

Electronic supplementary material for
A rhythm landscape approach to the developmental dynamics of
birdsong rhythm

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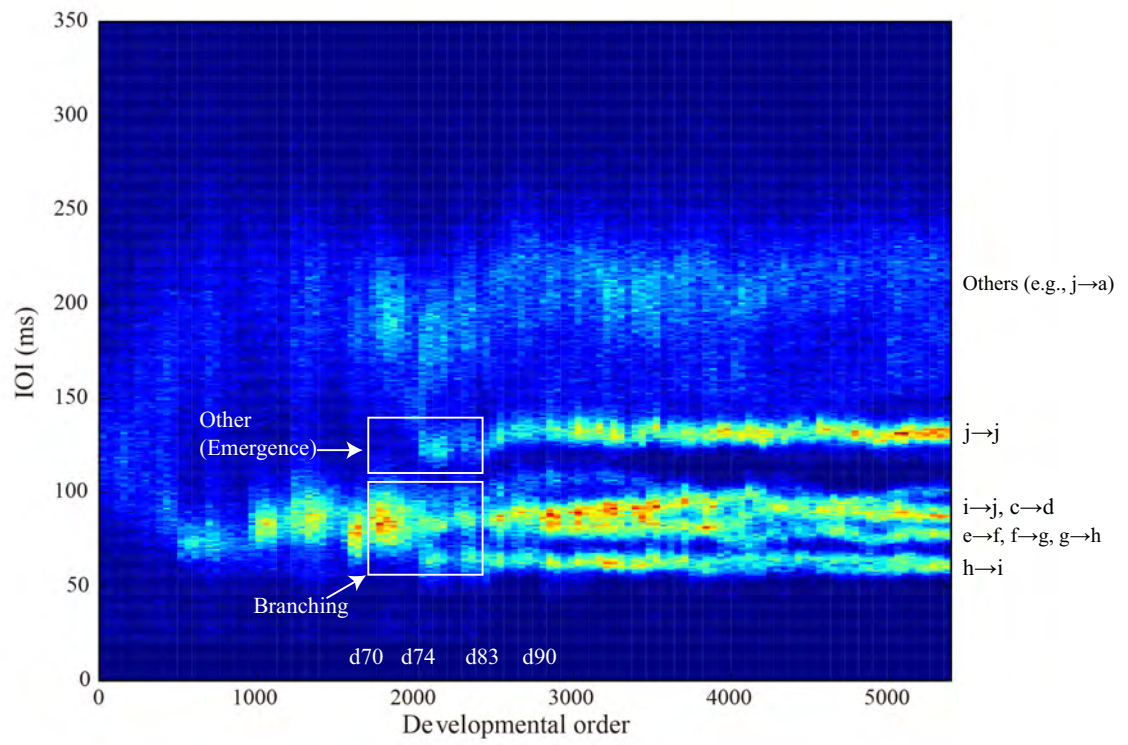


Figure S 1: **Rhythm landscape of bird1 (a higher resolution version of Fig. 2B).**

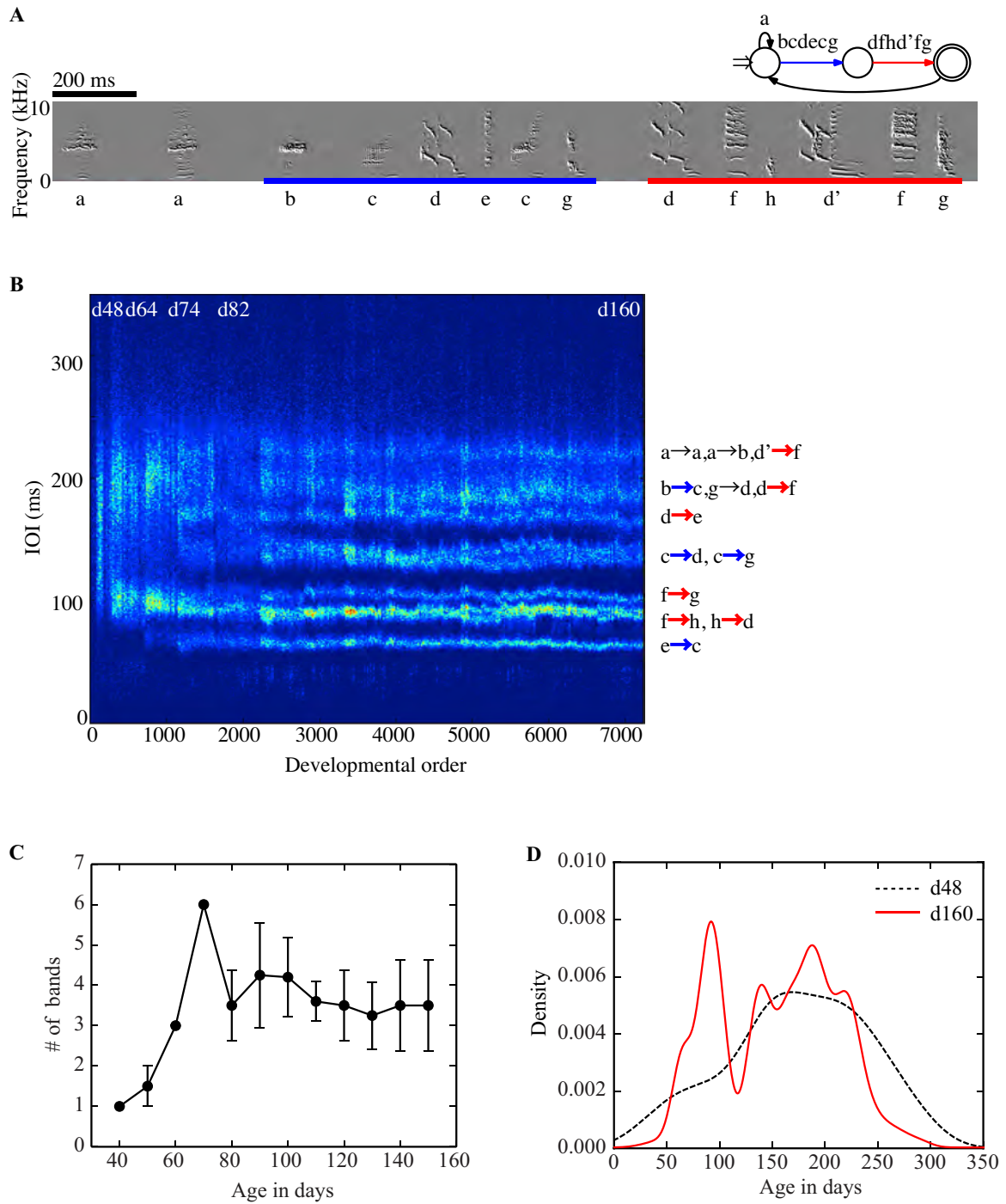


Figure S 2: **Bengalese finch song and its rhythm landscape (bird2)**. (A) A stereotypic song and its song syntax (transition diagram) constructed as previously described [1] from 30 songs in the last recording. Letters denote note types and colors correspond to different chunks. Black vertical lines denote note onsets and intermediate spaces denote inter-onset intervals (IOIs). (B) 2D visualization of the rhythm landscape where the brighter points denote higher density ($N=484786$). (C) Development of the number of bands in (B) (mean \pm sd). (D) IOI distributions for day 48 and day 160 after hatching.

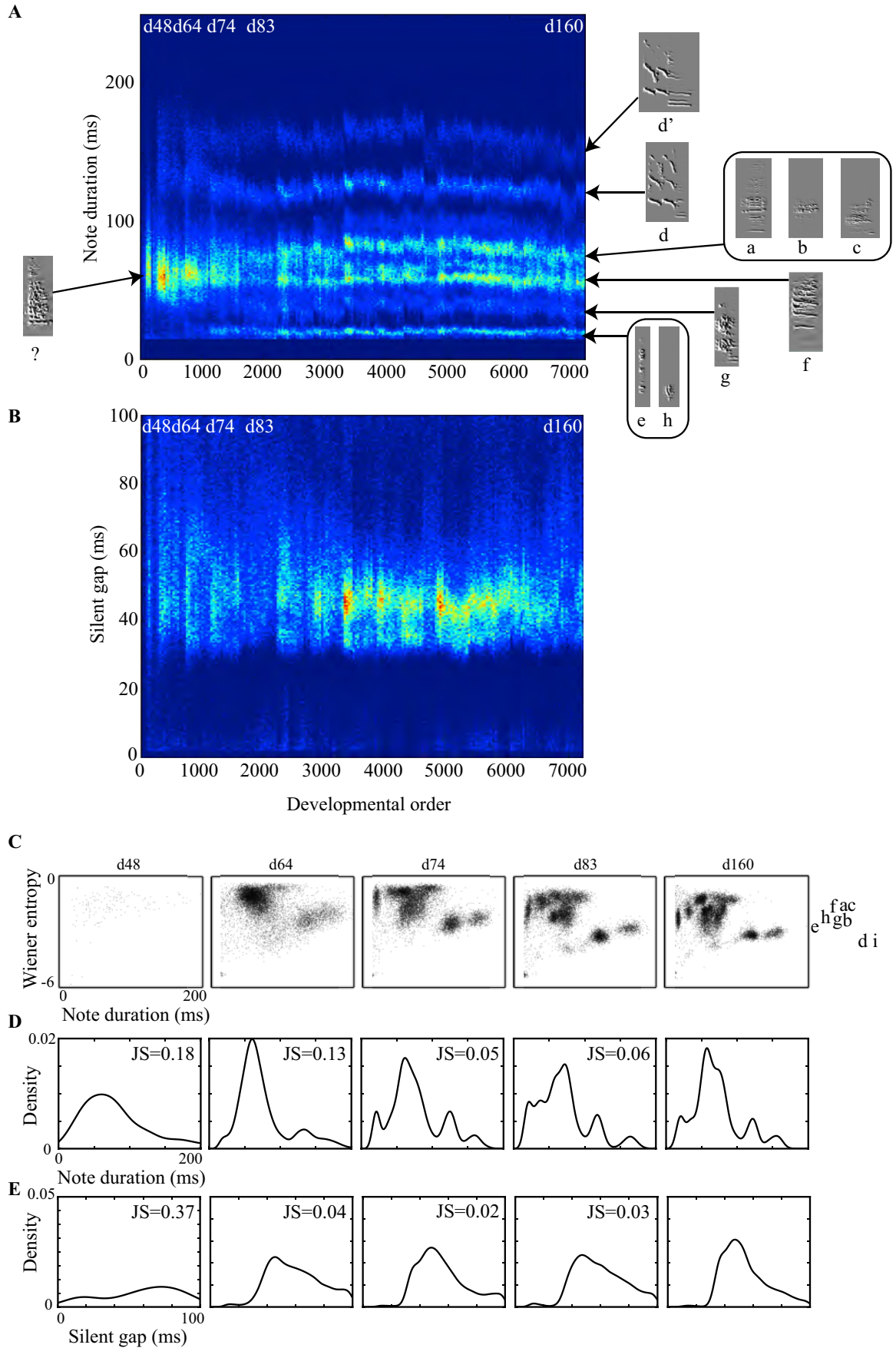
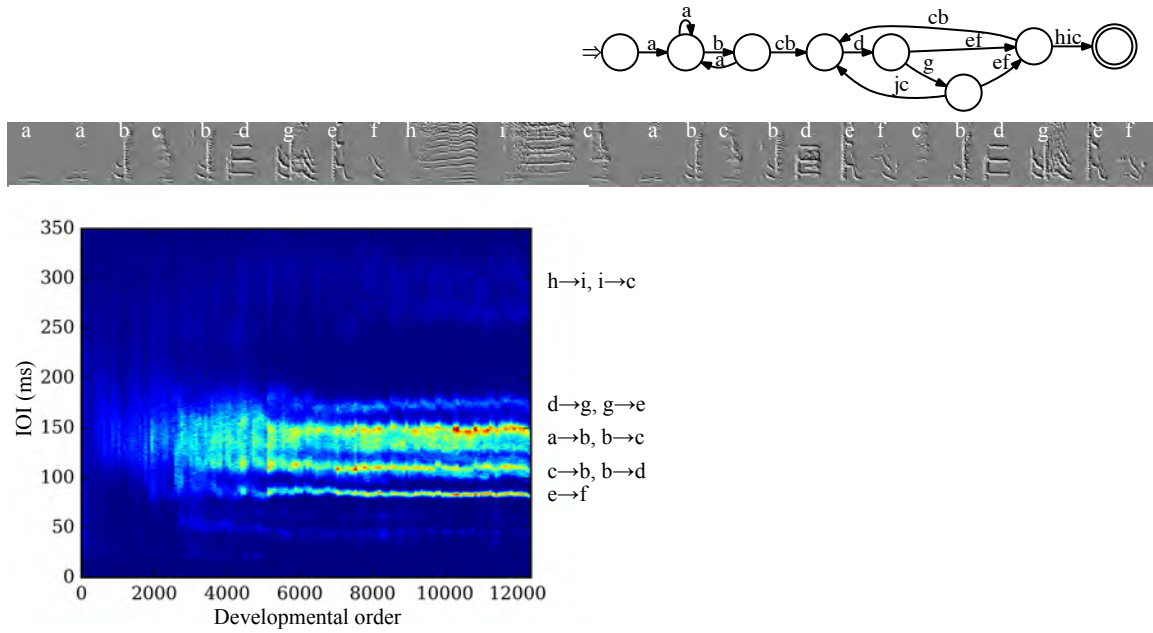


Figure S 3: **Song changes at the substrings level (bird2).** 2D visualization of developmental landscape for (A) note duration ($N=534499$) and (B) silent gaps ($N=485280$). (C) Scatter plots of Wiener entropy against note duration, showing the differentiation of 10 note types from a primitive vocalization. Distribution of (D) note duration and (E) silent gaps at different days.

A



B

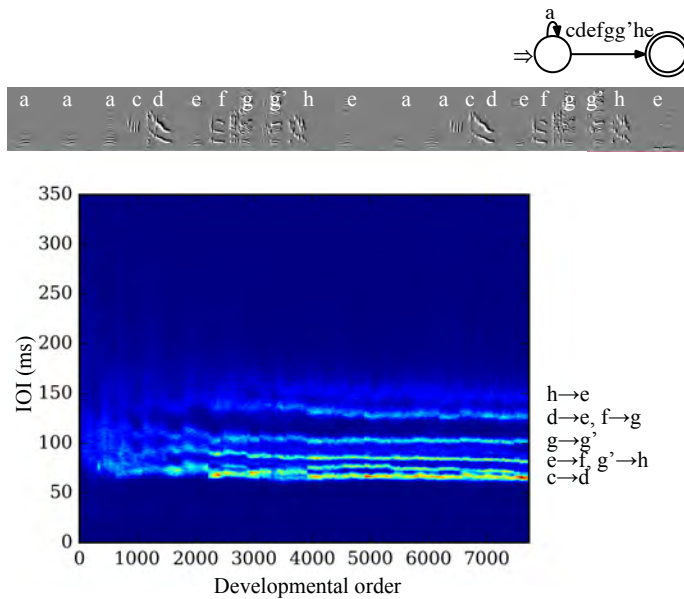
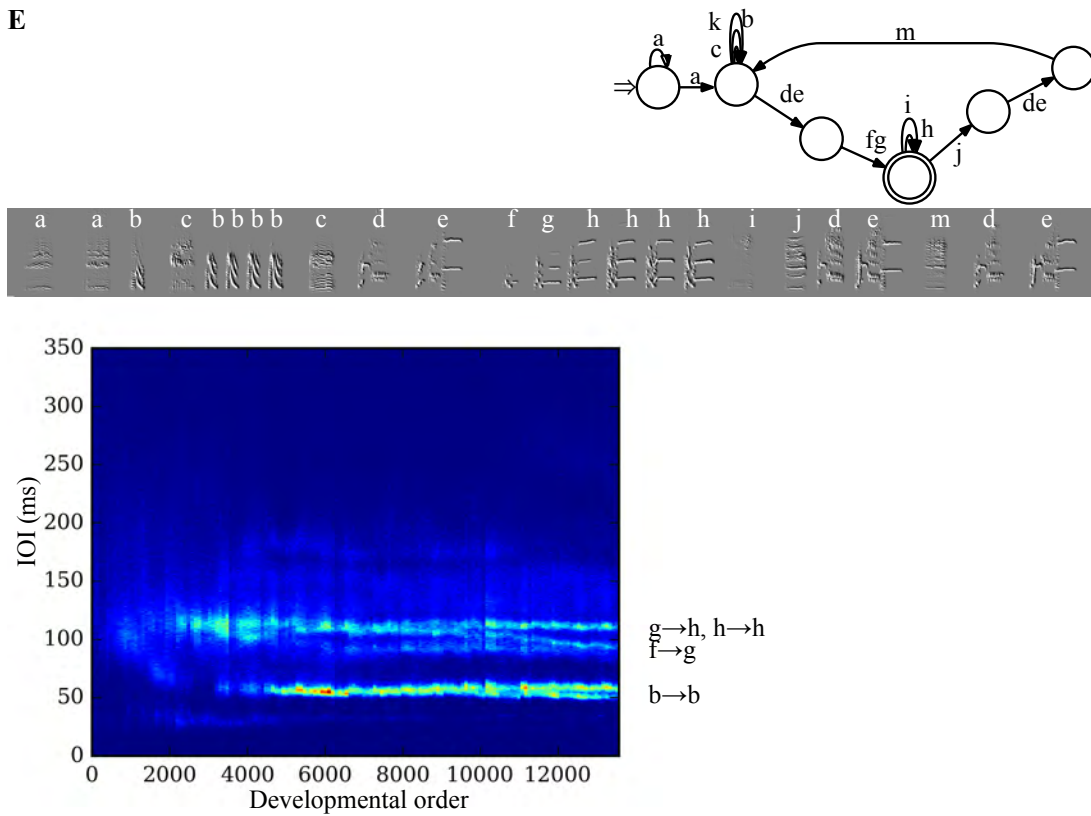


Figure S 4: **Examples of rhythm landscape.** (A) Bird3: # of note types = 10, # of transitions = 25. (B) Bird4: # of note types = 8, # of transitions = 17. Major transitions and transition diagrams are shown.

E



F

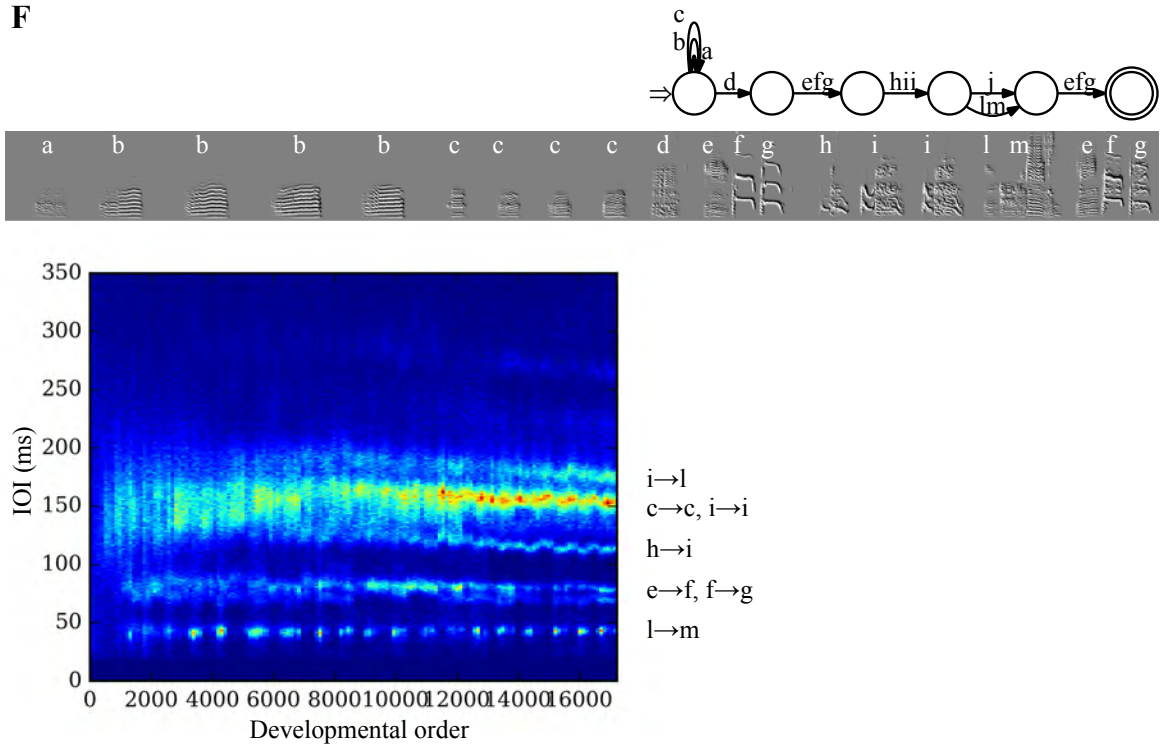
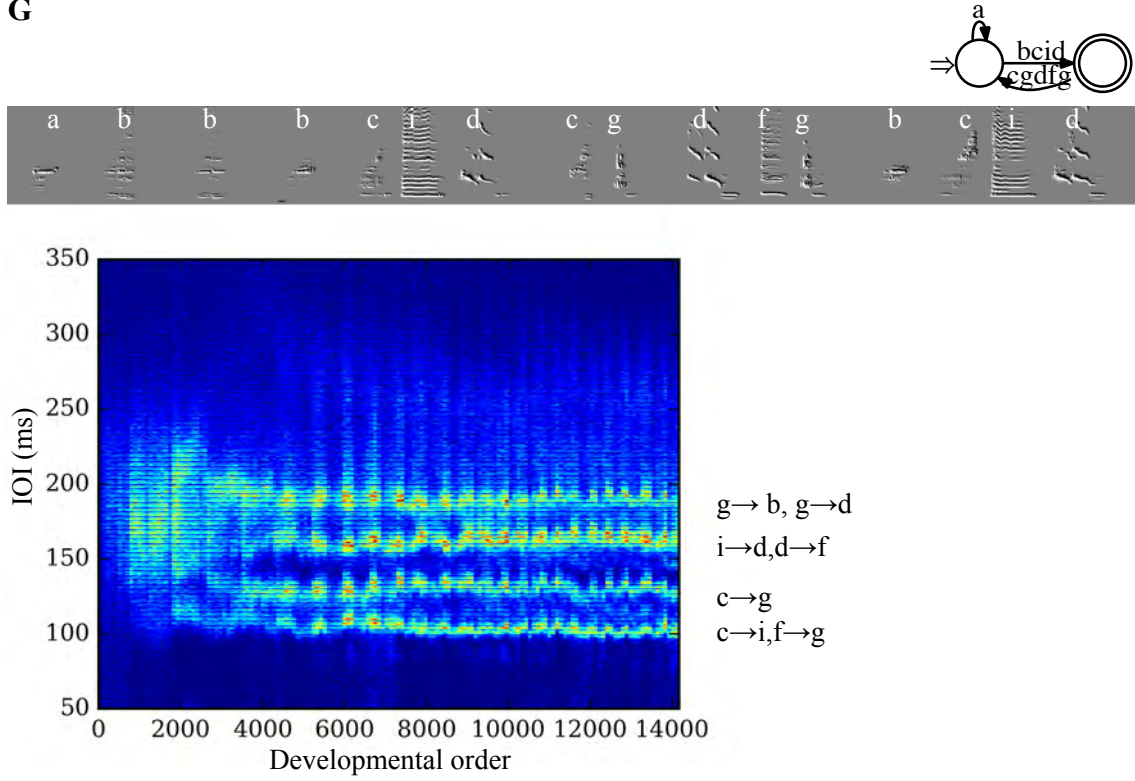


Figure S 6: **Examples of rhythm landscape.** (E) Bird7: # of note types = 13, # of transitions = 47. (F) Bird8: # of note types = 13, # of transitions = 47. Major transitions and transition diagrams are shown.

G



H

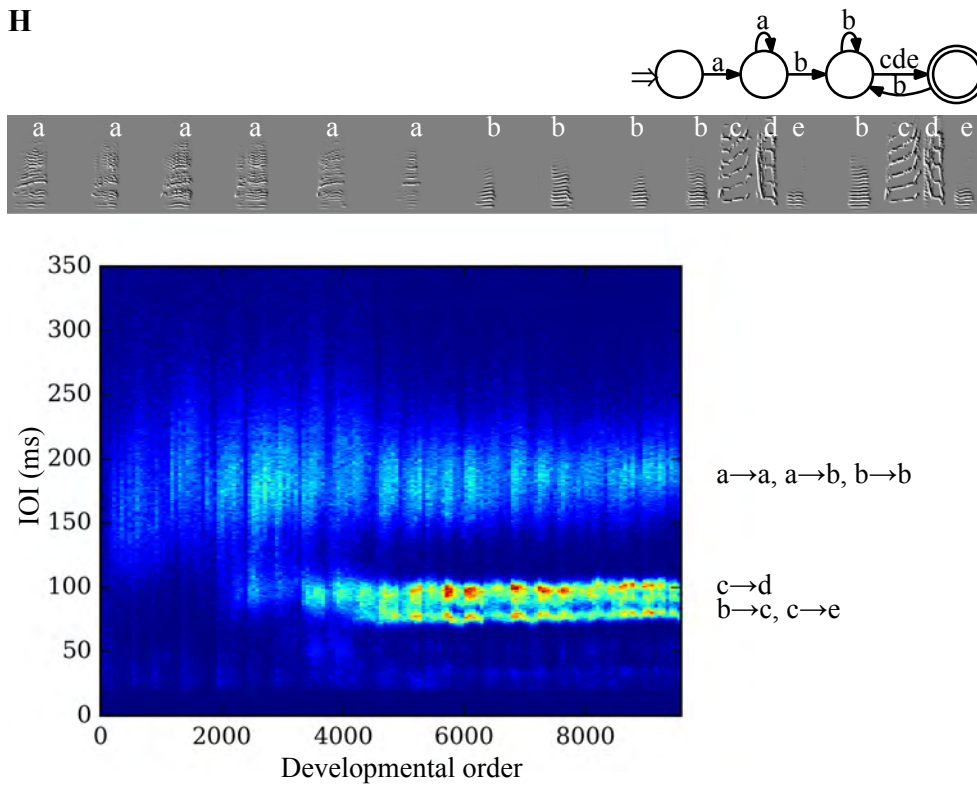


Figure S 7: **Examples of rhythm landscape.** (G) Bird9: # of note types = 8, # of transitions = 20. (H) Bird10: # of note types = 5, # of transitions = 13. Major transitions and transition diagrams are shown.

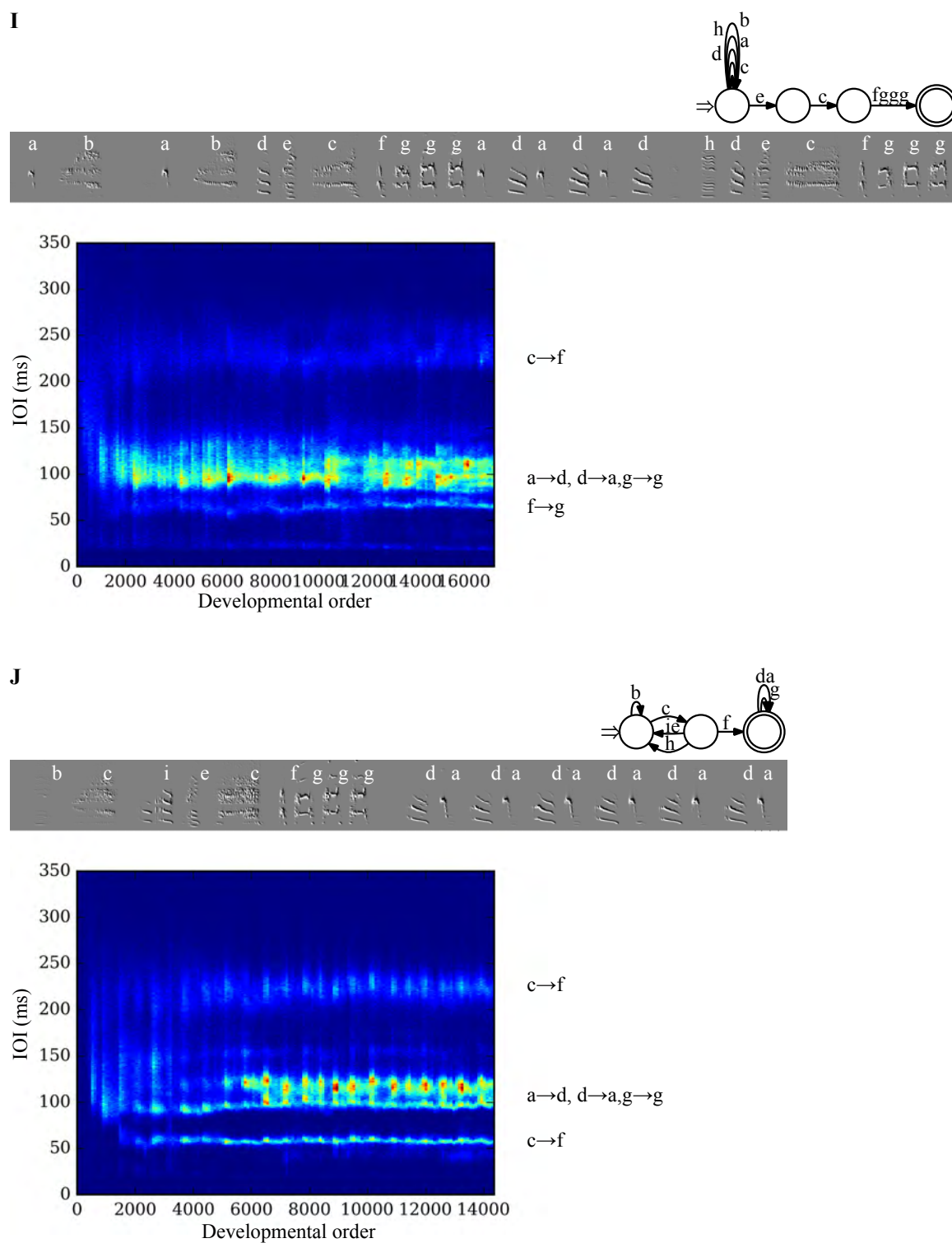


Figure S 8: **Examples of rhythm landscape.** (I) Bird11: # of note types = 6, # of transitions = 22. (J) Bird12: # of note types = 9, # of transitions = 29. Major transitions and transition diagrams are shown.

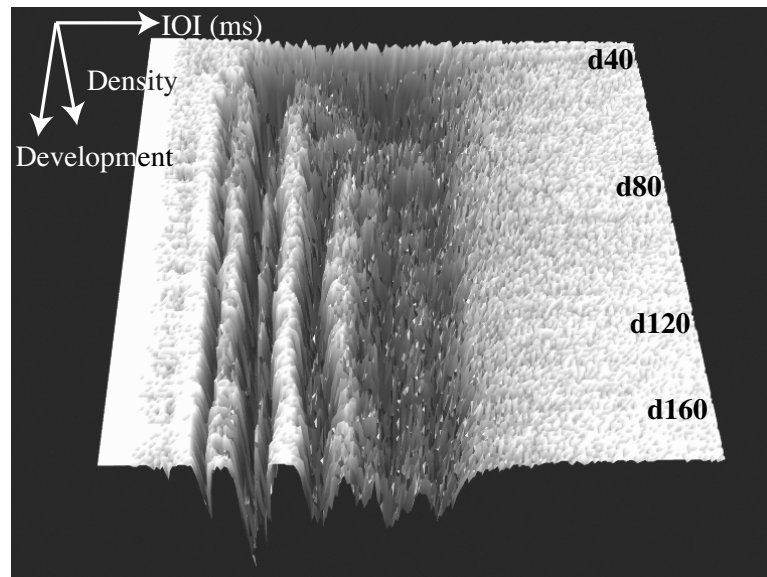


Figure S 9: 3D visualization of the rhythm landscape of a Bengalese finch song (bird2).

References

- [1] Kakishita, Y., Sasahara, K., Nishino, T., Takahasi, M. & Okanoya, K., 2009 Ethological data mining: an automata-based approach to extract behavioral units and rules. *Data Min. Knowl. Disc.* **18**, 446–471. (doi: 10.1007/s10618-008-0122-1).