Spontaneous song from humans and birds reveals dissociation between vocal learning and isochrony production

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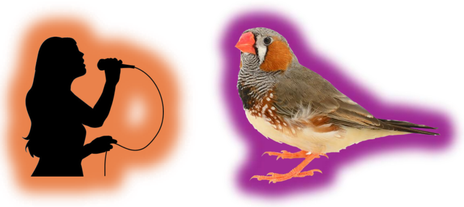
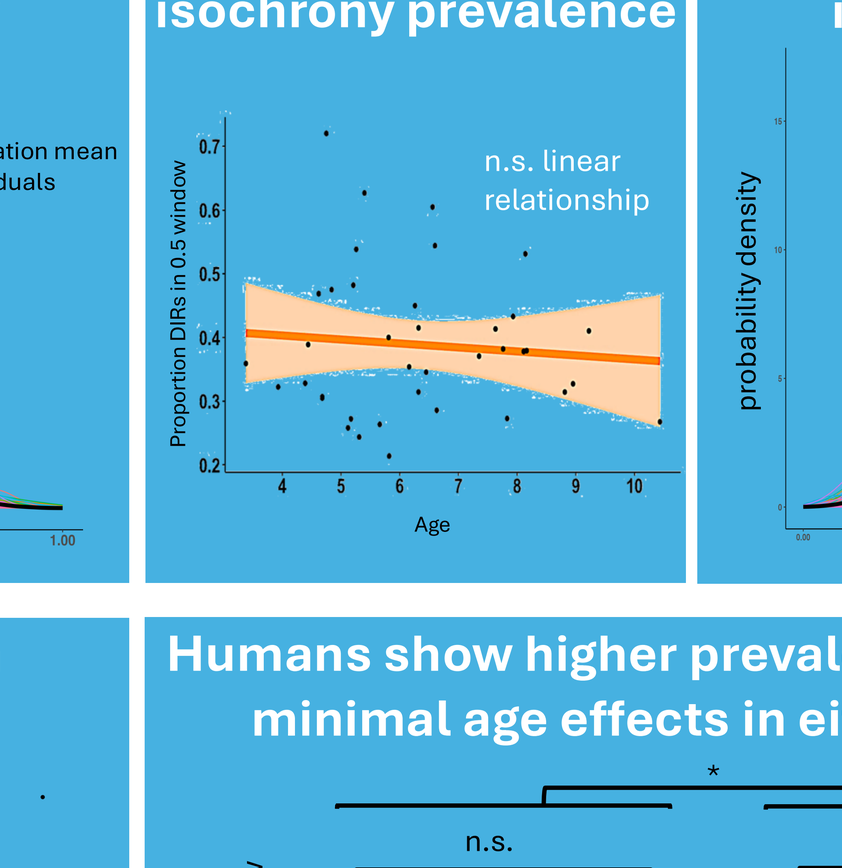
Isochrony – e.g. metronome rhythm – is fundamental to human music. What makes a species produce isochronous vocalizations? Prior work suggests this ability is served by vocal learning neural circuitry. We test this by asking whether humans and zebra finches (both vocal learner species) both show isochronous rhythm in their **spontaneous, complex song, through the lifespan**.

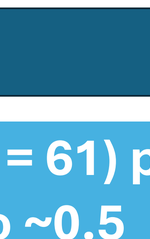
METHODS

We recorded improvised, spontaneous song from:
Humans
Kids (n = 38, 3-10 y/o)
Adults (n = 14, 23-82 y/o)
Zebra Finches (longitudinal n = 16; and n = 57 semi-naturalistically raised)
Juvenile (~60 days post-hatch)
Adult (~120 days post-hatch)



Timestamp onsets of notes/"syllables" and quantify rhythm with **dyadic interval ratio**



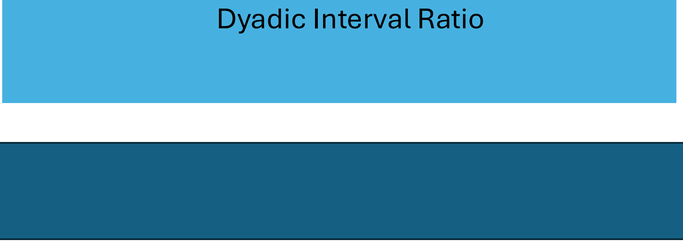


Ratio 0.5 indicates isochrony (e.g., metronome, or ticking clock)

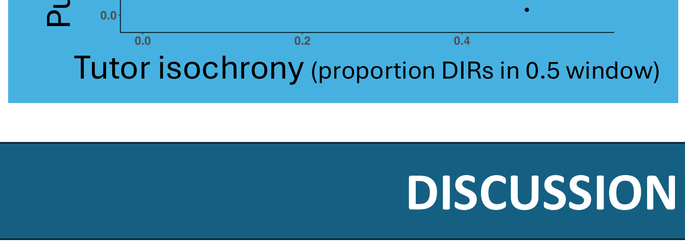
$$ratio = \frac{i_1}{i_1 + i_2}$$

RESULTS

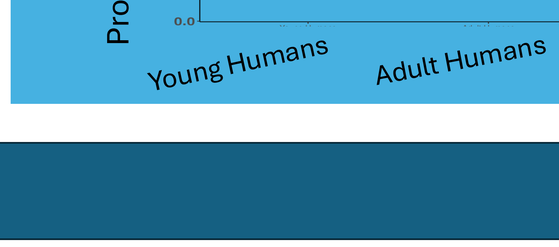
Nonmusicians' improvised song shows isochrony



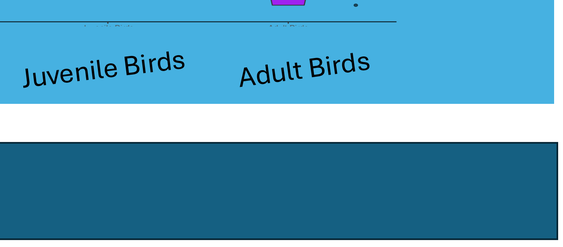
Human kids' song also shows isochrony



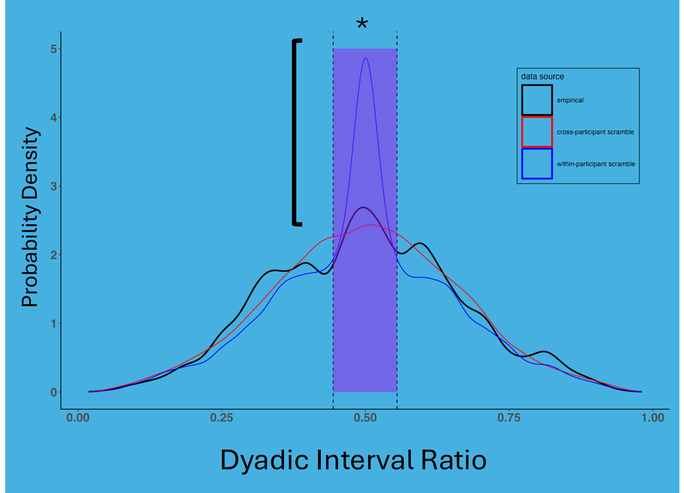
No effect of age on isochrony prevalence



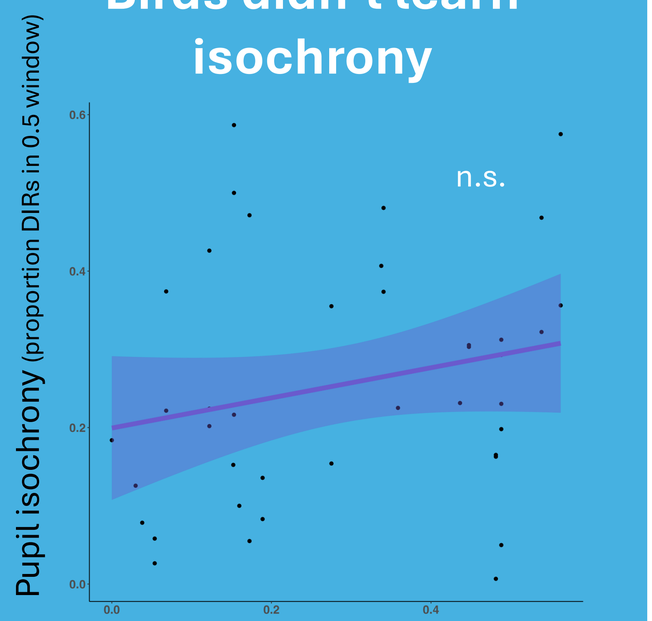
Birdsong (n = 61) peak in ratio ~0.5



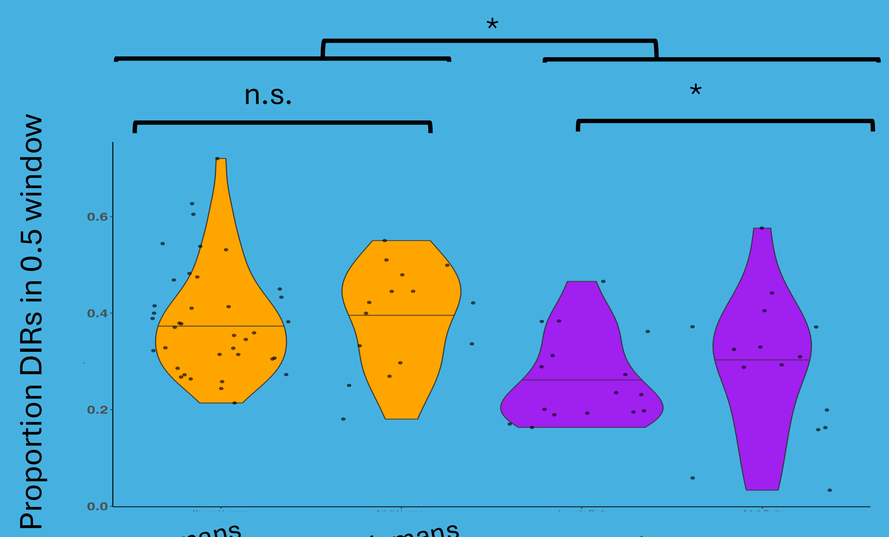
But this peak is lower than expected by chance



Birds didn't learn isochrony



Humans show higher prevalence isochrony; minimal age effects in either species



DISCUSSION

1. Isochrony is not exclusive to composed, rehearsed music, or percussive tasks: it is already present in **non-musicians' and children's improvised songs**. Isochrony therefore appears to have a strong bio basis → vocal learning?

2. Despite theories that isochrony is driven by neural circuitry underpinning vocal learning, we find that **zebra finches produce less isochrony than chance.** This does not appear to be a function of exposure: **tutor birds' isochrony production was not predictive of their pupils'**.

These findings add ecological validity to the claim that human have an early-developing, untrained inclination for isochrony in music, but this cross-species comparison suggests that **the presence of vocal learning circuitry alone cannot account for isochronous rhythm in complex song.**

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