Role of masker predictability in the cocktail party effect

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ABSTRACT
A cocktail party is an unpredictable auditory environment. Masking consists of an energetic component due to target and maskers exciting the same auditory filters and an informational component which is believed to reflect uncertainty. With some maskers there is a substantial informational component, with predictability release from masking when there is actual or perceived spatial separation between target and maskers that is found with other broadband maskers such as Gaussian noise or modulated noise. In the current experiments subjects identified a target word spoken by a male talker presented in five fixed formats: 1. 2 or 3 maskers arrayed in the horizontal plane in a 40 A-bc task. Ten masking conditions were used to study the predictability of the masking condition varied from 10% to 60%. We hypothesized that fixed SNR percent correct and spatial release from masking increased with increasing predictability. There was high individual variability in percent correct and in spatial release from masking and neither measure showed a significant effect of predictability. This suggests predictability of the spatial location of maskers is less important than predictability of other features such as content and that existing clinical measures adequately estimate spatial release from masking in normal hearing subjects.

ADDENDUM
There was concern that the fixed SNR approach may have underestimated the effects being studied. Since publication of the abstract a second study was completed in which several methodological changes were implemented: 1) Speech reception thresholds (SRTs) were measured adaptively. 2) Listeners were familiarized with the acoustic environment for many more trials prior to data collection. 3) We investigated whether simulating the lab environment by reducing the speaker array and using just two masking conditions affects the findings of the first study, with no effect of predictability on SRT or spatial release from masking. Reducing the array of speakers and masking conditions also had no effect on SRT or release. Taken together these findings support the hypothesis that predictability of the "cocktail party" environment informational masking may be specific to the predictability of the content of the maskers, but not the predictability of the number and/or location(s).

INTRODUCTION
Rationale: Masking of speech targets by speech interferers represents a familiar "cocktail party" scenario. Natural sounds are highly predictable factors that are most important in determining the amount of masking or spatial release from masking (SRM). Studies on informational masking, primarily with non-speech materials, have shown that increased predictability of the background interferers results in decreased masking in a "cocktail party" environment, many aspects of the maskers can vary unpredictably, including the content, location, number and other variables. Here we present results from studies that investigated the effect of speech masker unpredictability on speech intelligibility. In particular, we focused on the variability that can occur in the location and/or number of speech maskers in a realistic acoustic environment.

Choice of materials: One of the long term goals of this research is to extend our measures to patient populations and children. Many of the materials commonly used in speech masking experiments are other too difficult, as with Harvard IEEE sentences (Hawley, et al., 1999), or are comprised of a small cohort, which limits the number of conditions (HRTT sentences). In the experiments presented here we used a closed set of spondees, which simplifies the task, is suitable for clinical populations and children, and allows for repeat presentation of the same targets. Possible clinical applications: Typically, clinical procedures do not vary the masking condition from trial to trial, creating a listening environment that is more predictable than the real world. As a result they may underestimate the masking that will occur for the patients in realistic environments. If that is the case, then the procedure used here can easily be applied in clinical settings to more correctly predict performance of patients in the real world.

STUDY 1: Fixed SNR % correct, brief familiarization
Hypothesis 1: Performance on the task will improve with increasing predictability.
Hypothesis 2: Spatial release from masking will be greater with increasing predictability.

Method:
1. 10 masking conditions (see Fig. 1 above) 2 or 3 maskers on any given trial
2. Blocks of trials
   ➤ Equal: each condition 10% of trials
   ➤ Unequal: one condition: 20, 40, 60 or 80% (Remaining conditions varied randomly)
3. Start of each block: 20 familiarization trials
4. Blocks divided among 7 two-hour visits
5. Order of blocks balanced across subjects

RESULTS:
1) Greater masking for 2 maskers (0/0 and +90/+90) than for one (0 and +90), regardless of overall level equivalency (p < 0.0001)
2) Increased release is less marked when maskers are limited to only one hemifield (p < 0.0001)
3) No effect of predictability on performance
4) No effect of predictability on release from masking
5) High individual variability
6) Ceiling and floor effects for some subjects in some conditions

METHODS

STUDY 2: Adaptive procedure, long familiarization
Hypothesis 1: SRT will decrease with increasing predictability.
Hypothesis 2: Speech intelligibility will be greater with increasing predictability.
Hypothesis 3: SRT will be lower in the reduced masker array.
Hypothesis 4: Spatial release from masking will be greater in the reduced masker array.

Method:
1. SRTs measured adaptively in a 3-down 1-up procedure
2. Blocks of trials:
   ➤ Equal: each condition 20% of trials
   ➤ Unequal: one condition 80% of trials, rest of conditions 5% each
   ➤ Unequal: two only conditions in block: 0/0 +90/+90, 80/20 ratio
3. Start of each block: 100 familiarization trials
4. Blocks divided among 3 two-hour visits

RESULTS:
1) Increased release from masking when maskers are limited to only one hemifield (p < 0.001)
2) No effect of predictability on SRT
3) No effect of predictability on release from masking
4) Reducing the array of maskers had no effect on release from masking
5) Reducing the array of conditions had no effect on release from masking
6) Low individual variability
7) Longer familiarization did not change the basic result of study 1