CD 845 – Psychoacoustics
Spring 2006
Instructor, Frederick Gallun

Wednesday 3:00-4:30
Thursdays 4:30-6:00
Sargent College, 635 Commonwealth Ave., Room 215

Syllabus

Jan 18 Lecture: History of Psychophysics
No suggested reading

Jan 19 Lecture: Signal Detection Theory
Suggested reading: Egan, Schulman and Greenberg (1959) "Operating characteristics determined by binary decisions and by ratings" JASA, 31(6), 768-773

Homework 1

Jan 25 Lecture: Intensity Perception and Critical Bands
Suggested reading: Riesz (1928) "Differential sensitivity of the ear for pure tones" Physical Review, 31, 867-875

Jan 26 Discussion: Critical Bands and Excitation Pattern Modeling
Required reading:
1) Moore and Glasberg (1983) "Suggested formulae for calculating critical bands and excitation patterns," JASA, 74(3), 750-754
2) Florentine and Buus (1981) "An excitation pattern model for intensity discrimination," JASA, 70(6), 1646-1654

Homework 2

Feb 1 Lecture: Frequency and Pitch Sensitivity
Suggested reading: Plomp (1964) "The ear as a frequency analyzer", JASA 36(9), 1628-1636

Feb 2 Discussion: Repetition Pitch
Required Reading:
1) Burns and Viemeister (1976) "Nonspectral Pitch", JASA 60(4), 863-869
2) Burns and Viemeister (1981) "Played-again SAM: Further observations on the pitch of amplitude-modulated noise", JASA 70 (6), 1655-1660
3) Carlyon et al. (2002) "Temporal pitch mechanisms in acoustic and electric hearing", JASA 112(2), 621-633

Feb 8,9 NO CLASS – ARO

Feb 15 Discussion: Binaural Hearing I: Time and Intensity
Required Reading:
1) Sandel, Teas, Feddersen and Jeffress (1955) "Localization of sound from single and paired sources", JASA, 27
2) Mills (1958) "On the minimum audible angle", JASA, 30
3) Whitworth and Jeffress (1961) "Time vs. intensity in the localization of tones", JASA, 33
4) Hafter and Jeffress (1968) " Two-image lateralization of tones and clicks", JASA, 44

Feb 16 Discussion: Binaural Hearing II: Complex Stimuli
Required Reading:
1) Nuetzel and Hafter (1976) "Lateralization of complex waveforms: Effects of fine structure, amplitude and duration", JASA, 60
2) Bernstein and Trahiotis (1985) "Lateralization of low-frequency, complex waveforms: The use of envelope-based temporal disparities", JASA, 77
3) Stern, Zeiberg and Trahiotis (1988) "Lateralization of complex binaural stimuli: A weighted-image model", JASA, 84

Feb 22 Discussion: Binaural Hearing III: HRTFs
Required Reading:
1) Musicant and Butler (1984) "The influence of pinnae-based spectral cues on sound localization", JASA, 75
2) Makous and Middlebrooks (1990) "Two-dimensional sound localization by human listeners", JASA, 87
3) Shinn-Cunningham, Durlach and Held (1998) "Adapting to supernormal auditory localization cues. I. Bias and resolution", JASA, 103

Feb 23 Discussion: Binaural Hearing IV: Motion Perception
Required Reading:
1) Saberi and Perrott (1990) "Minimum audible movement angles as a function of sound source trajectory", JASA, 88
2) Chandler and Grantham (1992) "Minimum audible movement angle in the horizontal plane as a function of stimulus frequency and bandwidth, source azimuth, and velocity", JASA, 91
3) Lutfi and Wang (1999) "Correlational analysis of acoustic cues for the discrimination of auditory motion", JASA, 106

MIDTERM I

March 1 Lecture: Binaural Release from Masking
Suggested Reading: Hirsh (1948) "The influence of interaural phase on interaural summation and inhibition", JASA, 20

March 2 Discussion: Binaural Masking Level Differences
Required Reading:
1) Colburn and Durlach (1965) "Time-Intensity Relations in Binaural Unmasking", JASA, 38
2) Hafter, Bourbon, Blocker and Tucker (1969) "A direct comparison of lateralization and detection under conditions of antiphasic masking," JASA, 46
3) Zurek and Durlach (1987) "Masker-bandwidth dependence in homophasic and antiphasic tone detection", JASA, 81

March 8,9 **SPRING BREAK**

March 15 Lecture: Amplitude-Modulation: Sensitivity and Masking
Suggested Reading: Viemeister (1979) "Temporal modulation transfer functions based upon modulation thresholds", JASA, 66

March 16 Discussion: Modulation Masking
Required Reading:
1) Houtgast (1989) "Frequency selectivity in amplitude-modulation detection", JASA, 85
2) Sheft and Yost (1997) "Binaural modulation detection interference", JASA, 102
3) Dau, Kollmeier and Kohlrausch (1997) "Modeling auditory processing of amplitude modulation. II. Spectral and temporal integration," JASA, 102

Supplementary Readings (useful, but optional):
1) Dau, Kollmeier and Kohlrausch (1996) "A quantitative model of the ''effective'' signal processing in the auditory system. I. Model structure," JASA, 99
2) Dau, Kollmeier and Kohlrausch (1997) "Modeling auditory processing of amplitude modulation. I. Detection and masking with narrow-band carriers," JASA, 102

Homework 3

March 22 Lecture: Temporal Factors
March 23 Discussion: Temporal Integration, Resolution and Multiple Looks
Required Readings:
1) Green, Birdsall and Tanner (1957) "Signal detection as a function of signal intensity and duration," JASA, 29
2) Viemeister and Wakefield (1991) "Temporal integration and multiple looks," JASA, 90
3) Oxenham (2001) "Forward masking: Adaptation or integration?" JASA, 109

Homework 4

March 29 Lecture: Decision Making Under Uncertainty
Suggested Reading: Green (1960) "Psychoacoustics and Detection Theory", JASA, 32
March 30 Discussion: Uncertainty, Profile Analysis and Pattern Learning
Required Reading
1) Spiegel, Picardi and Green (1981) "Signal and masker uncertainty in intensity discrimination", JASA, 70
2) Kidd, Mason and Green (1986) "Auditory profile analysis of irregular spectra", JASA, 79
3) Espinoza-Varas and Watson (1986) "Temporal discrimination for single components of non-speech auditory patterns", JASA, 80

MIDTERM II has been cancelled to allow more time to work on final projects

April 5 Lecture: Entropy and Uncertainty: Informational Masking
Suggested Reading: Lutfi (1993) "A model of auditory pattern-analysis based on component-relative-entropy," JASA 94
April 6 Discussion: Modeling Informational Masking
Required Reading:
1) Oh, E. L., and Lutfi, R. A. (1998). "Nonmonotonicity of informational masking," JASA 104, 3489-3499.
2) Durlach, Mason, Gallun, Shinn-Cunningham, Colburn , and Kidd (2005). "Informational masking for simultaneous nonspeech stimuli: psychometric functions for fixed and randomly mixed maskers," JASA 118, 2482-2497.

April 12 Lecture: Repeated-Measures Analysis of Variance
Discussion: Informational Masking II: Release, Identification and Intelligibility
Suggested Reading: Arbogast, Mason and Kidd (2002) ''The effect of spatial separation on informational and energetic masking of speech,'' JASA, 112

April 13 Discussion: What is informational masking?
Required Reading
1) Neff (1995) "Signal properties that reduce masking by simultaneous, random-frequency maskers", JASA, 98
2) Durlach, Mason, Shinn-Cunningham, Arbogast, Colburn and Kidd (2003) "Informational masking: Counteracting the effects of stimulus uncertainty by decreasing target-masker similarity", JASA, 114
3) Durlach, Mason, Kidd, Arbogast, Colburn and Shinn-Cunningham (2003)"Note on informational masking", JASA, 114

Rough Draft of Final Projects Due April 14

April 19 Lecture: Speech: Production and Perception
April 20 Discussion: Speech Perception
Required Reading Diehl, Lotto and Holt (2004) "Speech Perception", Ann. Rev. Psych., 55

Homework 5 Due Wednesday, April 26
Drullman, Festen and Plomp (1994) "Effect of temporal envelope smearing on speech reception," JASA, 95
Shannon, Zeng, Kamath, Wygonski, and Ekelid (1995) "Speech recognition with primarily temporal cues," Science, 270

April 26 Lecture: Measurement and Effects of Hearing Impairment
April 27 Discussion: Speech Perception by the Hearing Impaired
Required Reading
1) Festen and Plomp (1990) "Effects of fluctuating noise and interfering speech on the speech reception threshold for impaired and normal hearing", JASA, 88
2) van Schindjel, Houtgast and Festen (2001) "Effects of degradation of intensity, time, or frequency content on speech intelligibility for normal-hearing and hearing-impaired listeners", JASA, 110

FINAL EXAM: Distributed April 28, Due May 5
Hartmann and Rakerd (1989) "On the minimum audible angle – A decision theory approach," JASA, 85
Carlyon, Buus and Florentine (1990) "Temporal integration of trains of tone pulses by normal and by cochlearly impaired listeners," JASA, 87
Chandler, Grantham and Leek (2005) "Effects of uncertainty on auditory spatial resolution in the horizontal plane," Acta Acust. Acust., 91

Final Projects Due May 9

Description
This class will be concerned with the historical roots of psychophysics, with an emphasis on psychoacoustics and signal detection theory. The class will meet at least twice for the discussion of any single topic. The first meeting (usually on Wednesday) will be devoted to a lecture exploring a particular method or perspective that is commonly applied in psychophysics as well as discussing background material. This will provide students with the resources necessary to engage in an active, informed discussion of a primary source (usually a journal article on psychoacoustics) at the next class meeting.

Requirements
All participants will be expected to read the journal articles and background material and to attend the lectures. Participation in class discussion is mandatory and will require a familiarity with the written materials associated with that discussion as well as the previous lectures. (35% of the final grade)

Five problem sets will be assigned over the course of the semester. Solutions will be due the following week on Wednesday. Problems will involve calculations as well as theoretical issues. The use of Matlab will be required for most (possibly all) problem sets. (15% of the final grade: 3% for each problem set)

There will be two take-home exams and a final. The exams will focus on an integration of practical and theoretical issues and will be designed to mimic actual problems that occur in a research laboratory. (25% of the final grade: 7.5% for each midterm and 10% for the final)
This has been revised. There will be only one midterm. The midterm is now worth 10% and the final exam 15%. (3/20/06)

Final Project
In addition, each member of the class will do one of the following:
1) give one of the background lectures (ideally on a topic on which the student is working);
2) write a report describing the background, methods, results and future directions of a psychophysical experiment that the student is actively conducting;
3) research and write a paper on one of the weekly topics (again, this should be a topic on which the student is working).

Note that the amount of preparation time expected for each of these is approximately equal. (25% of the final grade)

Materials
Access to Matlab must be arranged. Readings will be made available electronically.
Additional books will not have to be purchased.

Note: The picture at the top of this page is the faceplate from a Buchla 200 module, the Source of Uncertainty.
This course will not cover electronic music, however.