry, Taipei, Taiwan, Republic of China) and Ted A. Meyer (Washington Univ., St. Louis, MO 63110)

Presbycusis listeners are reported to have difficulty hearing speech in noisy sound fields. To resolve the issue of whether this difficulty is central or peripheral, an experiment, in which the spectrum of a masking noise was manipulated to replace acoustics that a listener's peripheral hearing loss filtered out of the input, was conducted. The experimental listeners were 12 people with high-frequency hearing loss who were 65 years of age or older (5 women/7 men) and the controls were 12 young adults with normal hearing (8 women/4 men). When PB words (200 words/condition) were presented at 65 dB SPL in a flat noise (S/N = 0 dB) at zero azimuth, the controls scored 53.9% correct and, when the speech and noise were separated by 90°, their score was 70.2% correct, an increase of 16.3%. Under the same experimental conditions, the experimental listeners scored 44.8% correct for signal and noise at zero azimuth and 53.4% correct for 90° separation, an increase of only 8.6%. When the noise presented to the experimental listeners was filtered to match their equal-loudness contours (high-frequency boost), however, their speech recognition improved to 59.5%, an increase of 14.7% over their mean score for no separation of signal from noise, evidence that their difficulty is of peripheral origin. [Work supported by DC 00174-11.]

9:30

3aPP7. Detection and identification of environmental sounds. Charles S. Watson, Gary R. Kidd, and Brian Gygi (Dept. of Speech and Hear. Sciences, Indiana Univ., Bloomington, IN 47405)

Most studies of auditory recognition and identification have employed either speech stimuli or nonspeech sounds generated in the laboratory (e.g., tones of various frequencies, tonal patterns, click trains). The present study employed 25 naturally occurring complex sounds (obtained from a commercial sound-effects library), such as those produced by doors closing, babies crying, helicopters in flight, and other familiar events. These sounds, equated for peak levels, were recorded with a background of broadband noise. The recorded sounds were presented to groups of six to eight listeners in both open- and closed-set formats (with the list of responses displayed continuously in the latter). Confusion matrices were generated using a wide range of event-to-noise (Ev/N) ratios. Two frequent confusions were identified for each item, and were used to create a three-alternative forced-choice test. Eight values of Ev/N were selected for each item in an effort to achieve uniform item identifiability. Average Ev/N required to achieve 50-percent-correct recognition, the slopes of psychometric functions, and the distribution of these measures among normal-hearing listeners are compared to the corresponding measures for speech identification. [Work supported by AFOSR and NIDCD.]

9:45

3aPP8. Perceptual fusion of multiple echoes. Sandra J. Guzman and William A. Yost (Parmlly Hear. Inst., Loyola Univ., 6525 N. Sheridan Rd., Chicago, IL 60626)

In a natural environment, perceptual fusion of a sound may occur despite the fact that multiple echoes exist. If a train of repeating sources and echoes is established experimentally, the echoes are suppressed and perceptual fusion is established. In the present study, perceptual fusion was investigated by having listeners attend to the last sound presented in a train of sources and echoes. The effects of the number of sounds presented during a train, time delay between sources and echoes, relative amplitude between sources and echoes, and number of echoes presented were investigated. Results indicate that there is an interaction between time delay and number of echoes in perceptual fusion. Relative amplitude of the source and echoes also affected perceptual fusion. These findings will be discussed in terms of the conditions under which perceptual fusion seems to occur and its relation to a listener's prior experience in an acoustic environment. [Work supported by NIDCD and AFOSR.]

10:00–10:15 Break

10:15

3aPP9. Franssen effect as a function of carrier waveform, carrier level, and room acoustics. Dan Mapes-Riordan, William A. Yost, and Sandra J. Guzman (Parmlly Hearing Inst., Loyola Univ., 6525 N. Sheridan Rd., Chicago, IL 60626)

The Franssen effect was studied as a function of the frequency of the source and echo sounds, the difference in frequency and level between the source and echo sounds, and as a function of the amount of room reverberation. A modification of the single-interval procedure used by Hartmann and Rakerd [*J. Acoust. Soc. Am.* **86**, 1366–1373 (1989)] was used to measure the degree to which the source and echo sounds were fused in terms of determining the location of the perceived sound. The amount of fusion was a nonmonotonic function of frequency, decreased as the frequency and level difference between the echo and source increased, and is greater for a room with more reverberation. The results will be discussed in terms of the precedence effect, listener's prior experience, and the plausibility hypothesis. [Work supported by a Program Project Grant from NIDCD and a grant from the AFOSR.]