Fine-scale dynamic adjustment of partner proximity during courtship displays in the Lance-tailed Manakin

Jo Fernandez-Jenkins, Kaya Simmons, Brandon Bonamarte, Elle Daily, Emily DuVal

FSU UNDERGRADUATE RESEARCH OPPORTUNITY PROGRAM
CENTER FOR UNDERGRADUATE RESEARCH & ACADEMIC ENGAGEMENT

FSU | FLORIDA STATE UNIVERSITY

Introduction

Mate selection is a complicated, variable process [1]. An effective courtship display is carefully coordinated to match the desired intensity of the other party [2]. Fine scale movements may provide insight into courtship outcomes [4].

Lance-tailed Manakins (*Chiroxiphia lanceolata*) are tropical lekking passerines with unique cooperative courtship displays.

These include two males, an alpha and beta partner, executing a tightly coordinated "leapfrog" movement for visiting females [1].

During these displays, individuals of both sexes dynamically adjust their position relative to others present [4].

Figure 1. Adult Male Lance-tailed Manakin

How does spatial proximity between males and females change throughout a display?

Aim 1: Determine how male/female proximity shifts across a leapfrog bout.

Aim 2: Investigate whether alpha and beta partners vary in how their leap proximity to the female changes over time.

Watch a Leapfrog Bout

Methods

This project used DeepLabCut (DLC), a deep learning software for markerless pose estimation and tracking [3]. The videos analyzed were recorded on Isla Boca Brava, Panama, where a population of Lance-tailed Manakins has been individually marked and behaviorally monitored since 1999. Video cameras were deployed at male display perches in 2013 and recorded activity during daylight hours.

Training involved extracting ~50 frames from 12 display videos.

We labeled body parts (N = 24 per bird) across frames to create a database for the algorithm to predict points (fig 2).

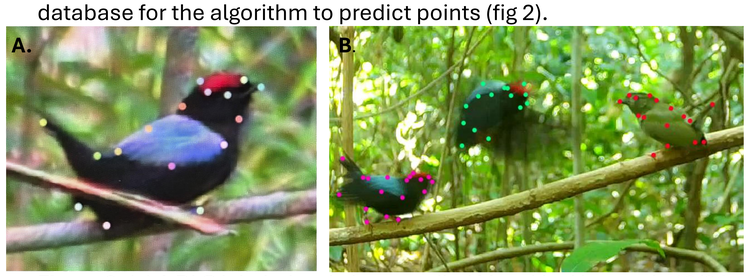

Figure 2. (a) A DLC labeled male Lance-tailed Manakin. Here, only 13/24 points are visible for labeling due to the bird's positioning. (b) A pair of males displaying for a female at a measured minimum distance.

Display bout videos were broken down into leapfrog (LF) bouts; each LF bout was made into a "subclip" containing LF rotations (fig 3).

Three 2013 subclips from site CCL2B were properly analyzed.

Frame-by-frame coordinates were taken from Excel, and their pixel values were standardized to convert to Euclidean distance in cm.

Local minima were calculated for distance between each male and the female to determine closest approach by each male in a LF rotation.

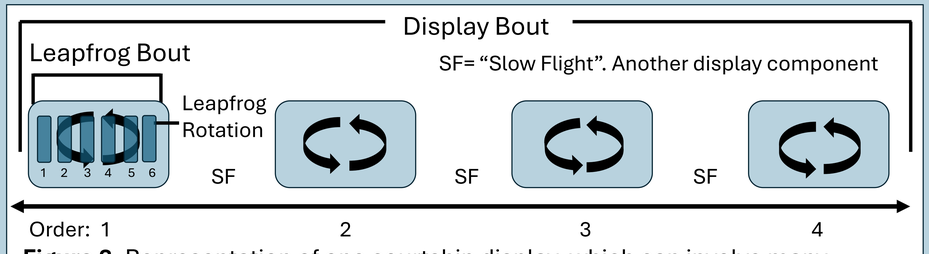

Figure 3. Representation of one courtship display, which can involve many leapfrog bouts within an overall display. During a LF bout, males repeatedly jump over one another in consecutive "leapfrog rotations"

Results

Aim 1. Determine how male/female proximity shifts across a leapfrog bout

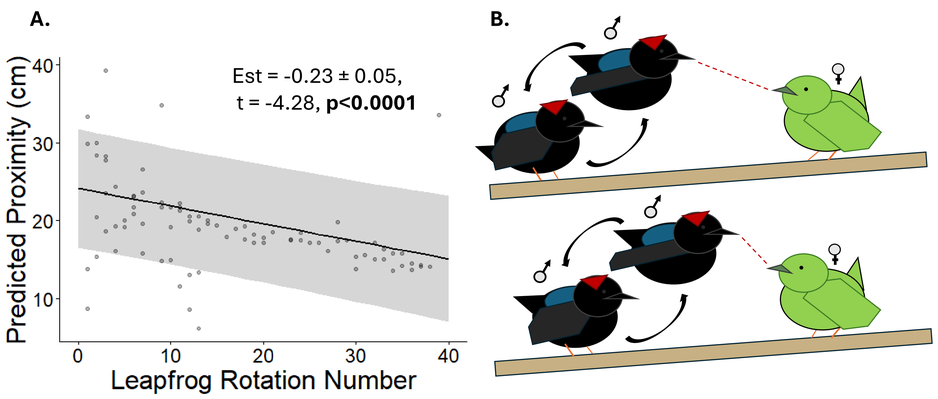

Figure 3. (a) LMM estimates show significant effect of leapfrog rotation number on male predicted proximity from the female. We analyzed N= 84 proximity measures from leapfrog rotations across three leapfrog bouts from different displays by one pair of males. (b) Example of proximity shrinking between leapfrog rotations.

Aim 2. Investigate if males of different social status may vary in proximity to female across a leapfrog bout

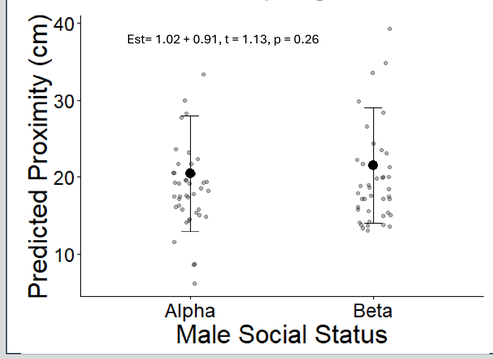

Figure 4. LMM shows effect of male status on proximity. There is no significant effect of alpha/beta status on distance from the female. We analyzed N= 84 proximity measures from leapfrog rotations across three leapfrog bouts from different displays by one pair of males.

No interaction was found between alpha/beta status and distance from the female.

Conclusions and Significance

Across leapfrog bouts, proximity between individuals significantly decreases; social status does not have an impact on proximity change, with alphas and betas having consistently similar approaches.

However, this preliminary analysis was conducted on the leaps in just 3 LF bouts from different displays by one male pair. Expanding the depth of data analysis will allow us to explore additional questions and may reveal further variation (see future steps).

A better understanding of whether proximity patterns reflect male coordination and/or female evaluation will deepen knowledge of behavioral cues influence on Lance-tailed Manakin mating success.

More broadly, this work highlights the interactive decision-making in complex sexual displays.

Future Steps

Our analysis of leapfrog bouts captures just one key component of a display that can include 11 different elements. Future work could continue exploring fine-scale variation within leapfrog bouts, and across additional display behaviors. Some examples may include:

- How does proximity shift between LF bouts across a display bout?
- Are these results replicable with a large sample size?
- Is there a LF proximity trend that could cue success in courtship?
- Which individual initiates proximity change?
- Does LF bout duration have a constant proximity rate change independent of time?
- How do proximity trends compare across display elements?

To accomplish these future steps, we will extract and analyze position data from additional LF bouts and male pairs, including the same pair across years and displays for different females.

Acknowledgements

I sincerely thank the DuVal Lab for their invaluable support and guidance throughout this research. Funding for this work was in part provided by grant DEB LTREB # 2243423 to E.H.D.

References

[1] DuVal E.H (2007) Cooperative display and lekking behavior of the lance-tailed manakin (*Chiroxiphia lanceolata*). *The Auk* 124 (4): 1168-1185

[2] Patricelli, G., Uy, J., Walsh, G. *et al.* Male displays adjusted to female's response. *Nature* 415, 279–280 (2002).

[3] Mathis, A., Mamidanna, P., Cury, K.M. *et al.* DeepLabCut: markerless pose estimation of user-defined body parts with deep learning. *Nat Neurosci* **21**, 1281–1289 (2018).

[4] Janisch J, Perinot E, Fusani L, Quigley C. Deciphering choreographies of elaborate courtship displays of golden-collared manakins using markerless motion capture. *Ethology*. 2021; 127: 550–562.