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13\. ABSTRACT (*Maximum 200 words*)

This research program examined the large detrimental effects of masker uncertainty on the detection of a simple, known target signal. The basic task was the detection of a 1000-Hz sinusoid presented simultaneously with maskers composed of a few sinusoidal components whose frequencies were changed with each presentation. The masker properties were such that it is difficult to account for the results with traditional detection models which posit the use of a single filter centered at the signal frequency. The goal of this research was to understand the conditions under which performance is degraded by masker uncertainty, the processes involved, and whether procedures or cues could be identified to aid performance. Overall, the masking produced by uncertainty: 1) showed large individual differences and training effects; 2) was observed over a much greater range of conditions than expected and was largely independent of energy in a critical band around the signal; 3) was reduced by procedures and cues which aid stimulus comparisons or memory and by temporal differences between stimuli; 4) showed nonlinear additivity of masking with broadband noise; and 5) showed much larger effects for frequency uncertainty than for uncertainty in overall masker level or component amplitudes.

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Final Technical Report

"DETECTION OF KNOWN SIGNALS IN ARBITRARY BACKGROUNDS"
AFOSR-87-0374

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Final Technical Report

"Detection of Known Signals in Arbitrary Backgrounds"
(AFOSR 87-0374)

Principal Investigator: Donna L. Neff, Ph.D.

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I. ABSTRACT

This research program examined the large detrimental effects of masker uncertainty on the detection of a simple, known target signal. The basic task was the detection of a 1000-Hz sinusoid presented simultaneously with maskers composed of a few sinusoidal components whose frequencies were changed with each presentation. The masker properties were such that it is difficult to account for the results with traditional detection models which posit the use of a single filter centered at the signal frequency. The goal of this research was to understand the conditions under which performance is degraded by masker uncertainty, the processes involved, and whether procedures or cues could be identified to aid performance. Overall, the masking produced by uncertainty: 1) showed large individual differences and training effects; 2) was observed over a

much greater range of conditions than expected and was largely independent of energy in a critical band around the signal; 3) was reduced by procedures and cues which aid stimulus comparisons or memory and by temporal differences between stimuli; 4) showed nonlinear additivity of masking with broadband noise; and 5) showed much larger effects for frequency uncertainty than for uncertainty in overall masker level or component amplitudes.

II. Research Objectives and Statement of Progress

Introduction

The primary goal of this research program has been to gain a better understanding of the interaction of peripheral and central processes in auditory masking under conditions of high stimulus uncertainty. Under these conditions, central processes appear to influence performance more than under conditions of low stimulus uncertainty, with a concomitant reduction in the relative importance of peripheral factors. As outlined in more detail below, the basic experimental task has been the detection of a sinusoidal signal in the presence of multicomponent masker complexes whose frequency content varies with each stimulus presentation. The large effects of such masker uncertainty (typically 20-40 dB) are perplexing in terms of traditional theories of frequency selectivity because there is no uncertainty associated with the signal to be detected, little or no masker energy falls within the peripheral signal filter, and listeners are highly practiced at the task. The work was organized in terms of three related questions: 1) What aspects of the multicomponent maskers govern performance? 2) How much of the masking observed is due to peripheral versus central processes, and under what conditions do peripheral models fail? and 3) What is the nature of the central decision process, that is, what is the role of memory and what decision strategies are used? The results of all experiments supported by this grant are summarized below, catagorized in terms of these three questions.

Overview of Standard Stimuli and Procedures

Most of the experiments share a common set of standard stimuli described here. Thus, only deviations from this standard set will be noted. The signal was a 200-ms, 1000-Hz sinusoid. The maskers were composed of multiple sinusoids, drawn from a 300-3000 Hz range that excluded the signal and all other components within a 160-Hz critical band around the signal. Component amplitudes were equal, and total power was equated at 60 dB SPL across conditions regardless of the number of masker components. The 200-ms maskers were presented simultaneously with the signal, both with 5-ms, cosine-squared, onset/offset ramps. The number of the components in the maskers was varied from 2 to 100 across conditions and experiments, but was typically fewer than 20.

Variations in the degree of uncertainty both demonstrate and help quantify the contribution of more central processes. Any release from masking produced simply by reducing uncertainty cannot be attributed to peripheral energy-based processes. The most common comparison is between maximum uncertainty or "within-trial" variation (different masker for each test interval) and the next lower level of uncertainty, "between-trial" variation (same masker for the two intervals of a trial, but a different masker for each trial). The difference in performance in these two conditions determines the minimum size of the effect of masker uncertainty. In a few cases, conditions of minimal uncertainty or "between blocks" variation also were tested, in which a single masker sample was used throughout a block of trials. Note that these terms are defined for procedures with two or more listening intervals. Single-interval procedures may be viewed as inherently less uncertain in that they cannot have "within trial" variation. The results summarized below focus on the largest effects, that is, those for conditions of maximum uncertainty. Results for lower levels of uncertainty served to clarify the existence and magnitude of the effects discussed. Except for the experiment which examined variations in procedures, a "cued" two-alternative, forced-choice, adaptive procedure was used to estimate signal threshold. The cue was the signal presented alone in quiet before each trial.

Individual Differences

The effects of stimulus uncertainty summarized below describe the majority of listeners, but not all. Out of nearly 40 listeners tested on the standard conditions described above, about 1/3 either showed little effect of masker uncertainty initially or, more frequently, showed large effects that decreased significantly with training. For the other more typical listeners, the uncertainty effects were generally large and resistant to extensive training or extreme variations in the masker properties (e.g., 1000-Hz wide gaps in the spectrum around the signal). Note that the uncertainty effects were observed in spite of the fact that procedures were chosen to work against such effects and encourage "single-filter" detection strategies by omitting components within the critical band around the signal and by presenting the signal in quiet before each trial. Presumably these procedures encouraged some listeners to adopt an analytical approach which reduced or eliminated the effects of uncertainty.

Summaries of Specific Experiments

A. Factors Which Produce Masking with Multicomponent Stimuli

Exp. 1. Restricting masker range and interactions of masker bandwidth and component density. This experiment examined whether restrictions of the frequency range of the masker components would reduce masking relative to conditions with the full 300-3000-Hz range. Masker components were limited to the high (1080-3000 Hz) or the low (300-920 Hz) side of the signal, or progressively wider gaps around the signal were introduced either by removing components in successive linear 100-Hz steps to +/-700 Hz, or in two logarithmic steps to 1 octave. In "band narrowing" conditions, the range of possible components was progressively compressed from 1 to 1/2 to 1/4 octave bands around the signal, still excluding critical-band components. For two listeners who showed large effects of masker uncertainty under the standard conditions, limiting components to the high or low frequency side of the signal or widening the notch around the signal did little to improve performance. Maskers limited to lower frequencies typically produced somewhat more masking than full-range or higher-frequency maskers. The higher frequencies appeared to dominate the uncertainty effect, in that decreasing uncertainty improved performance for maskers limited to high-frequency components, but did not affect performance for maskers limited to low frequencies. Paradoxically, forcing components into narrower bandwidths around the signal could reduce masking by about 5 dB for the two listeners who showed large uncertainty effects (two other listeners showed little effect of masker uncertainty). In contrast, estimates of the width of the peripheral auditory filter at the signal frequency obtained with notched-noise maskers, did not differ across the four listeners. The two who showed larger uncertainty effects, however, also showed lower efficiency in processing the filter output.

To summarize, masking produced by uncertainty was extremely resistant to change as masker energy was progressively removed from the frequency region around the signal. Further, large individual differences in the effect of masker uncertainty were not reflected in measures of auditory filter shape (Neff and Callaghan, 1988b).

Exp. 2. Relative effects of uncertainty in component amplitude, component frequency, and overall level for multicomponent maskers. This experiment explored whether variations in the component amplitudes or overall level of the masker would also produce decrements in performance, either in isolation or in combination with frequency uncertainty. If so, more general models of uncertainty effects could be developed. Additionally, the conditions facilitate contrasts to profile analysis in which overall level is varied to ensure that the facilitative effects of the "profile" results from across-band listening. In profile analysis, variations in overall level can degrade performance by 5-6 dB, but large beneficial effects of the profile remain.

When randomly varied, overall masker levels were chosen from 20- or 40-dB ranges (5-dB steps), and levels for individual components were chosen from 10- or 20-dB ranges (1-dB steps; scaled to maintain equal rms across waveforms). *In both cases, the midpoint of the range was 60 dB SPL. Initially, it* appeared that there were large effects of randomizing overall masker level. There were patterns in the data, however, that were difficult to explain. A careful re-examination of the data-collection and analysis programs revealed an error, which when corrected resulted in only small effects (0-5 dB) of variation in overall masker level, both in isolation and in combination with frequency uncertainty. These results are now consistent with the effect of varying masker level with more traditional stimuli, specifically, bands of noise or multicomponent "profiles."

The effect of variation in component amplitudes was also 5 dB or less, and inconsistent across listeners and conditions. On average, thresholds increased as component-amplitude variation was increased to a range of about 10 dB, then decreased again with further variation. This non-monotonicity is explained if component variation beyond a certain point effectively reduces the number of masker components. Previous experiments with these multicomponent maskers have shown that masking increases as the number of components is increased for maskers with less than about 20 components. Overall, these data on level variation indicate that listeners do not detect the signal on the basis of absolute level within some filter around the signal. When frequency uncertainty is present, it is the primary factor limiting performance; the contribution of level variation is small by comparison.

To summarize, the effect of uncertainty in the overall level of the masker did not significantly degrade performance either alone or in combination with frequency uncertainty. Similarly, uncertainty in the relative level of the components within a masker also had little effect, except when the variation in amplitude was sufficiently great to effectively reduce the number of masker components (Neff, 1990b).

B. Relation of Peripheral and Central Processes

Exp. 1. Forward masking produced by masker uncertainty. This study examined whether the large effects of masker uncertainty observed in simultaneous masking would also occur in forward masking. After collecting a small set of simultaneous-masking data to confirm the expected effects of masker uncertainty, the signal was shortened to 10 ms and presented 0 to 32 ms after masker offset. The amount of forward masking increased monotonically with the number of masker components, in contrast to the nonmonotonic functions for simultaneous masking which had a broad maximum for maskers with 10 components. Further, the amount of forward masking remained well below the masking produced by a broadband noise of equal total power, whereas simultaneous maskers produced considerably more masking than the noise. Both within- and between-listener variability was smaller in forward masking, which is the reverse of the usual observation of more stable performance in simultaneous masking. Finally, between 10-15 dB less masking was produced by the forward maskers, and a similar reduction in masking was observed when the signal in simultaneous masking was shortened to 10 ms and centered in the masker.

To summarize, temporal differences between stimuli appeared to offset the effects of masker uncertainty, providing a measure of peripheral effects. The use of a signal shorter than the simultaneous masker provides a straight-forward measure of peripheral masking and has already been incorporated as a control condition in several experiments (Neff, 1990a).

Exp. 2. Release from masking produced by changes in signal properties. Three sets of conditions examined whether rather simple changes in the properties of the *signal* might improve performance in simultaneous masking with high masker uncertainty. Results for the 1000-Hz sinusoidal signal, equal in duration to the masker at 200 ms, were used as the reference for any release from masking.

In the first set of conditions, the type of signal was varied with the hypothesis that a more dynamic signal or one whose temporal or spectral characteristics differed from the masker components would be easier to detect. The signal types chosen were an amplitude-modulated sinusoid and a quasi-frequency modulated sinusoid, both with carrier frequencies of 1000 Hz and 25-Hz modulation rates, and a 50-Hz wide narrowband noise centered at 1000 Hz. The modulation rate or envelope variability of these signals was clearly audible in quiet, and the broader spectra of these signals still fell within the 160-Hz gap in masker components around 1000 Hz. There was no consistent pattern of results across listeners. At best, these signals produced a release from masking relative to the reference sinusoidal signal of 5-10 dB for listeners who showed any effect at all. To assess whether nonoptimal modulation rates had been chosen, a later experiment with a different group of listeners tested a wide range of modulation rates but found no better choice.

In the second set of conditions, signal duration was shortened relative to the duration of the simultaneous masker in a replication and extension of the conditions described above in the study of forward masking. The 200-ms signal in the reference condition was shortened to 100 and then to 10 ms, with the shorter signals temporally centered in the masker. For all three listeners, there was a large and consistent reduction in masking for the 100 ms signal and a further reduction for the 10-ms signal. This reduction averaged 25 dB and was 45 dB for one listener. Consistent with the forward-masking data, temporal differences between stimuli were very effective in eliminating the effect of masker uncertainty. A second set of conditions varied the relative position of the 10-ms signal within the masker and found that the release from masking was smaller for signals placed at masker onset, but equally large for signals in the temporal center or near masker offset.

In the final set of conditions, the spatial representation of the 1000-Hz sinusoid was varied. The masker and signal were presented: 1) to one ear as in all previous work (monaural); 2) to both ears (diotic); 3) to both ears with the signal out of phase across ears (dichotic); and 4) to separate ears (cross-ear). Thus, these conditions examined the masking level difference or MLD for multicomponent maskers under conditions of masker uncertainty. To provide a comparison to existing literature, a broadband noise was also used. The results indicate that listeners could detect the signal at low levels when it was presented in a separate ear from the masker, although one listener required considerable practice to do so. Reversing signal phase across ears also produced a release from masking for all listeners, which averaged 12 dB and ranged from 5 to 27 dB. Only one listener, however, showed a pattern of results in which the magnitude of the release from masking paralleled the magnitude of the effect of frequency uncertainty. The other three showed essentially a constant release from masking across all conditions. Unlike changes in signal type or duration, which seem to reduce only the masking due to stimulus uncertainty, dichotic presentation appears to improve performance in all conditions, but does not seem particularly helpful in reducing uncertainty *per se*. The fact that little or no masking was observed in the cross-ear conditions suggests that listeners might be trained to detect the signal by initial exposure to cross-ear conditions followed by conditions in which the percept of the signal is gradually shifted to the same ear as the masker.

To summarize across all the conditions of Exp. 2, temporal differences between masker and signal greatly reduced the effects of frequency uncertainty, whereas different types of signals and spatial differences produced by changing from diotic to dichotic presentation of the signal did not (Neff, 1989).

Exp. 3. Combined masking produced by masker uncertainty and stimulus energy. One way to gain a better understanding of masking associated with uncertainty is to examine how it combines with peripheral masking. Combining multicomponent maskers with broadband noise should produce one of three results: 1) no effect of the less effective masker, 2) a release from masking relative to that observed for the multicomponent maskers alone because the noise would reduce the perceptual dissimilarity of the stimuli from trial to trial, or 3) additional masking beyond that expected from the energy summation of the two maskers, as has been observed with numerous combinations of simultaneous maskers. This experiment tested the effect of combining the masking produced by frequency uncertainty to that produced by stimulus energy. Growth-of-masking functions for broadband noise and for multicomponent maskers with 2 to 100 components were used to select levels for individual maskers that produced 10, 20, 30, or 40 dB of masking. Multicomponent and noise maskers were then presented in equated and unequated combinations in terms of the amount of masking produced. Data collection and analysis were more difficult than anticipated because of long-term training effects and large individual differences. In general, however, additional masking beyond a linear energy summation was observed, that is, masking increased more than 3 dB for each doubling of input energy. For conditions in which the masking produced by the two maskers was equated, additional masking decreased from around 12 to 2 dB as the number of components in the multicomponent masker increased from 2 to 100. The data were well fitted by Lutfi's model for combined simultaneous maskers (Lutfi, 1983, 1985), with exponents that systematically approached 1.0 as the number of components increased to approximate broadband noise.

To summarize, the combination of masking effects attributed primarily to uncertainty with those attributed primarily to stimulus energy was greater than that predicted from a linear sum of the effects of either masker alone. The pattern of additional masking was similar in form to many other combinations of simultaneous maskers, except that the growth of additional masking depended on the number of components in the masker. As the multicomponent maskers became more noise-like, the masking effects became more additive. Given that the peripheral, or energy-based masking, effect of a multicomponent masker can be estimated by shortening the signal duration, models of additivity of masking (e.g., Humes and Jesteadt, 1989) can be used to estimate the central, or informational masking, effect (Neff, Jesteadt and Callaghan, 1988).

C. Nature of the Central Processor

Exp. 1. Psychometric functions. This experiment addressed both the nature of the central processor and the adequacy of our measurement procedures. The form of the psychometric function was examined for several levels of masker uncertainty through a combination of direct measures and post-hoc analyses. The majority of studies in this research project have used a "cued" two-alternative, forced-choice, *adaptive* procedure to estimate signal threshold, in which the cue was the signal presented alone in quiet before each trial. The standard deviations associated with these threshold estimates were typically higher for multicomponent maskers than for sinusoidal or noise maskers (5-10 dB compared to 2-3 dB). This suggested that psychometric functions might be shallow for multicomponent maskers with few components, perhaps because the adaptive procedure was sampling from many different steep functions. Therefore, both adaptive thresholds and corresponding psychometric functions were obtained for 10-component maskers for both within- and between-trial masker variation. The psychometric functions for both levels of uncertainty were indeed shallow, typically spanning a range of 30-40 dB compared to the 10-dB range for broadband noise. Thresholds derived from the functions, however, were in good agreement with thresholds measured adaptively.

For between-trial masker variation, 50 of the original 200 masker waveforms were randomly selected and psychometric functions were examined for each using signal levels from 10-80 dB SPL. These psychometric functions were well fitted in d-prime by signal-level coordinates and also typically spanned a 30-40 dB range. Adaptive thresholds based on a pool of 50 maskers did not differ significantly from those based on 200, and were in agreement with the average of the predicted thresholds across the 50 maskers from the psychometric functions. Although individual maskers could differ in effectiveness by 10-15 dB, the majority produced similar masking. Overall, the adaptive procedure was judged to characterize performance adequately. For two of the original four listeners still available, psychometric functions were obtained for each of the 50 maskers under conditions of minimal uncertainty. The initial analyses indicate that the slopes of the majority of these maskers do become steeper as uncertainty is reduced, as expected, but that the range of slopes across maskers is broad.

To summarize, measurement or post-hoc reconstruction of psychometric functions for all levels of masker uncertainty indicate that the slopes are shallow and the range is 30-40 dB. Comparisons of thresholds measured adaptively to thresholds derived from these functions indicate that the adaptive procedure is adequate (Neff and Callaghan, 1987a).

Exp. 2. Memory and decision processes in conditions of high masker uncertainty. In this experiment, procedural comparisons were used as an initial approach to understanding more about the nature of the processes evoked by high masker uncertainty. Such comparisons also provided information on whether the "cued" 2AFC procedure used in the bulk of the work to date was optimal. In particular, no formal study had been done to determine whether the cue (the signal presented in quiet before each trial) was actually helpful to most listeners. Performance was compared across four procedures for multicomponent maskers with high frequency uncertainty: 1) two-alternative, forced-choice (2AFC) with a cue; 2) 2AFC without a cue; 3) single-interval, yes/no (YN) with a cue; and 4) YN without a cue. Because the YN procedures are inherently less uncertain in that only one masker sample is presented, both within- and between-trial uncertainty were used for the 2AFC conditions. Before beginning conditions with multicomponent maskers, listeners received extensive training on all procedures with broadband-noise maskers. This ensured that the listeners thoroughly understood each procedure and provided direct comparisons to the existing literature on theoretical and observed differences among procedures with simpler stimuli such as sinusoids or broadband noise. If it is the change in masker spectra across the two intervals in a 2AFC trial that degrades performance, then listeners should do as well or better in a single-interval task. This is opposite from expectations based on traditional models of signal detection, but would be predicted by Wickelgren's (1969) memory model. Because differences between procedures of theoretical importance can be quite small, and because individual differences and training effects can be large in conditions of high uncertainty, over 2000 trials were run for each condition for each of eight listeners.

The results clearly indicate that the cue was helpful in both the 2AFC and YN procedures, which confirms earlier pilot work. Presumably the cue both reinforces analytical listening and reduces memory demand for the characteristics of the signal. Surprisingly, the 2AFC procedure with within-trials variation showed significantly better performance than the YN procedure for the multicomponent maskers as well as for the broadband noise, both in terms of lower thresholds and in the speed of training to asymptote. This is reassuring in terms of the choice of procedures used in previous studies, but expectations based on the degree of masker uncertainty would have favored YN over 2AFC. Overall performance was quite poor, but listeners appeared to derive some benefit from comparing the spectra of the stimuli even when these spectra differed considerably in frequency composition.

Performance was also compared for YN and 2AFC "between-trials" procedures, both for cued and uncued conditions, to determine whether there was any effect of one versus two samples of the *same* masker sample, that is, of multiple looks at the masker. As expected, performance was better when masker spectra could be directly compared. Further data collection is needed to clarify whether criterion effects in the YN procedures degraded performance relative to the 2AFC procedures when implemented adaptively.

To summarize, 2AFC and yes-no adaptive procedures were compared, each with and without a cue. Signal cues aided detection in all procedures, and two listening intervals were better than one, contrary to expectations based on uncertainty. Although the effects are not large, listeners appear to benefit from across-interval comparisons despite the uncertain masker spectra.

Implications for Future Work

In the experiments reported here, it has been shown that masker frequency uncertainty can produce large amounts of masking in a simple detection task. Although a minority of listeners do not show these effects, those that do are remarkably resistant to training, and, of more importance, show little effect of changes in the stimuli that remove masker energy from wide regions around the signal. In future work, one can make use of this relative insensitivity to stimulus placement (in the frequency domain) to separate stimuli for masker uncertainty from those for signal uncertainty. Given the large release from masking observed across all listeners with temporal differences between stimuli, reference conditions with short stimulus durations can now be used to estimate the effects of uncertainty, in place of less reliable estimates based on reductions in the level of uncertainty. Finally, with the knowledge gained from this research program about the stimuli and procedures which produce large effects of masker uncertainty, new stimuli and procedures can be developed which will allow the effects of masker uncertainty to be quantified and allow more general models of auditory processing under conditions of high stimulus uncertainty to be developed.

III. Cumulative Publications Years 1-3

Articles and Chapters

Neff, D. L., and Callaghan, B. P. (**1987b**). "Simultaneous masking by small numbers of sinusoids under conditions of uncertainty," in *Auditory Processing of Complex Sounds*, edited by W. A. Yost and C. S. Watson (Erlbaum: Hillsdale, New Jersey), 37-46.

Neff, D. L., and Callaghan, B. P. (**1988a**). "Effective properties of multicomponent simultaneous maskers under conditions of uncertainty," J. Acoust. Soc. Am. **83**, 1833-1838.

Neff, D. L. (**1990a**). "Forward masking by maskers of uncertain frequency content," J. Acoust. Soc. Am., in press.

Abstracts

Neff, D. L., and Callaghan, B. P. (**1987a**). "Psychometric functions for multicomponent maskers with spectral uncertainty," J. Acoust. Soc. Am. Suppl. 1 **81**, S53.

Neff, D. L., and Callaghan, B. P. (**1988b**). "Frequency effects for multicomponent maskers with high spectral uncertainty," J. Acoust. Soc. Am. Suppl. 1 **84**, S141.

Neff, D. L., Jesteadt, W., and Callaghan, B. P. **(1988)**. "Combined masking under conditions of high uncertainty," J. Acoust. Soc. Am. Suppl. 1 **83**, S33.

Neff, D. L. **(1989)**. "Signal parameters that reduce masking produced by multicomponent maskers with high spectral uncertainty," J. Acoust. Soc. Am. Suppl. 1 **85**, S143.

Neff, D.L. **(1990b)**. "Relative effects of uncertainty in overall level, component level, and component frequency for multicomponent simultaneous maskers," J. Acoust. Soc. Am. Suppl. 1 **87**, S158.

Other Presentations

Neff, D.L. "Detection of familiar signals in arbitrary backgrounds," AFOSR Conference, December 1987, Chicago, IL.

Neff, D.L. "Detection of familiar target sounds in the presence of constantly changing background sounds," Colloquium Series, Psychology Department, University of Nebraska, September 1987, Lincoln, NE.

Neff, D.L. "Reducing the effects of masker frequency uncertainty." Colloquium, Waisman Center, University of Wisconsin, June 1989, Madison, WI.

Neff, D.L. "Signals which reduce the effects of masker frequency uncertainty," MLD Society meeting, July 1989, Bloomington, IN.

Neff, D.L. "Ignoring irrelevant stimuli: Problems in uncertain listening situations," Colloquium, Department of Hearing and Speech, University of Kansas Medical Center, November 1989.

Manuscripts in Preparation

Neff, D.L. "Psychometric functions for multicomponent maskers under varying degrees of masker uncertainty," to be submitted to J. Acoust. Soc. Am.

Neff, D.L. and Jesteadt, W. "Combined masking under conditions of masker spectral uncertainty," to be submitted to J. Acoust. Soc. Am.

Neff, D.L. "Reducing simultaneous masking produced by masker frequency uncertainty," to be submitted to J. Acoust. Soc. Am.

IV. Consultants

Dr. David M. Green, from the University of Florida at Gainsville, spent two days in our laboratory in December 1987. Although funds were allocated in the grant for his visit, they were not needed, as Dr. Green simply extended his stay in Omaha after an Advisory Board Meeting for the Institute. Discussions with Dr. Green on theoretical issues related to psychometric functions and the relation of our research to his work in profile analysis were particularly useful.

Given the availability of consultant funds, Dr. Robert Lutfi, from the Waisman Center and Department of Speech and Hearing at the University of Wisconsin, came as a consultant for two days in September 1988. Dr. Lutfi's recent work in the area of informational masking is directly relevant to this research program. Dr. Lutfi has been working on a model derived from information theory to account for the results of his experiments in which listeners are asked for judgments about the underlying distributions for stimuli which vary in one or more dimensions, such as frequency and level. It is not clear, however, how to relate either the data or the theory to situations in which the variation is in the "irrelevant" rather than "relevant" dimension.

In June 1989, I was invited to spend several days in Dr. Lutfi's laboratory at the University of Wisconsin as a consultant. We discussed a series of experiments to help bridge the gap between research on uncertainty in "relevant" (signal) versus "irrelevant" (masker) stimuli, and to provide information needed for a more general theory of informational masking.

With Year 3 consultant funds, Dr. Gerald Kidd from the Department of Communication Disorders at Boston University spent two days in our laboratory. We have worked collaboratively on a project involving stimulus uncertainty in frequency discrimination since 1983. Dr. Kidd's continuing work on "profile analysis" and, in particular, his recent work on the effects of level variation (both in overall masker level and component amplitudes) is directly related to experiments conducted in our laboratory this past year.