# TIMBRAL SEGREGATION OF SIGNALS AND THE AUDITORY ATTENTIONAL BLINK

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## 1. INTRODUCTION

This study serves as a continuation of previous inquiries by Slawinski and Goddard (1999: Goddard and Slawinski, 2001) into the nature of the Auditory Attentional Blink (AAB). AAB effects are seen experimentally when dynamic sound streams are presented to participants who are instructed to attend and respond only to those sounds within the stream that meet some criterion (e.g., those that are louder than the others). A "blink" is said to occur when two to-be-attended (TBA) signals are presented in rapid succession and are reported as a single signal. The effect does not occur due to energy masking, but rather due to some shortcoming in sensory or cognitive processing. Supposedly, one signal's processing is not completed due to the processing of the other signal. The former is referred to as the Probe (P), and the latter as the Target (T). It is unknown precisely what causes this effect, what physical parameters are necessary to produce the effect, and whether or not the effect is similar in its causes to the Attentional Blink in vision, about which far more is known.

A typical blink task will involve the presentation of several streams of stimuli, some of which contain P alone, and some of which contain T and P. Increased failure to report P in the presence of T defines the blink effect. In visual research, this is typically observed when the onsets of T and P are about 450ms apart (e.g., Raymond, Shapiro & Arnell, 1992). The criterion that is used to segregate TBA signals from the rest of the stream may be varied between blink tasks, and the results of this variation are as yet unexplored. Previous studies have typically employed intensity as the criterion, yielding a clear AAB effect (e.g., Slawinski and Goddard, 2001). The current study employs spectral characteristics as the criterion, and is aimed at further clarifying parameters necessary for producing the AAB in hopes of learning more about possible causes for the effect. Specific aims of the study will be to determine what kind of a blink effect (if any) this streaming task will produce, to explore possible differences between TBA-signal identification and mere detection tasks, and to look for learning effects in the AAB phenomenon. Learning effects are expected, since the blink does not seem to significantly affect our perception of speech– a rapidly changing signal and a likely candidate for the AAB effect. Learning effects may help explain this.

## 2. METHOD

### 2.1. Participants

29 volunteers participated in the study. All were screened and met criteria for normal peripheral hearing (at a level sufficient to discriminate between sounds being used in the study). Participant age ranged from 19 to 51 years. Data from seven participants were not included in analyses, mainly due to their apparent misunderstanding of the task.

### 2.2. Stimuli

Participants listened to several streams of pure-tone distractor signals with complex TBA signals embedded among them. All signals were comparable in intensity and envelope. Signals that participants were asked to attend to consisted of an organ and a bell sound sampled from a synthesizer, while filler signals in the streams consisted of tones varying in frequency between 200Hz and 2.5kHz. Streams consisted of a total of 16 sounds each.

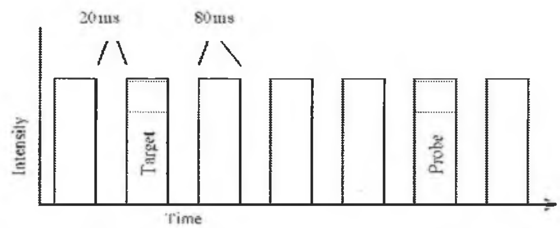


Figure 1. Diagram of a portion of one experimental signal stream. Inter-stimulus intervals and signal durations are shown. Variations in timbre are represented by variations in colour.

### 2.3. Procedure

Example streams were played for participants until they demonstrated that they understood the task and that they could accurately discern targets from the filler sounds.

Each participant listened to 80 streams during their trial. Half of the participants were asked to simply indicate how many targets (zero, one, or two) they had heard in each stream, while the other half were asked to identify the sounds they heard (the sounds were given labels before these participants' trials, which were taught to the participants). 40 streams in each trial contained only P as a control measure (a measure of the likelihood of a participant's reporting P in the absence of T), while the other 40 contained both T and P (a measure of the effects of the presence of T on the report of P). Delay between the onset of T and the onset of P in experimental streams (those containing both P and T) was also varied between 100 and 500ms in 100ms steps, a variable known as Stimulus Onset Asynchrony (SOA). Streams of varying SOA and condition (experimental/ control) were played in random order. As a final independent variable, each participant's performance on streams from the first half of each trial (20 experimental and 20 control streams) was compared with performance in the second half of each trial (20 experimental and 20 control streams) to assess learning effects.

## 3. RESULTS

A mixed-model ANOVA revealed significant main effects for SOA and Condition (control versus experimental), as well as a significant learning effect. Significant Learning by Condition and Condition by SOA interactions are shown graphically below.

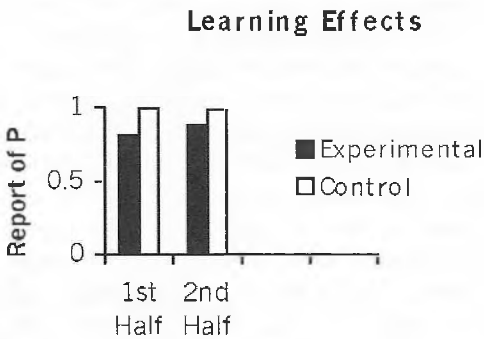


Fig. 2. Significant learning effect. X axis shows 1st v/s 2nd half of trials performed by each participant, Y axis shows the likelihood out of one of reporting P when presented with (black bar) and without (white bar) T. Performance in experimental trials improved significantly for the second half of trials performed. SOA of individual streams was balanced between the two halves of each trial.

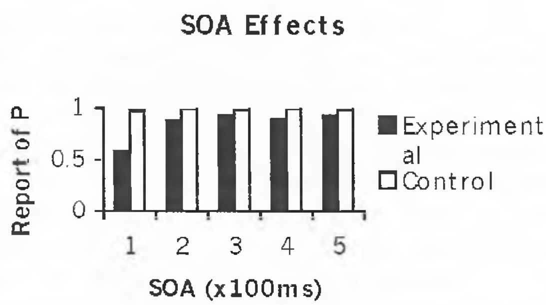


Figure 3. Significant blink effects were seen at SOAs 1, 2 and 5. Y axis shows the likelihood out of one of reporting P when presented with and without T.

## 4. DISCUSSION

As is shown in Fig. 2, a blink effect was observed at SOAs 1, 2, and 5. The lack of statistically significant effects at SOAs 3 and 4 was most likely due to lack of statistical power and increased variance within these SOAs. These results suggest that the AAB is robust across streaming tasks, although further manipulation of streaming tasks may be necessary to determine this with more certainty.

The lack of an effect of task demands (identify versus detect) suggests that the root of the AAB is at some step in signal processing common to both processes, as they were carried out in this experiment specifically. It is possible, however, that this result is merely an artifact of participants carrying processing of signals through to an identification in spite of the fact that they had not been taught labels for the TBA signals in the "detect" condition- i.e., participants may have attached their own labels to these sounds and attempted to discriminate them from each other even in this condition. Further research is required to determine which common processing step is responsible for the non-effect, and to determine whether or not it was also an artifact of a lack of statistical power in this study.

Learning effects (i.e., amelioration of the blink after repeated exposure to stimuli) observed in this experiment provide an interesting new basis for study– the AAB is evidently not an absolute limitation of the system, rather it is caused by limitations that are resolved as stimuli become more familiar. One candidate for such a process may be streaming itself; auditory scene analysis seems prone to learning effects (Bregman, 1990), and it has been demonstrated in previous Attentional Blink research that easier streaming tasks (i.e., those involving more exaggerated differences between TBA and not-TBA signals) yield weaker blink effects (Raymond et al. 1995).

## 4. REFERENCES

Bregman, A. S. (1990). Auditory Scene Analysis: The Perceptual Organization of Sound. (Authored Book). MIT Press, Cambridge, MA.

Goddard, K. M. and Slawinski, E. B. (1999). Modality Specific Attentional Mechanisms Can Govern the Attentional Blink. Canadian Acoustics, 27, 98-99.

Raymond, J. E., Shapiro, K. L. & Arnell, K. M. (1992). Temporary Suppression of Visual Processing in an RSVP Task: An Attentional Blink? Journal of Experimental Psychology: Human Perception & Performance, 18, 849-860.

Raymond, J. E., Shapiro, K. L. & Arnell, K. M. (1995). Similarity Determines the Attentional Blink. Journal of Experimental Psychology: Human Perception & Performance, 21, 653-662.

Slawinski, E. B. and Goddard, K. M. (2001). Age-Related Changes in Perception of Tones Within a Stream of Auditory Stimuli: Auditory Attentional Blink. Canadian Acoustics, 29, 3-12.