Long-term exposure to substrate-borne vibrations and the behavioral response of ground crickets (Trigonidiidae)

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Introduction

Noise can be complex with components propagating through the air and/or substrate. The presence of noise in multiple sensory channels creates tradeoffs; animals need to be on alert for predator cues or those associated with other risks while also detecting signals and cues related to mating and/or foraging opportunities (Lima & Bednekoff, 1999). Sensory systems have evolved to detect the many characteristics of sound whether its airborne, water-borne, or substrate borne. Noise has the potential to interfere with an individual's ability to detect and assess beneficial sounds. By focusing on airborne signals and noise, we are overlooking the complexity of animal signals and noise that have direct consequences to fitness and reproductive success.

Research into the impacts of noise on animals is a growing field; however, less than 4% of published research in this field focused on invertebrates (Shannon et al., 2016). Invertebrates rely on both airborne and substrate borne cues to assess their environment, localize and evaluate potential mates and rivals, and to detect approaching prey or predators (Pollack, 2017). Orders such as Orthopterans are capable of detecting broadband airborne sound into the ultrasonic range as well as substrate borne vibrations.

In this project we wanted to determine if wild populations of crickets, (*Allonemobius fasciatus*), that occupy habitat close to heavily trafficked rail ways typified by increased levels of substrate-borne vibrations display a lower response to substrate-borne cues compare to populations in quiet locations.

Works Cited

Lima, S. L., & Bednekoff, P. A. (1999). Temporal Variation in Danger Drives Antipredator Behavior: The Predation Risk Allocation Hypothesis. *The American Naturalist*, *153*(6), 649–659.
Pollack, G. S. (2017). Insect Bioacoustics. *Acoustics Today*, *13*(2).
Shannon, G., McKenna, M. F., Angeloni, L. M., Crooks, K. R., Fristrup, K. M., Brown, E., … Wittemyer, G. (2016). A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological Reviews*, *91*(4), 982–1005.

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Methods

Subjects

- Striated ground crickets (*A. fasciatus*) were collected at two sites: along a railroad corridor (noise) & rural farm pasture (quiet)
- Males were exposed to vibrational stimuli in the laboratory while chirping
- Males were placed with a female to induce chirping

Substrate-borne Vibrational Stimuli

- Created in Adobe Audition v. 3.0
- Broadband stimuli: 100-1,000Hz played through a transducer attached to the underside of a platform
- Stimuli was calibrated using a Laser-Doppler Vibrometer
- 30s vibrational stimuli intensities: 2.0 mm/s, 2.5 mm/s, 3.0 mm/s, & 4.0 mm/s

Variables Measured

- Response to stimuli (Y/N)
- Latency to stop chirping (seconds)
- Latency to resume chirping (seconds)

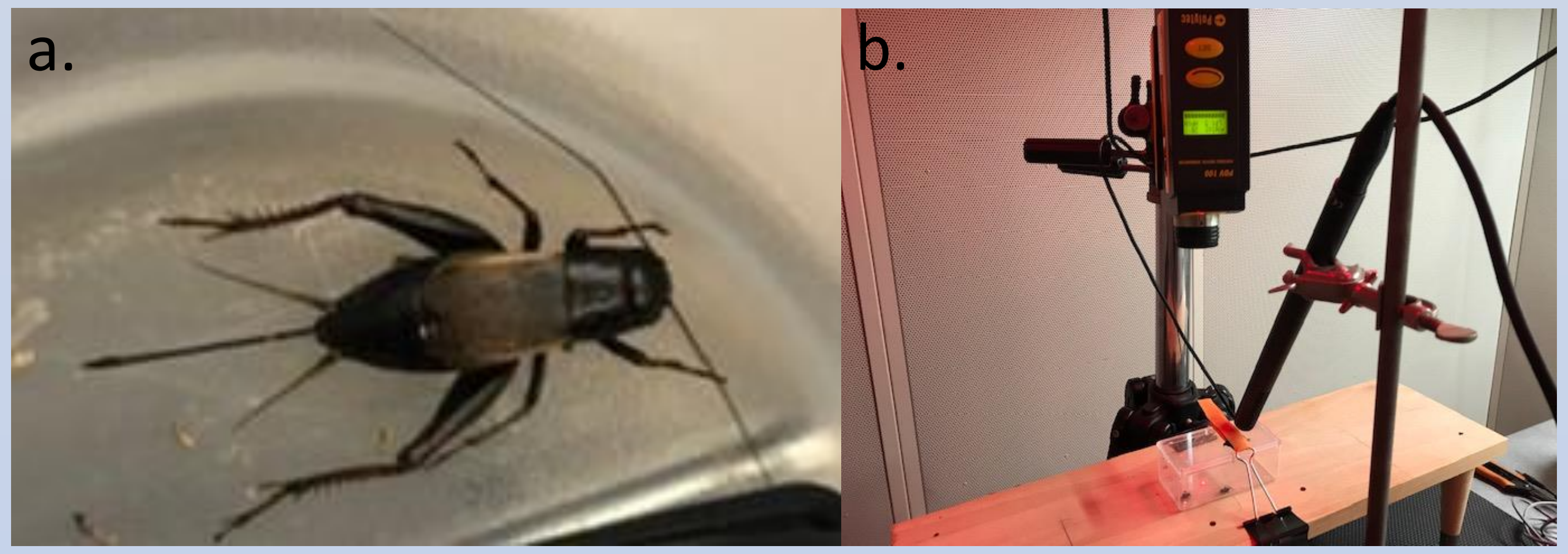

Figure 1: a) Striped ground crickets (*A. fasciatus*), were collected at two different sites representing the presence of increased substrate-borne vibrations(1.0mm/s) and low substrate-borne vibrations (0.3 mm/s). b.) The laboratory setup to record the responses to vibrational cues. A transducer was attached to the bottom of a platform, a male and female cricket were placed atop the platform. A Laser-Doppler Vibrometer recorded the intensity of the stimuli and a directional microphone coupled to an audio recorder, recorder the male's chirps.

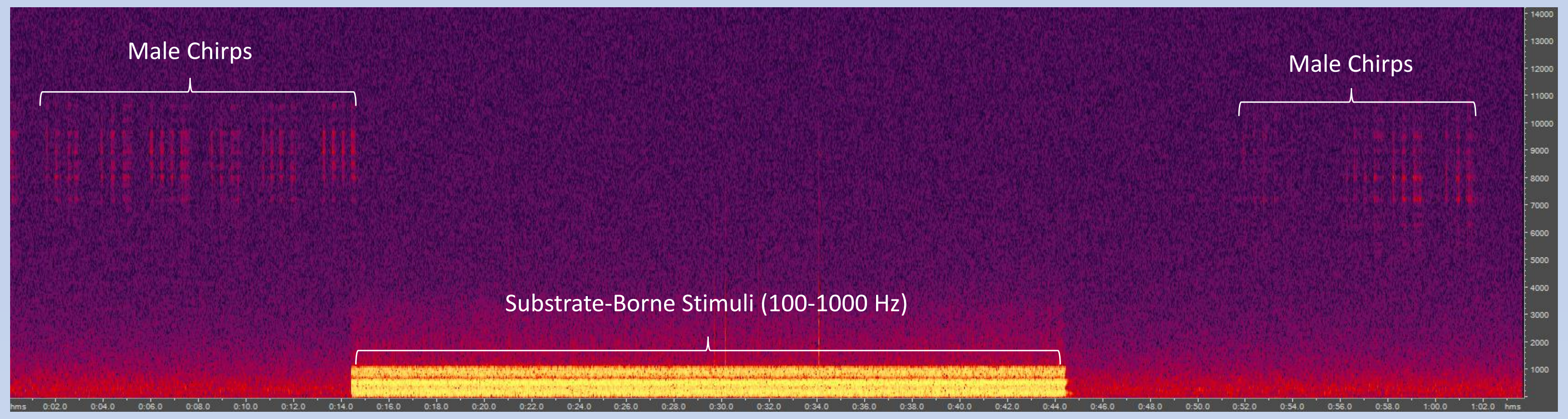

Figure 2: A spectrogram of a male's response to substrate-borne vibrational cues played at an intensity of 4.0 mm/s. Time (s) is on the x-axis and frequency (Hz) is on the y-axis.

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Preliminary Results

- The likelihood of a male to respond to vibrational stimuli was not impacted by past exposure to substrate-borne vibrations
  - $\chi^2 = 2.159$, $P = 0.71$, $N=12$

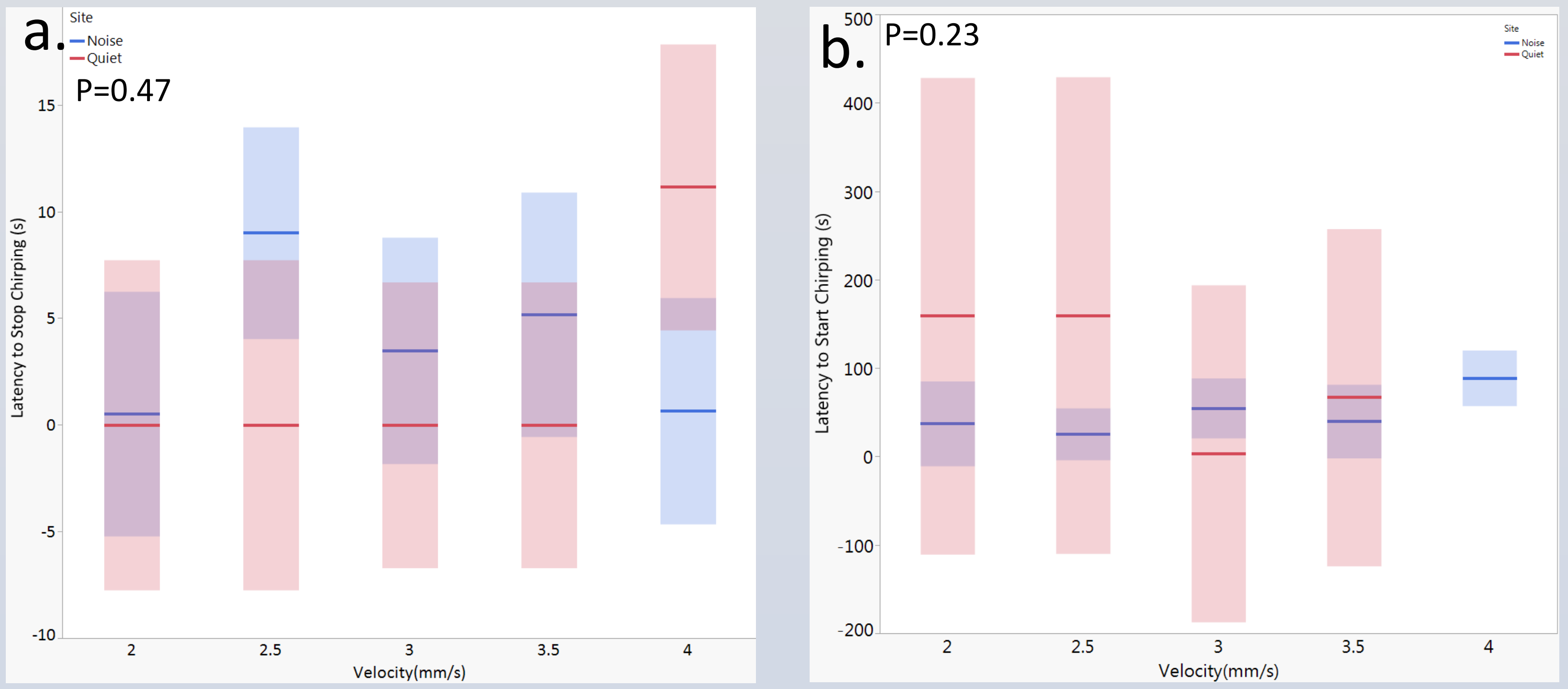

Figure 3: a.) The time (s) that it took male crickets to respond to substrate-borne cues was not influenced by past exposure to high levels of substrate-borne vibrations or the intensity of the stimuli ($R^2=0.09$ $P=0.47$). b) Once calling ceased, the time (s) to start chirping was also not influenced by past exposure to high levels of substrate-borne vibrations or the intensity of the stimuli($R^2=0.21$ $P=0.23$)

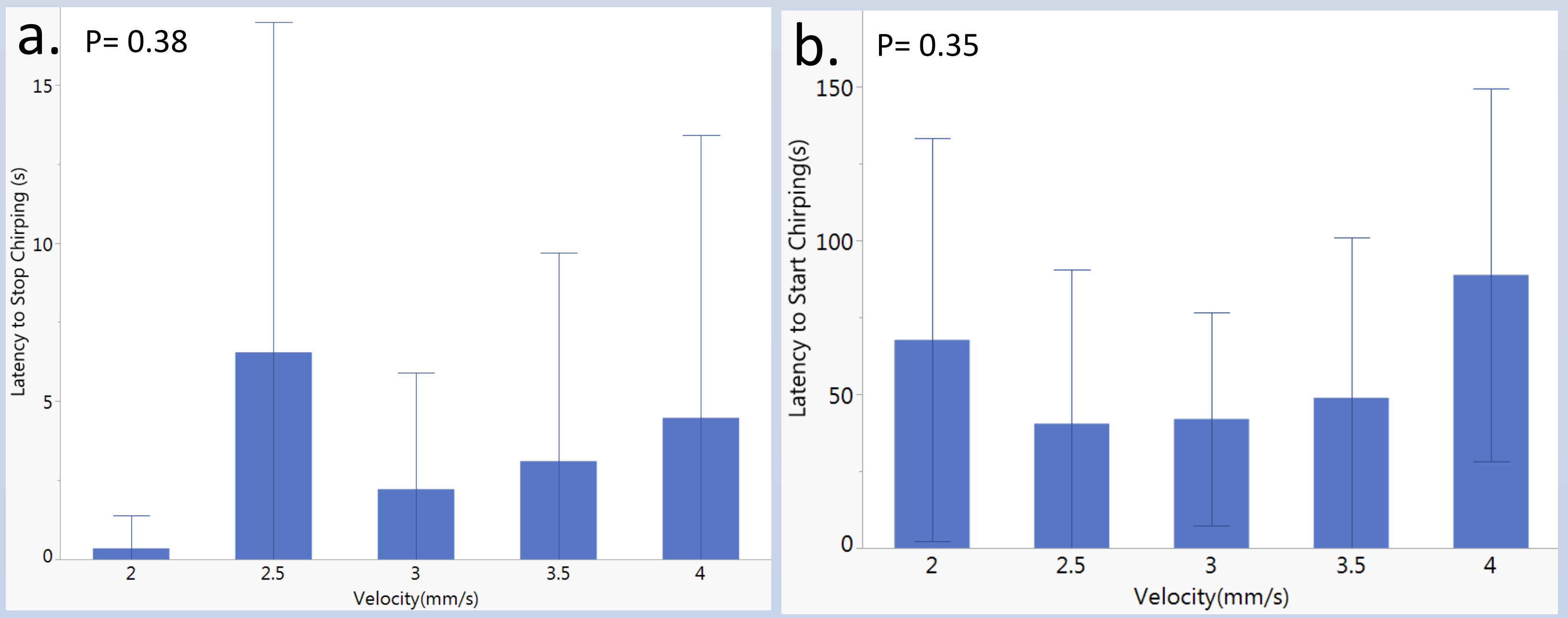

Figure 4: Regardless of past exposure to high levels of substrate-borne vibrations, the intensity of the substrate-borne stimuli did not affect a) the latency (s) to stop chirping with the onset of the stimuli (F=1.07 , P=0.38) or b) the latency to start chirping after the initial cessation of chirping (F=1.14 , P=0.35).

Conclusion

Preliminary experiments indicate that *A. fasciatus* males from noisy environments do not exhibit behavioral response patterns different than those from putatively quiet conditions. Noise from railways and roadways have components of both airborne and substrate-borne noise, however As a species that relies on both airborne and substrate-borne cues, we may need to further investigate multi-modal noise effects.

Moving forward, I will analyze the spectral and temporal components of the male's chirps as well as introduce intermittent stimuli. Field recordings will also be collected to further investigate how a rail corridor influences behavior.