Attentional Capture by Sound Disappearance

Nicholaus P. Brosowsky (umbroson@cc.umanitoba.ca)
Todd A. Mondor (todd.mondor@umanitoba.ca)
Department of Psychology, University of Manitoba
190 Dysart Rd, Winnipeg, MB R3T 2N2

Abstract

Three experiments are reported in which the attentional capture effect of sound disappearance was assessed. In all experiments participants were required to judge the pitch of target sounds that were preceded by one or more context sounds. In Experiments 1 and 2, targets presented in the same location as a context sound that had abruptly terminated 100 ms before its presentation, were identified better than target sounds presented in a different location. This result was obtained both when targets followed a single context sound (Experiment 1) and when targets followed pairs of dichotically-presented context sounds that terminated at different points (Experiment 2). The results of Experiment 3 replicated those obtained in the previous experiments and showed that under some conditions the facilitative effect could persist at intervals longer than 100 ms. The results of these experiments suggest that under some conditions, the disappearance of a sound can capture attention.

Keywords: Auditory; sound; attention capture; disappearance, offset; exogenous.

Introduction

Given our dynamic, perceptually rich environment, it seems intuitively reasonable that an abrupt change, such as the sudden appearance or disappearance of an object, might cause a reflexive allocation of attention towards that change. Such a shift in attention would permit an appropriate and timely response. Not surprisingly, current research suggests that our perceptual and attentional processes responsible for keeping track of the continuous flow of information about objects and events have adapted in a way that allows a constant updating of our perceptual representations to reflect any relevant change in our environment (Samuel & Weiner, 2001).

There is a large body of literature suggesting that the abrupt appearance of a visual or auditory stimulus can attain attentional priority irrespective of our goals and beliefs (Theeuwes, 1991; Yantis & Jonides, 1984). Such stimuli (or cues), when placed near a target stimulus (Mondor & Bryden, 1992; Posner, 1980) or which contain similar properties to the target (Mondor & Lacey, 2001), have been shown to produce facilitative effects in target discrimination paradigms. Researchers generally agree that these cues automatically draw attention to a particular location or property even if they provide no predictive information regarding the target and do not share any features with it. This involuntary allocation of attention is commonly referred to as *attention capture* (Mulckhuyse & Theeuwes, 2010).

Similar evidence has been reported in the visual literature suggesting that the sudden disappearance of a stimulus can also capture attention (Pratt & McAuliffe, 2001; Theeuwes, 1991; Yantis & Jonides, 1984). Pratt and McAuliffe (2001), for example, used a location-cue paradigm, similar to that developed by Posner and Cohen (1980), to investigate the effects of object disappearance. Participants were presented with two place-holder boxes to the left and right of a fixation point. A dot could either appear in one of the boxes (onset cue) or the display would begin with the cue and disappear (offset cue) prior to target presentation. Similar to previous results, early SOAs (100 ms) produced a facilitative effect while later SOAs (900 ms) produced an inhibitory effect.

Given the amount of empirical investigation into object disappearance in visual attention, it is surprising that there are no analogous studies in auditory attention using the traditional cue paradigm. There are however, a few studies that have examined the role of onset and offset cues with respect to the “Simon effect”. Most recently, a study by Nishimura and Yokosawa (2010) investigated the effects of auditory accessory stimulus onsets and offsets on the Simon effect. Participants in this study responded to a centrally presented visual target with either a right or left key-press and the accessory stimuli were presented binaurally through headphones. The accessory stimuli consisted of a 300 Hz pure tone and white noise. In the onset condition, a central fixation point was presented for 2000 ms followed by the target stimulus and one of the accessory stimuli (presented monaurally to the left or right ear) presented simultaneously. In the offset condition, the pure tone and white noise were presented dichotically with the central fixation cross for 2000 ms, at which point one of the two sounds would offset simultaneously with presentation of the target stimulus. The results of this study showed response time facilitation when the key-press corresponded with the location of the accessory stimulus in the onset condition. In the offset condition, responses were significantly quicker when the key-press corresponded with the auditory channel that persisted rather than the offsetting channel.

There are, however, some important differences between these studies on the Simon effect and traditional cue paradigms. First, Nishimura and Yokosawa’s (2010) study utilized a crossmodal paradigm where the target was visual and the cues were auditory. Considering the results in visual offset studies vary greatly, and some differential effects are found in cross-modal attention capture studies (Spence & Driver, 1996), it is unclear how the cross-modal offset results would correspond to a unimodal paradigm. Secondly, in a typical Simon effect experiment the cue and target are presented simultaneously, while in typical cue paradigm facilitative effects are found when the cue precedes the target by 50 to 200 ms (Mondor & Lacey, 2001; Spence & Driver, 1994). Lastly, and perhaps most importantly, the accessory Simon task does not involve target localization. In the typical cue paradigm target location is irrelevant to the discrimination or detection task and the target can appear in multiple locations. In contrast, the accessory Simon task consistently presents the target in the center of the display. From these results, it is unclear whether an auditory offset can cause a reflexive allocation of attention to the corresponding location.

The present study has been designed to investigate whether similar effects of object disappearance in visual attention will be found in auditory attention. All three experiments were designed in a similar fashion as the location-cue paradigms used by Posner (1980), Pratt and MacAuliffe (2001) and Mondor and colleagues (e.g., Mondor & Lacey, 2001). Given the inconsistent results in the visual attention literature, it is unclear whether early or late target presentation will produce facilitative, inhibitory or null effects.

Experiment 1

In Experiment 1 participants were presented with a single context sound followed by a target sound, each of which could be presented from the right or left speakers.

The targets followed the context sound with an inter-stimulus interval (ISI) of either 100 or 200 ms. A target discrimination task, judging the pitch of the target (high or low), was performed for all trials. In order to learn how to discriminate between the high and low tones participants were required to complete a training session before completing 96 experimental trials. While similar to a traditional cuing paradigm, previous research studying abrupt onsets used short cue durations (50 ms) with varied stimulus-onset asynchronies (50 to 750 ms) between the cue and target. To avoid possible onset effects, the context sound in the current study was 1000 ms in duration with a varied inter-stimulus interval (100 or 200 ms). Given that this design employs a task independent of lateralization, evidence of attention capture will be apparent if responses on Valid trials (those trials where the cue offset and target are located in the same channel) are executed more quickly than Invalid trials (trials where the target and cue are presented in different channels) as per other classic location-cue studies (Mondor & Bryden, 1991, 1992; Posner, 1980; Pratt & McAuliffe, 2001; Spence & Driver, 1994).

Method

Participants. Twelve undergraduate students attending the University of Manitoba participated in exchange for course credit. None of the participants reported any corrected or uncorrected hearing impairments.

Materials.

Computer and sound system. The experiments were controlled by a Dell Pentium computer operating at 800 MHZ running the E-Prime programming software (Psychology Software Tools, Inc., 2003). Sounds were presented over Altec Lansing speakers (model #VS2620) at a 45° angle from the listener and at an intensity of approximately 70 dB.

Sounds. Sounds were synthesized using Adobe Audition 1.5 (Adobe, 2004) at a sampling rate of 44100 Hz. Two target sounds were created. Both of these were pure tones, one at 262 Hz and the other at 330 Hz, and both were 100 ms in duration including 5 ms onset and offset amplitude ramps incorporated to eliminate clicks associated with abrupt intensity changes. In addition, two context sounds, a 'buzz' and a 'croak', were also synthesized (these were identical to sounds with the same names created and used by Leboe & Mondor, 2007). The *buzz* context sound was created using a square wave and included a fundamental frequency of 200 Hz plus the first (400 Hz), second (600 Hz), third (800 Hz) and fourth (1000 Hz) harmonics. In relation to the intensity of the fundamental frequency, the harmonics were presented at 40%, 30%, 20% and 10%, respectively. The *croak* context sound was created using a sine wave with a fundamental frequency of 500 Hz that was modulated randomly between 450 and 550 Hz at a rate of 40 times per second. The *buzz* and *croak* sounds were each 1000 ms in duration including 5 ms onset and offset amplitude ramps.

Procedure. The experiment consisted of a training session, two practice sessions and an experimental session. During the training session participants were instructed to listen to the target tones until the distinction between them was clear (verbal confirmation). Following the training session, the first practice session began. During each trial, one of the target tones (100 ms in duration) was presented in isolation following 500 ms of silence. The participants were instructed to indicate whether the tone presented was the high- or low-pitched tone using the keyboard ('1' for high-pitched and '2' for low-pitched). Participants received accuracy feedback (presented on the computer screen: correct or incorrect) following each response and were instructed to initiate the next trial when they were ready by pressing the space-bar on the keyboard. Each participant was required to achieve 70% accuracy to move on to the second practice session. If a participant did not meet this criterion they were required to go through the training session again and complete another block of practice trials. The second practice session consisted of 16 trials and was identical to the experimental trials, except that participants received accuracy feedback following each response. Participants were required to achieve 70% accuracy on the second practice session before moving on to the experimental trials. If a participant did not meet this criterion after the first block they repeated one or more blocks of 16 practice trials until they had done so.

For the experimental session, participants were presented with either the buzz or croak context sound in either the left or right channel followed by one of the two target tones presented in either the left or right channel. The time period between the end of the context sound and the beginning of the target sound (Inter-Stimulus Interval or ISI) could be either 100 ms or 200 ms. On half of the 96 trials, the target sound was presented in the same location as the preceding context sound (these will be referred to as 'Valid trials'), and on the other half of the trials the target sound was presented from the channel opposite the context sound (these will be referred to as Invalid trials). Across trials, the high- and low-pitched sounds were presented equally often and each of these were preceded equally often by the buzz and croak context sounds.

Results and Discussion.

Mean correct RT (outlying RTs, defined as those more or less than 2.5 standard deviations from the initial mean, were eliminated from the calculation of mean RT used in this and all other experiments) and error rate as a function of Trial Type and ISI are described in Table 1. Both RT and error rates were submitted to a two-way within-subjects analysis of variance (ANOVA; Trial Type [Valid, Invalid] X ISI [100, 200]). The RT analysis revealed significant main effects of Trial Type, $F(1,11) = 6.55$, $p = .027$, and ISI, $F(1,11) = 25.10$, $p < .001$, and a significant interaction between ISI and Trial Type, $F(1,11) = 8.78$, $p = .013$. The analysis of error rates produced no significant results in all cases ($p > .05$).

To explore the significant effects on RT, performance was examined separately for the 100 ms and 200 ms ISI conditions. At 100 ms ISI, RT varied significantly as a function of trial type, $F(1,11) = 10.19$, $p < .01$, as participants responded significantly more quickly on Valid trials (M = 577 ms) than on Invalid trials (M = 607 ms). At 200 ms ISI, however, performance on the two trials types did not differ significantly ($p > .05$).

Table 1: Mean response times (RT) and percent error rates (PE) with standard deviations (in parentheses) from Experiment 1.

		Valid	Invalid
100 ms ISI	RT (ms)	577 (31.94)	607 (31.55)
	PE	5.03 (1.18)	6.08 (1.61)
200 ms ISI	RT (ms)	553 (31.54)	555 (29.70)
	PE	5.9 (2.12)	6.95(1.32)

Given that the response times were faster when the target followed the disappearance of the context sound at the early ISI of 100 ms these results can be taken as preliminary evidence that object disappearance can direct attention. However, it is possible that the absence of any sound in the opposite channel was in fact directing attention as opposed to the sound offset. Another possibility is that the onset of the cue produced a facilitative effect. Experiment 2 was designed to address these issues by adding a second, competing context sound, while maintaining the paradigm of Experiment 1. If it was in fact the offset of the context sound directing attention in Experiment 1, then the results should be replicated Experiment 2 despite the added context sound.

Experiment 2

The results of Experiment 1 are consistent with the possibility that the disappearance of an auditory object can capture attention at short ISIs (100 ms). In Experiment 2, we sought to determine whether this result would be replicated when two context sounds are presented simultaneously, one ending before the other. Similar to Experiment 1, one context sound offset either 100 or 200 ms prior to the presentation of the target while the second context sound ended 25 ms prior to the target (see Figure 1). There is a large body of evidence that suggests that at least 50 ms is required to disengage attention and shift to a new object (Logan, 2005; Theeuwes, Godijn, & Pratt, 2004). We reasoned that 25 ms was likely an insufficient amount of time to redeploy attention to the other channel prior to the target onset. Therefore, in this paradigm, evidence of attention capture will be apparent if responses are executed more quickly when the target is presented in the same channel as the earlier offsetting context sound. This also eliminates a possible confound in Experiment 1, that the valid trials were facilitated by the presentation of a single context sound in only one channel.

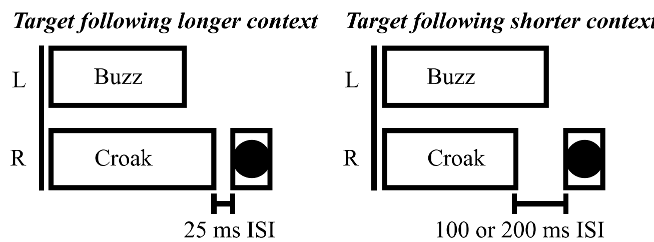

Figure 1. Schematic illustration of Experiment 2.

Method

Participants. Thirty undergraduate students attending the University of Manitoba participated in exchange for course credit. None of the participants reported any corrected or uncorrected hearing impairments.

Materials. The computer, sound system and sounds used in Experiment 2 were identical to those used in Experiment 1. The experimental paradigm was similar to the first experiment except that different context sounds were presented concurrently from different locations (one from the left channel and one from the right channel). In addition, whereas one of the context sounds terminated either 100 or 200 ms prior to the onset of a target, the other terminated 25 ms prior to the target. The target sound was presented either in the same location as the longer context sound (25 ms ISI) or in the location of the shorter context sound (100 or 200 ms ISI). Therefore, the two context sounds began at the same time but one ended 75 ms or 175 ms before the other. Several different durations of the context sounds were used so that listeners were unable to anticipate precisely when

Table 2: Mean response times (RT) and percentage errors (PE) with standard errors (in parentheses) for both measures, as a function of Context and Channel in Experiment 2

		Target following longer context sound (25 ms ISI)	Target following shorter context sound (100 ms or 200 ms ISI)*
Small-Context-Difference	RT (ms)	697 (32.48)	674 (29.43)
	PE	7.74 (1.33)	6.28 (1.44)
Large-Context-Difference	RT (ms)	654 (29.43)	666 (28.53)
	PE	6.04 (1.33)	6.98 (1.73)

**ISI was 100 ms in the 'Small-Context-Difference' condition and 200 ms in the Large-Context-Difference condition*

they might end. Specifically, the shorter / longer durations (in ms) of the pair of context sounds used on a particular trial could be 1000 / 1075, 1450 / 1525, 1950 / 2025, 900 / 1075, 1350 / 1525, and 1850 / 2025. Target sounds were randomly presented to either the left or right channel and could occur either 25 ms after the context sound that ended last or 100 ms or 200 ms after the context sound that ended first.

Procedure. The procedure for Experiment 2 was similar to that used in Experiment 1. However, as noted above, two context sounds were presented dichotically on each trial . One of these ended 75 ms or 175 ms before the other and the single target sound presented on each trial could occur either in the same channel as the context sound that ended first (ISI in this case was either 100 ms or 200 ms) or in the same channel as the context sound that ended last (ISI in this case was 25 ms). The target sound was always presented after both context sounds had ended.

We thought it possible that the overall context in which targets were presented may have an impact on performance. For this reason we designed the experiment so that participants completed an equal number of trials when the context sounds differed in duration by 75 ms (referred to as the 'small-context-difference' condition) and when they differed by 175 ms (referred to as the 'large-context-difference' condition). Within each of these conditions, participants completed an equal number of trials when the target was presented in the same channel as the context sound ending first (referred to as 'target following shorter context sound') and when the target was presented in the same channel as the context sound ending second (referred to as 'target following longer context sound'). We preserved this distinction in our analysis and evaluated performance for the small-context-difference and large-context-difference conditions separately.

Participants completed a total 196 experimental trials. All other methodological details were the same as for Experiment 1.

Results and Discussion

Mean correct RT and error rates as a function of Channel and Context are displayed in Table 2. As in Experiment 1, a two-way within-subjects ANOVA (Channel [Target following longer context sound, Target following shorter context sound] x Context [Small-Context-Difference, Long-Context Difference]) was conducted using RT and error rates as the dependent measures. The RT analysis showed a significant main effect of Context, $F(1,29) = 9.97$, $p = .004$, and a significant interaction between Context and Channel, $F(1,29) = 5.33$, $p < .028$. The main effect of Channel was not significant, F (1, 29) = 1.03, p = .32.

A separate analysis of the Small-Context-Difference condition revealed that RT varied significantly as a function of Channel, $F(1,29) = 5.05$, $p = .032$; participants responded significantly more quickly when the target followed the shorter context sound ($M = 674$ ms) than the longer context sound ($M = 697$ ms). However, in the Large-Context-Difference condition there was no significant difference in response times. $F(1,29) = 1.93$, $p = .176$.

The analysis of error rates produced no significant main effects of Context or Channel ($p > .05$). There was a significant interaction effect between Context and Channel [$F(1, 29) = 6.07$, $p = .02$], though further analysis of the Small- and Large-Context-Difference conditions revealed no significant differences between error rates ($p > .05$).

Participants responded more quickly to the target when it followed the shorter context sound but, as with Experiment 1, this effect occurred only when the target followed at 100 ms ISI and not when it followed at 200 ms ISI. These results, again, suggest that the sudden disappearance of sound can direct attention.

Experiment 3

Experiment 3 was designed to replicate the findings in Experiment 2 while extending the paradigm to examine the effects of later target presentation. As noted above, the visual attention literature is inconsistent about how long the attentional capture effect will persist following object disappearance; therefore it is unclear what the effects of the longer ISI will be. Furthermore, the results of Experiment 1 would suggest that later target presentation will lead to null effects, but it is unclear whether the presentation of two competing context sounds will cause differential effects. In Experiment 3, the conditions used in Experiment 2 are included again along with conditions in which the target is presented at longer ISIs.

Method

Participants. Sixteen undergraduate students attending the University of Manitoba participated in exchange for course credit. None of the participants reported any corrected or uncorrected hearing impairments.

Materials. The computer, sound system and sounds used in Experiment 3 were identical to those used in Experiment 2.

Procedure. The procedure for Experiment 3 was identical to Experiment 2 except that target sounds could be presented either 25 ms following the last-ending context sound and 100 or 200 ms following the first-ending context sound (Brief ISI condition; see Figure 1) or either 425 ms following the last-ending context sound and 500 or 600 ms following the first-ending context sound (Long ISI condition; see Figure 2). These additional ISIs were incorporated to assess the time-course of orienting in response to abrupt offsets.

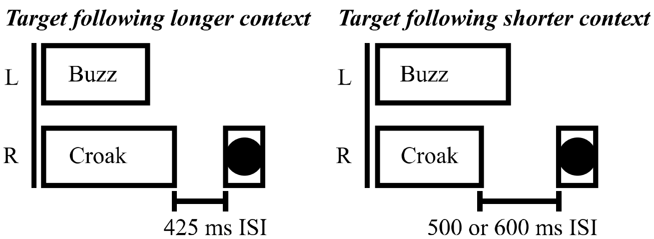

Figure 2. Schematic illustration of the Long ISI trials in Experiment 3.

In keeping with the reasoning we elaborated in Experiment 2, we designed the experiment so that performance could be evaluated separately for each combination of the relative durations of the context sounds. Thus, the data was analyzed as a three-way factorial design (ISI Category [Brief, Long] X Channel [Target following longer context sound, Target following shorter context sound] X Context (Small-Context-Difference, Large-Context-Difference).

Experiment 3 was the same as Experiment 2 in all other respects.

Results and Discussion

Mean correct RT and error rate as a function of Context, Channel and ISI are described in Table 3. A three-way within-subjects ANOVA (ISI Category [Brief, Long] X Channel [Target following longer context sound, Target following shorter context sound] X Context (Small-Context-Difference, Large-Context-Difference) was conducted for the RT and error rates. The analysis of error rates yielded no significant effects in all cases ($p > .05$). The RT analysis revealed a significant main effect of ISI Category, $F(1,15) = 60.95$, $p < .001$, and a significant interaction effect between Context and Channel, $F(1,15) = 8.77$, $p = .01$.

To remain consistent with earlier RT analyses, each of the Context conditions was analyzed separately. The RT analysis of the Small-Context-Difference condition revealed a main effect of ISI Category, $F(1,15) = 51.99$, $p < .001$, and Channel, $F(1,15) = 11.35$, $p = .004$. Overall, participants responded more quickly when the target followed the shorter context sound ($M = 568$ ms) than when it followed the longer context sound ($M = 589$ ms) and response times in the Long ISI condition ($M = 554$ ms), were significantly faster than the Brief ISI condition ($M = 612$ ms).

Further analysis of the Brief ISI condition revealed that participants responded significantly more quickly when the target followed the shorter context sound ($M = 601$ ms) than when it followed the longer context sound ($M = 624$ ms), $F(1, 15) = 6.35$, $p = .024$. Likewise, in the Long ISI condition participants also responded significantly more quickly when the when the target followed the shorter context sound ($M = 536$ ms) rather than the longer context sound ($M = 553$ ms), $F(1,15) = 5.28$, $p = .036$.

The analysis of the Large-Context-Difference condition revealed a significant effect of ISI Category, $F(1,15) = 31.39$, $p < .001$, though no significant effect of Channel, $F(1,15) = .199$, $p = .662$, and no interaction effect, $F(1, 15) = 1.12$, $p = .307$. Further analyses of the Brief and Long ISI categories produced non-significant results; RT did not significantly vary as function of Channel placement in either the Brief, $F(1,15) = .227$, $p = .606$ or Long ISI conditions, $F(1,15) = 1.5$, $p = .240$.

The results of the Brief ISI condition replicated the findings of Experiment 2, where participants responded more quickly when the target followed the shorter context sound on the Small-Context-Difference trials (100 ms ISI), but not on the Large-Context-Difference trials (200 ms ISI). Likewise, in the Long ISI condition, participants responded more quickly when the target followed the shorter context sound on the Small-Context-Difference trials (500 ms ISI), but not on the Large-Context-Difference trials (600 ms ISI). Therefore, there was a significant attentional capture effect when there was a small difference between the offsets (75 ms), but not when there is a large difference (175 ms).

Table 3: Mean response times (RT) and percentage errors (PE) with standard errors (in parentheses) for both measures, as a function of ISI Category, Context and Channel in Experiment 3.

		Brief ISI		Long ISI	
		Target following longer context sound (25 ms ISI)	Target following shorter context sound (100 ms or 200 ms ISI)*	Target following longer context sound (425 ms ISI)	Target following shorter context sound (500 ms or 600 ms ISI)**
Small-Context-Difference	RT (ms)	624 (21.50)	601 (20.28)	553 (18.06)	536 (16. 20)
	PE	4.56 (1.14)	3.62 (0.91)	4.44 (1.11)	4.25 (1.06)
Large-Context-Difference	RT (ms)	616 (30.70)	609 (22.08)	541 (15.60)	554 (20.01)
	PE	2.81 (0.70)	4.00 (1.00)	4.31 (1.08)	3.25 (0. 81)

**ISI was 100 ms in the 'Small-Context-Difference' condition and 200 ms in the Large-Context-Difference condition*

***ISI was 500 ms in the 'Small-Context-Difference' condition and 600 ms in the Large-Context-Difference condition*

Furthermore, the effect persisted with a much later target presentation.

Concluding Comments

In three experiments we explored whether the sudden disappearance of a sound can capture attention in a similar fashion to the sudden occurrence of a sound. All three experiments utilized a cue paradigm similar to that developed by Posner and colleagues (1980) and used in other similar auditory and visual attentional capture experiments (e.g., Mondor & Lacey, 2001; Pratt & McAuliffe, 2001; Spence & Driver, 1994). In Experiment 1, we found that participants responded significantly more quickly when the target followed the offset cue, but only when the inter-stimulus interval was 100 ms. This suggests that the sudden disappearance of a sound can capture attention and it takes about 100 ms to orient to the offset.

In Experiment 3, the extent to which attention might be captured at longer intervals was examined.. The results showed that despite the late target presentation, participants still responded more quickly when the target followed the shorter context cue, but again only when the difference between the cues was small (75 ms). Similar to the findings of Experiment 2, there were null effects when the difference between the cues was large (175 ms). It seems likely, given the literature, that the 75 ms difference is not enough time to reorient to the second offset maintaining the attentional capture effects of the first offset.

Interestingly, the results of Experiments 1 and 2 suggested that the attentional capture effects would not persist when the ISI between the cue and target was longer than 100 ms. However, in Experiment 3 when the second context cue disappears shortly after the first, the effect persisted with an ISI of 500 ms. This suggests that the overall context (two competing cues versus a single cue) had an impact on the attentional capture effect of the offset.

Taken together, the results of the three experiments reported above provide evidence that auditory attention may be oriented reflexively to the spatial position in which a sound abruptly disappears.

References

Leboe, L. C., & Mondor, T. A. (2007). Item-specific congruency effects in nonverbal auditory Stroop. *Psychological research*, *71*(5), 568–75. doi:10.1007/s00426-006-0049-3

Logan, G. D. (2005). The time it takes to switch attention. *Psychonomic bulletin & review*, *12*(4), 647–53. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16447377

Mondor, T. A., & Bryden, M. P. (1991). The influence of attention on the dichotic REA. *Neuropsychologia*, *29*(12), 1179–1190. Retrieved from http://www.sciencedirect.com/science/article/pii/0028393291900324

Mondor, T. A., & Bryden, M. P. (1992). Orienting of auditory spatial attention: effects of a lateralized tone cue. *Neuropsychologia*, *30*(8), 743–52.

Mondor, T. A., & Lacey, T. E. (2001). Facilitative and inhibitory effects of cuing sound duration, intensity, and timbre. *Perception And Psychophysics*, *63*(4), 726–736.

Mulckhuyse, M., & Theeuwes, J. (2010). Unconscious attentional orienting to exogenous cues: A review of the literature. *Acta psychologica*, *134*(3), 299–309. doi:10.1016/j.actpsy.2010.03.002

Nishimura, A., & Yokosawa, K. (2010). Visual and auditory accessory stimulus offset and the Simon effect. *Attention, Perception, & Psychophysics*, *72*(7), 1965–1974. doi:10.3758/APP

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology*, *32*(1), 3–25. doi:10.1080/00335558008248231

Pratt, J., & McAuliffe, J. (2001). The effects of onsets and offsets on visual attention. *Psychological research*, *65*(3), 185–91. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11571913

Samuel, A. G., & Weiner, S. K. (2001, December). Attentional consequences of object appearance and disappearance. *Journal of experimental psychology. Human perception and performance*. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11766935

Spence, C., & Driver, J. (1994). Covert spatial orienting in audition: Exogenous and endogenous mechanisms. *Journal of experimental psychology: Human perception and performance*, *20*(3), 555–574. doi:http://dx.doi.org.proxy2.lib.umanitoba.ca/10.1037/0096-1523.20.3.555

Spence, C., & Driver, J. (1996). Audiovisual links in endogenous covert spatial attention. *Journal of experimental psychology. Human perception and performance*, *22*(4), 1005–30. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8756965

Theeuwes, J. (1991). Exogenous and endogenous control of attention: The effect of visual onsets and offsets. *Perception & psychophysics*, *49*(1981), 83–90. Retrieved from http://link.springer.com/article/10.3758/BF03211619

Theeuwes, J., Godijn, R., & Pratt, J. (2004). A new estimation of the duration of attentional dwell time. *Psychonomic bulletin & review*, *11*(1), 60–4. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15116987

Yantis, S., & Jonides, J. (1984). Abrupt visual onsets and selective attention: Evidence from visual search. *Journal of Experimental Psychology: Human perception and performance*, *10*(5). Retrieved from http://pbs.jhu.edu/sebin/g/i/Yantis-Jonides-JEPHPP-1984.pdf