AD-A193 421 DEMODULATION PROCESSES IN AUDITORY PERCEPTION(U) KANSAS UNIV LAWRENCE L L FETH 01 MAR 88 AFOSR-TR-88-0376 AFOSR-87-0091 1/1

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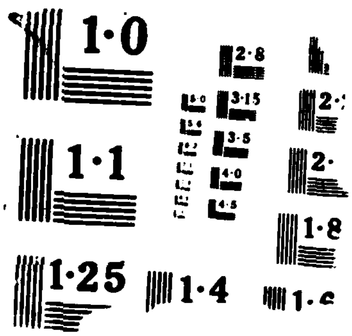
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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFOSR - 87-0091	5. MONITORING ORGANIZATION REPORT NUMBER(S) AFOSR-TR- 88-0376
6a. NAME OF PERFORMING ORGANIZATION University of Kansas; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
6c. ADDRESS (City, State and ZIP Code) 2101 Haworth Hall, Lawrence, KS 66045	7b. ADDRESS (City, State and ZIP Code) Building 410, Bolling AFB DC 20332-6448
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOSR; 8b. OFFICE SYMBOL (If applicable) NL	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER AFOSR-87-0091
8c. ADDRESS (City, State and ZIP Code) Bolling Air Force Base, D.C. 20332	10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
61102F	2313	A6	

11. TITLE (Include Security Classification) Demodulation Processes in Auditory Perception

12. PERSONAL AUTHOR(S) Lawrence L. Feth, Ph.D.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Annual	FROM 12-1-86 TO 11-30-87	1988-3-1	3

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The attached interim report covers the first 12 month period of the project. A signal-processing computer model of human auditory perception of complex, time-varying sounds has been revised to incorporate the ability to follow a frequency that changes over time. Such frequency changes are thought to convey the information important for the perception of speech, music and other important sounds. Testing of the revised model is underway using a two alternative forced choice discrimination task. Listeners are required to distinguish between a sound with a smooth linear frequency glide and another covering the same trajectory in a series of discrete steps. We expect to determine the temporal parameters for the revised model from these discrimination experiments.

DTIC ELECTE APR 0 1 1988 S E D

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE NUMBER (Include Area Code)	22c. OFFICE SYMBOL
JOHN F. TANGNEY	(202) 767-5021	NL

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

SECURITY CLASSIFICATION OF THIS PAGE

AFOSR-87-0091

AFOSR-TR- 88-0376

DEMODULATION PROCESSES IN AUDITORY PERCEPTION

Lawrence L. Feth, Ph.D.
Speech-Language-Hearing
University of Kansas
2101 Haworth Hall
Lawrence, KS 66045

1 March 1988

Interim Report for Period 1 December 1986 - 30 November 1987

Accession For	
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Prepared for

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Bolling Air Force Base
Washington, D.C. 20332

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ANNUAL TECHNICAL REPORT

Dec. 1, 1986 - Nov. 30, 1987

The overall goal of this project is to understand the ability of the human listener to track frequency modulations in speech, music or other environmentally important sounds. Specifically, we have devised a signal-processing model of this ability that is implemented on our laboratory minicomputer. The computer model calculates the Envelope-Weighted Average of the Instantaneous Frequency (EWAIF) for complex sounds. Our previous research with elementary signals indicated that a listener's ability to distinguish one complex sound from another can be predicted by determining the EWAIF value for each sound. Discriminability is then predictable from that listener's ability to distinguish one pure tone from another. In the current project, we have refined the computer model and we are testing its performance by comparing its predictions with the perceptual abilities of human listeners.

The revised model has the ability to track frequency changes (transitions) in complex sounds. These frequency transitions are thought to convey important information in the perception of speech, music and other sounds. For the revised model, we must determine a signal-processing time-frame. That is, a brief interval of time over which the model performs the EWAIF calculation. For on-going sounds, we assume that the listener's auditory system performs a running, short-term analysis of the complex sound. The signal-processing time-frame is the interval over which a brief sample of the sound is analyzed.

To test our revised model, we devised a new series of discrimination tests. Our listeners are asked to distinguish between two complex sounds. Each sound is frequency-modulated from an initial, to a final frequency. One sound moves from the initial to the final frequency over a smooth, linear trajectory; the other sound moves over a discrete, multiple-step path. As the number of steps increases, the duration and size of each individual step decreases. For a small number of steps, we expect that the listener will have no trouble distinguishing the smooth glide from the multiple-step sound. However, if our short-term analysis model is valid, we expect listeners to have greater difficulty in distinguishing the glide from the multiple-step sound when the number of steps is large. We plan to use the inability of our listeners to discriminate glide sounds from multiple-step sounds to guide our selection of the temporal parameters for the model.

Once we have determined the temporal parameters for the short-term analysis, we plan to move on to the difficult problem of wide bandwidth sounds. There is a flurry of activity in this area, characterized as "profile analysis" by David Green and his associates. We have shown in our preliminary work, that the EWAIF model has implications for the profile analysis work. Specifically, we suspect that much of the early work on "profile" signals is tainted by a stimulus artifact. Complex sounds synthesized from collections of sinusoids, as the early profile sounds were, have inherent amplitude and frequency fluctuations that are changed when one sinusoid is incremented in amplitude. Thus, we maintain that listener performance in the early profile analysis tasks is confounded by a frequency modulation cue that alters the pitch of the complex sound when the "profile" of the background sound is altered. The fault in the profile analysis approach lies in the characterization of complex time functions by their long-term Fourier line spectra, and the notion that the auditory system processes the spectrum rather than the complex signal.

LIST OF RESEARCH OBJECTIVES AND CURRENT STATUS

1. Implement a short-term, tracking version of the EWAIF model on the laboratory minicomputer using the ILS signal processing package.

The model has been implemented as a two parameter short-term analyzer. That is, two temporal parameters are required to specify the analysis process. The two parameters are the time-frame, or window, and the lag. The lag indicates the temporal overlay from one analysis window to the next sequential one. We are currently converting the two parameter model into a one parameter model, by using a moving average filter instead of the window and lag process.

2. Begin the series of discrimination experiments that will be used to test the predictions of the short-term running EWAIF model.

Preliminary work using simple one-step versus glide discrimination was conducted in the spring semester of 1987. Over the summer term and fall semester, we have been testing listeners in the multiple-step vs. glide task. We began using signals in the 1000 Hz region, with transitions from 900 to 1100 Hz. Other frequency transitions in the 1000 Hz region and in other frequency regions will be tested in the spring semester of 1988.

PARTICIPATING PROFESSIONALS

Lawrence L. Feth, Ph.D.	Principal Investigator
Lisa J. Stover, M.A.	Graduate Research Assistant
Richard A. Gerren, Ph.D.	Post-doctoral Fellow (NIH)

PUBLICATIONS AND PRESENTATIONS

EWAIF: ENVELOPE-WEIGHTED AVERAGE OF INSTANTANEOUS FREQUENCY MODEL APPLIED TO COMPLEX SOUND PERCEPTION. L.L. Feth, L.J. Stover, and R.A. Gerren. Presented at the tenth mid-winter research meeting of the Association for Research in Oto-laryngology (ARO) Feb. 1987.

COMPLEX SOUND DISCRIMINATION PREDICTIONS: TEST OF THE EWAIF MODEL. L.L. Feth, L.J. Stover, and R. A. Gerren. Presented at the eleventh mid-winter research meeting of the ARO Feb. 1988.

AUDITORY TEMPORAL ACUITY MEASURED IN NORMAL HEARING LISTENERS USING TRANSIENT SIGNALS. R.A. Gerren, L.L. Feth, and L.J. Stover. Presented at the eleventh mid-winter research meeting of the ARO Feb. 1988.

PATENTS AND INVENTIONS

No patentable inventions have resulted from this research project.

STATEMENTS

A manuscript for submission to the Journal of the Acoustical Society of America is in preparation. We expect to submit it by late spring or early summer 1988.

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