WHY DO VEERIES (*CATHARUS FUSCESCENS*) SING AT DUSK? COMPARING ACOUSTIC COMPETITION DURING TWO PEAKS IN VOCAL ACTIVITY

JOEL HOGEL
Earlham College, 801 National Road West, Richmond, IN 47374-4095

MENTOR SCIENTISTS: DRS. KENNETH SCHMIDT AND KARA BELINSKY
Texas Tech University, 2500 Broadway, Lubbock, TX 79409

INTRODUCTION

Acoustic communication can be broadly defined as transmission of information between animals via vocalizations or other sound production methods (Wiley and Richards 1978). Recently, researchers have been considering the constraints on acoustic signaling and the challenges animals face when trying to communicate efficiently. The efficiency of vocalizations at relaying the intended message depends partly on the amount of competing noises there are in the signalers acoustic space (Klump 1996). For instance, in Zebra Finches (*Taeniopygia guttata*), the ability to receive and respond to a song was reduced in the presence of background noise (Narayan et al. 2007). Also, background noise was found to inhibit female response to courtship songs in the both the fruit fly *Drosophila montana* and the tree frog *Hyla arborea* (Samarra et al. 2009; Richardson and Lengagne 2010). Because background noise inhibits a receiver's ability to perceive individual sounds, it is hypothesized to have negative consequences, such as energy waste and fitness loss, on acoustic signalers (reviewed in Bee and Micheyl 2008, Klump 1996).

The sources of background noise affecting a signaler are numerous. Traffic and other urban sounds make up a significant proportion of background noise experienced by bird species that live in close proximity to humans (Parris and Schneider 2009, Pohl et al. 2009). Another major source of background noise comes from other birds' vocalizations during peaks in singing activity (i.e. the dawn and dusk choruses). Pohl *et al.* (2009) found that in Great Tits (*Parus major*), the ability to receive intraspecific signals was drastically reduced in the presence of an acoustically simulated dawn chorus. This phenomenon, in which other animal vocalizations inhibit an individuals' ability to communicate successfully, is commonly called the "cocktail party" problem, and it has been shown to be a contributing factor in shaping the evolution of a number of different species' vocalization patterns (reviewed in Bee and Micheyl 2008). It is hypothesized that signalers may adapt to the cocktail party problem by adjusting their singing behavior. Several studies have supported this hypothesis with evidence that birds make short-term adjustments to their vocalizations during noisy parts of the day.

One of the noisiest times of day occurs at dawn. This is because many birds have a peak in vocal activity at this time (Trippe 1867). An interesting yet unstudied way that birds might solve the cocktail party problem is by singing during different periods of the day (i.e. not dawn) in order to utilize unused acoustic space. In other words, a species might be able to communicate more effectively by singing more frequently during less noisy periods. The dusk chorus in diurnal avian species may be partly explained if dusk singers are utilizing an acoustic space that other species are not.

Veeries (*Catharus fuscescens*) are a possible species on which to test this hypothesis. Veery song is quite complex. It typically starts with an ascending first syllable, followed by a number of repeating syllables (often containing multiple frequency bands) and concluding with a second similar group of repeated syllables that are shifted down in frequency (Samuel 1972). While most songbirds have their largest peak of singing at dawn, Veeries and some other thrushes have two comparably large peaks at both dawn and dusk (Samuel 1972, Slagsvold 1996). Veeries may benefit from dusk singing if there is less acoustic competition from sympatric species at this time. I hypothesize that Veeries will encounter more acoustic competition at dawn than dusk. I will test this hypothesis by comparing the amount of interspecific vocal masking that Veeries experience during these two peaks of singing. If Veeries experience less acoustic competition at dusk than they do at dawn, it might partially explain why they display a relatively intense bout of dusk singing.

METHODS

Collection of Veery song samples occurred over two summers (from mid May to late June, 2009 and 2010) at the Cary Institute of Ecosystem Studies in Dutchess County, southeastern New York State, USA. The approximately 325 ha of Cary Institute property is mostly eastern deciduous forest (Schmidt 2005). The most common passerines that inhabit the wooded areas include Veeries, Gray Catbirds and Wood Thrushes (Belinsky, anecdotal).

Veeries were recorded during the dawn and dusk choruses, approximately 1 hour before and after sunrise and sunset. We recorded samples of Veery songs using a Telinga parabolic reflector, a Sennheiser MKH 62 microphone and a Marantz MPD 660 digital recorder (sampling rate of 44.1 kHz, bit rate of 705.5 kbps). This equipment allowed us to collect high-quality directional recordings that focus on the song of the focal bird in the same way a receiver (perhaps a female veery) would be listening.

From the recordings I collected in the field, I selected 30 Veery recordings from each dawn and dusk for spectrographic analysis. I chose the 60 recordings to analyze based on spectrogram clarity and the average song amplitude. Spectrogram analysis was conducted with the software Raven Pro 1.4 (Cornell Lab of Ornithology). Once I determined the sound files to use, I then selected the segment from each recording that contained the 10 continuous songs of the highest quality. I then counted the number of songs in each segment that were masked by another species' song. A song from the focal male was considered masked if any heterospecific avian vocalization > 75 db overlapped it in frequency and time. For each masked song, I noted the species of bird masking (the loudest in cases of > 1 species) when distinguishable. I counted the number of masks in each 10-song segment, and then calculated the mean number of masks per 10 songs for the 30 dawn and 30 dusk recordings. I conducted a student's t-test on these means using the software Microsoft Excel 2004 for Mac (Version 11.6). Using the same software, I also compared mean number of different species masking per 10 Veery songs at dawn and dusk.

RESULTS

I selected 30 dawn recordings made between 05:03 and 06:10 EDT and 30 dusk recordings from between 18:43 and 21:11. The 60, 10-song-segments were on average 62 s long (standard error = 1.916). The length of the 10-song segments did not differ between the dawn and dusk recordings ($p = 0.452$).

167 of the 600 total songs were masked. 102 of the masks occurred at dawn and 65 at dusk. I found that Veeries experienced a higher rate of masking at dawn than dusk based on the frequency of masking during each 10-song-segment. On average Veeries were masked 3.4 times at dawn and 2.2 times at dusk ($P=0.040$, see figure 1). There were also more masking species present per 10-song-segment at dawn than dusk. This is illustrated by the average number of different species masking per 10 songs at dawn and dusk ($p=0.026$, see figure 2). There were a total of 11 species that masked Veery songs. All 11 species were present at dawn, while only 7 of these were present at dusk. The most common species masking Veeries was the Gray Catbird. Its songs accounted for approximately 23% of the observed masks (see table 1).

DISCUSSION

Based on these data, it appears that Veeries face less acoustic competition during the dusk chorus than during the dawn chorus. This is based on my comparison of masking frequencies and masking species diversity during the two choruses. More masks occurred and more species were present masking Veeries at dawn than dusk. These results are in support of my hypothesis.

Although no other studies to my knowledge have compared acoustic competition during the dawn and dusk choruses, a number have found that species adjust the short-term timing of their vocalizations in order to avoid background noise and/or acoustic competition. Knapton (1987) found that Eastern Meadowlarks (*Sturnella magna*) adjust the timing of their songs to avoid intraspecific vocal masking. Ficken et al. (1974) presents convincing data which points to the active adjustment of song patterns in Least Flycatchers (*Empidonax minimus*) and Red-eyed Vireos (*Vireo olivaceus*) in order to avoid overlapping each other’s songs. Moreover, Planqué & Slabbekoorn (2007) gathered song data from 20 vocally dominant avian species in the tropics and found significantly less acoustic masking than expected if birds ignored each other’s vocalizations. My study is consistent with these findings, but advances the topic by considering the importance diel singing patterns have on the amounts of acoustic competition birds experience.

Thrushes (family *Turdidae*) are known to be vocally active around dusk. American Robins (*Turdus migratorius*) can be observed vocalizing nearly as much as Veeries around sunset (personal observation). This work may help to direct future research focusing on Thrushes’ singing behavior. Brumm found that Nightingales (*Luscinia megarhynchos*), a species closely related to Veeries, avoid playback vocalizations from six sympatric songbird species by adjusting their short-term singing patterns (2006). Over evolutionary time, it is possible that Nightingales and other thrushes have evolved a pronounced dusk chorus in order to communicate more effectively.

However, these are still the only two peaks of Veery song. If the only thing to consider is competition, then why do all species not spread their songs out evenly over the day? There is clearly a preference for singing at one or both of these times, but not so much in between. There are a huge amount of factors that could play a role in determining the temporal patterns of acoustic communication in Veeries and avian species as a whole.

LITERATURE CITED

Bee, M. A., Micheyl, C. 2008. The cocktail party problem: What is it? how can it be solved? and why should animal behaviorists study it? Journal of Comparative Psychology **122:**235-251.

Brumm, H. 2006. Signaling through acoustic windows: Nightingales avoid interspecific competition by short-term adjustment of song timing. Journal of Comparative Physiology **12:**1279-1285.

Ficken, R. W., Ficken, M. S., Hailman, J. P. 1974. Temporal pattern shifts to avoid acoustic interference in singing birds. Science **183:**762-763.

Knapton, R. W. 1987. Intraspecific avoidance and interspecific overlap of song series in the Eastern Meadowlark. The Auk **104:**775-779.

Klump, G. M. 1996. Bird communication in the noisy world, p. 321-338. *In* D. E. Kroodsma and E. H. Miller [eds.], Ecology and evolution of acoustic communication in birds. Cornell University Press, Ithaca.

Narayan, R., Best, V., Ozmeral, E., McClaine, E., Dent, M., Shinn-Cunningham, B., Sen, K. 2007. Cortical interference effects in the cocktail party problem. Nature Neuroscience **10:**1601-1607.

Parris, K., Schneider, A. 2009. Impacts of traffic noise and traffic volume on birds of roadside habitats. Ecology and Society **14:**29.

Planqué, R., Slabbekoorn, H. 2007. Spectral overlap in songs and temporal avoidance in a Peruvian bird assemblage. Ethology **114:**262-271.

Pohl, N., Slabbekoorn, H., Klump, G., Langemann, U. 2009. Effects of signal features and environmental noise on signal detection in the great tit, *Parus major*. Animal Behaviour **78:**1293-1300.

Richardson, C., Lengagne, T. 2010. Multiple signals and male spacing affect female preference at cocktail parties in treefrogs. Proceedings of the Royal Society B: Biological Sciences **277:**1247-1252.

Samarra, F., Klappert, K., Brumm, H., Miller, P. 2009. Background noise constrains communication: acoustic masking of courtship song in the fruit fly *Drosophila montana*. Behaviour **146:**1635-1648.

Slagsvold, T. 1996. Dawn and dusk singing of male American robins in relation to female behavior. Wilson Bulletin **108:**507-515.

Trippe, T. M. 1867. The awakening of the birds. The American Naturalist **1:**401-403.

Wiley, R. H., Richards, D. G. 1978. Physical constraints on acoustic communication in the atmosphere: Implications for the evolution of animal vocalizations. Behavioral Ecology and Sociobiology **3:** 69-94.

APPENDIX

TABLE 1. Total number of Veery songs masked per species at dawn and dusk.

	dawn	dusk
american crow	2	-
american robin	7	7
black-capped chickadee	3	2
common yellowthroat	2	2
gray catbird	28	10
northern cardinal	1	-
ovenbird	16	13
red-bellied woodpecker	2	-
red-eyed vireo	4	-
tufted titmouse	9	3
wood thrush	17	5
other	11	23

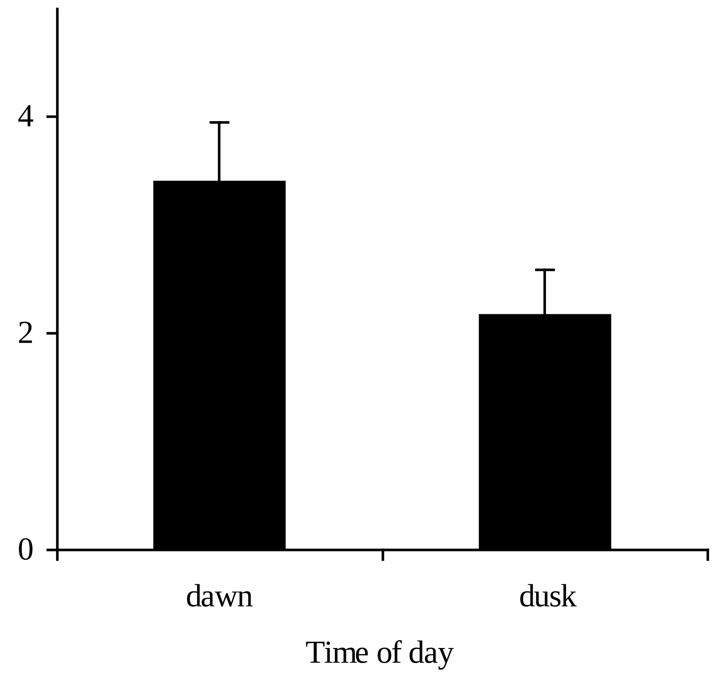

FIGURE 1. Average masking frequency at dawn and dusk, error bars represent standard errors.

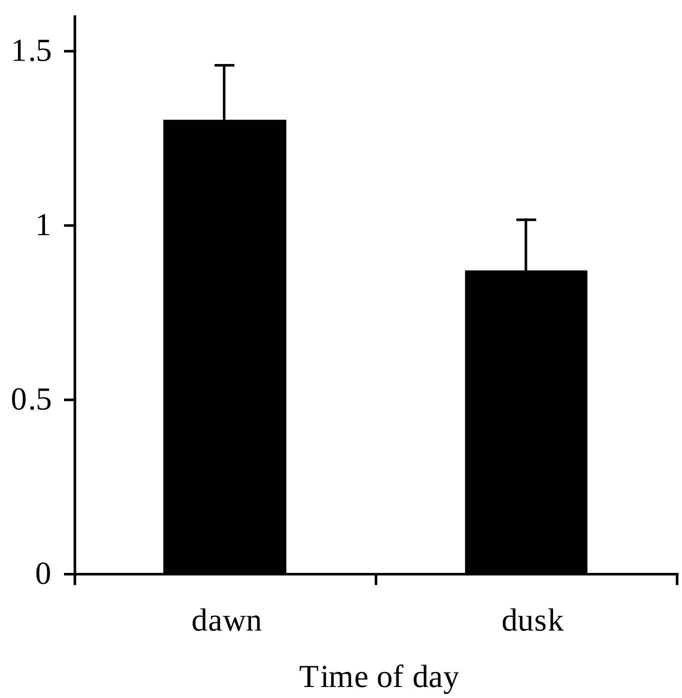

FIGURE 2. Average number of different species masking during the dawn and dusk choruses.