Plasticity in Female Cricket Phonotactic Response to Model Male Cricket Calls

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Abstract

The response of a female cricket to a male's calling song is called phonotaxis (directed movement with respect to a sound source). Recent research determined there is a great amount of plasticity in the female cricket response to the male calling song (Stout et al. 2010). Burden (2009) mathematically quantified the plasticity of the physical characteristics of the wildtype calling song in male *Gryllus pennsylvanicus* and *Gryllus veletis*. Specific physical characteristics (amplitude and overall length of chirp, syllable duration, syllable period, and carrier frequency) of the male's chirp covary within a chirp (Burden 2009). My project evaluates whether females prefer certain of these covarying male chirps over others. Dynamic model calling songs were generated from averages of actual wild chirps. A total of seven model chirps were created, each of which were played for a female cricket positioned on a treadmill to determine whether female crickets are selective to those chirps. Individual female crickets can choose between these calls, but the population of females does not prefer particular male calls within the tested range.

Outline

1. Introduction
    a. How I became involved
    b. Why crickets?
    c. Chirp anatomy
    d. Background research
    e. My questions:
        i. Does playing male calling songs that <u>covary</u> cause females to show preferences for particular male calling songs?
        ii. Does closely mimicking the natural male call eliminate the variability, plasticity, and skipping of the female phonotactic response?
        iii. Do females perform "better" or "worse" phonotaxis to different male calling songs?
2. Methodology
    a. Animal care
    b. Modeling
    c. Behavioral testing
3. Results
    a. Quality and quantity comparisons for *G. pennsylvanicus* and *G. veletis* are not statistically significant
4. Conclusions
    a. Individual selective female crickets can show preferences for particular male calling songs
    b. Females can respond to calls outside the natural male calling song range
    c. At the population level, no significant preferences are found to the calling songs tested
    d. The use of a dynamic chirp does not explain the previously seen variability in phonotaxis or the phenomenon of skipping

Literature Cited

Burden C. 2009. Variability in the calling song of two field cricket species (*Gryllus veletis* and *G. pennsylvanicus*). Abstract of Graduate Student Research Thesis; July 2009; Andrews University, Michigan.
This thesis studied the range of variability of male crickets' calling songs in the wild. It was found that many individual characteristics of the males' calls covary. For example, as the call duration increases, the relative amplitude also increases. It also studied the effects of temperature, and other environmental factors, on the characteristics of the male calling song.

Burden C, Atkins G, Greene C, Steely T, and Stout J. Temperature coupling. Program No. 796.7, 2008 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2008. Online.
This study illustrated the effects of temperature on the varying parameters of the male cricket calling song.

Burden C, Purvis S, Magispoc M, Anderson K, Meyer V, Stout J, and Atkins G. 2007. Phonotaxis by female crickets is more variable than the males' calling song. 8th Congess of the International Society for Neuroethology; 2007 July 22-27; Vancouver, Canada.
This study examined *G. veletis*, *G. pennsylvanicus*, and *A. Domesticus* crickets. The range of variation of syllable period in the male crickets' calls was found to be smaller than the range of syllable periods that the female crickets would respond phonotactically to.

Stout J, Navia B, Jeffery J, Samuel L, Hartwig L, Butlin A, Chung M, Wilson J, Dashner E, and Atkins G. 2010. Plasticity of the phonotactic selectiveness of four species of chirping crickets (*Gryllidae*): Implications for call recognition. Physiological Entomology (2010), DOI: 10.1111/j.1365-3032.2009.00713.x
This paper analyzed the plasticity of the female cricket phonotactic response by using a large sample size, and determining that female crickets are most likely not conspecifically selective.

Stout JF, Atkins GJ, Bronsert M, Hao J, and Walikonis R. 2002. Influence of Juvenile Hormone III on the Development and Plasticity of the Responsiveness of Female Crickets to Calling Males through Control of the Response Properties of Identified Auditory Neurons. Hormones, Brain and Behavior 3:167-193.
This paper discussed the importance of auditory neurons in the neural processing of female cricket phonotactic response in addition to the effects of hormonal modification on phonotactic response. Juvenile Hormone III is shown to influence firing thresholds of auditory interneurons such as L1.

Thorson J, Weber T, and Huber F. 1982. Auditory behavior of the cricket. J Comp Physiol. 146:361-378.
This study found that syllable period was the most important feature of the male cricket calling song in determining whether or not the female would exhibit phonotaxis.

Weber T, Atkins G, Stout JF, and Huber F. 1987. Female *Acheta domesticus* track acoustical and visual targets with different walking modes. Physiological Entomology 12:141-147.
In this study, female *A. domesticus* crickets were placed on a Kramer treadmill and tested for phonotactic response. This paper confirms the accuracy of the treadmill method for analyzing cricket phonotaxis.