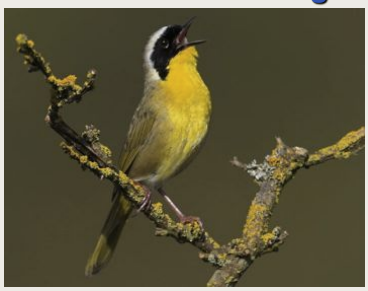
The Proximate and Ultimate Causes of Bird Songs



Species-Specific Songs

- Common Yellowthroat: witchety, witchety, witchety
- Ovenbird: teacher! teacher! teacher!
- Chickadee: chickadee, dee, dee, dee
- Vireo: here I am, where are you?
- White-throated sparrow: old John Peabody, Peabody, Peabody

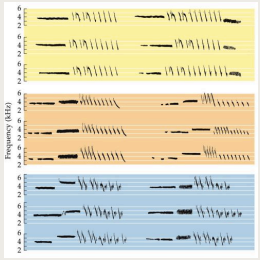
- birds seem to have dialects; birds of dif pop will sing same song but some variability among species
- why aren't they the same??
- think, they should be since they use them to ID themselves as a particular species; so why dif?

White-Crowned Sparrow Alaska

- West Coast of NA; pops all along west coast
- have dif vars on same song

White-Crowned Sparrow Washington

Regional Dialects: Proximate



- Genetics?
- Environment?

Fig. 2.1

- distinctly dif sounding songs
- underlying mech? machinery dif?- PROX q's
- or genetic drift??
- study: collected samples; no significant dif in gntcs
- prox mech doesn't seem to be contributing nxt
- dif dialects b/c dif envts? I.e. young pop could have just heard slightly dif from elders; much like hmns

Experiments (Marler *et al.*)

- Hand-reared in isolation = noises but no song
- Hand-reared with conspecific recordings = proper song develop't

- study: raised young chicks in dif envts (in lab) so to have dif scenarios
(1) hand-reared in silent envt; made noises but nvr sang
- thus, need to experience song in youth in order to devo later on
(2) now w/ recordings of their own species singing the song; able to sing song properly
- thus, there is an envt component in order to devo proper song
- however, we know that in nature they don't hear just their own song but many
- so why just their own song result?

Experiments (Marler *et al.*)

- Hand-reared with song of male of another species = song poorly developed
- Males reared with song of their own species but moved early on = song fully developed

(3) - species dif songs; bird will sing song that heard of other species but not very well
(4) - need to hear song at specific times of youth?- early on in birth then stopped recordings (short time heard song); song fully devo'd

- thus, need to hear song in order to learn, hear own songs to hear properly, when hear other songs can learn but not very well (so some sort of gntc underpinning that favors own songs but not good at other species songs), and specific time need to hear song (i.e. youth- neurons actively being formed; about 10-50 days) or will not perform song properly
- many prox mechs *

Experimental Conclusions

- Acoustical experience necessary early in life for song development
- General ability for song but innate preference for own species
- Nestlings require a tutor

- require to have been shown song
- missing from study: influence of social component (birds around them)
- i.e. not learning from speakers but learning from other indvls; could be important in learning song

Effect of Social Experience
(Baptista and Petrinovich)

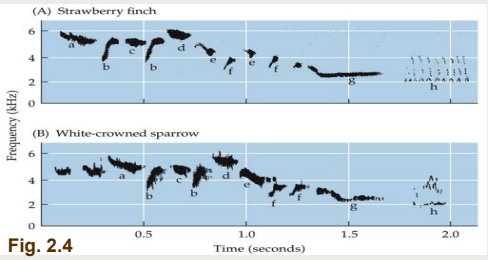
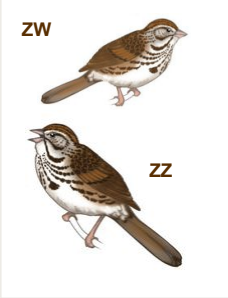


Fig. 2.4

- study: rear birds with indvl of another species of bird
- baby bird can learn song of dif species pretty well; w/ socl component, can learn song of another species much more effectively compared to learning from a speaker
- clear intrxn btw gns and envt; need to hear something from envt to activate machinery

Other Proximate Questions

- Is song genetically based?
- Where in brain is it stored and controlled?



- so what are the gntc factors going into songbirds?
- mls (ZZ) sing, not fmls (ZW)
-

Male vs. Female Brain Develop't

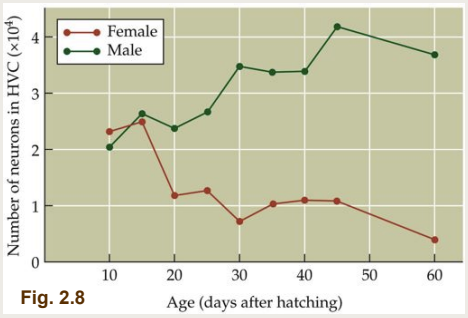


Fig. 2.8

- HVC: higher vocal center; part of brain involved in vocalizations
- during critical neuronal window (i.e. 10-50 days), same number of neurons the same at first
- shortly after, in mls HVC neurons shoot up and fmls plummet
- end of learning pd, pretty big dif in HVC neurons

Gene Activity

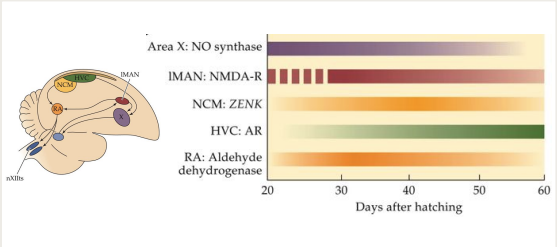


Fig. 2.9

- gn more active when colour darker
- some punctuated; on-off trigger pulsing
- dif gns active at dif times; helps to clarify what might be going on in key life stage
- can look at the types of things are going on and related to envt
- thus, we do see correlation in devo and gns looked at here but still doesn't mean they caused

Gene Activity

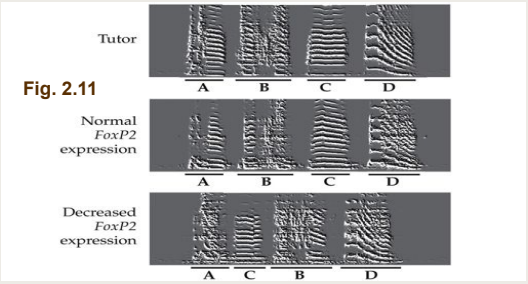


Fig. 2.11

- we can use knock-out studies; when gn doesn't work, what happens?
- see, norm chick has norm song and can match tutor but with gn knocked out, song not nearly as well devo'd
- learning dis due to inproper fxning of gn
- thus, gn is involved in some way in devo of proper song
- so now getting some prox mechs that lead to bhvr

Neurophysiology of Song

- IMAN and X involved in learning songs
- RA connected to nXIIts and IMAN
- nXIIts connected to syrinx
- RA control song output?

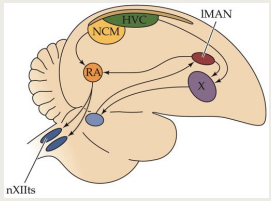


Fig. 2.13

- specific regions of brain, not important; msg is that dif regions of brain are very active in learning song area of brain
- wiring that comes out of part of brain, connected to vocal box; so we see activity during learning and the fact that part of the brain active during this learning, connected to vocal box
- so would expect for mls to need RA's of brain and fmls, not really

Robust Arcopallium (RA)

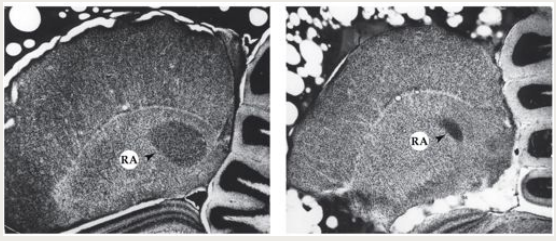


Fig. 2.14

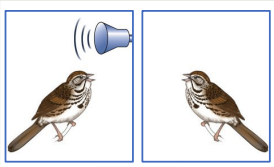
- in mls: RA big and in fmls: RA small

Chicken or Egg?

Song Development

creates ⇅ allows

Brain Tissue



Experiment: birds raised in normal acoustical environment vs. in isolation and compare brains
Conclusion: brains the same

- which leads to which?
- does song devo lead to increase in brain tissue, or does increase in brain tissue cause devo of song??
- study: take birds of dif envt, lk at brains of norm acoustic envt and compare to bird brains raised in silent envt
- concl: brains are the same!
- so brain tissue lead song devo; have big RA so able to sing song
- thus, gntcs plays a big role
- PROX: what is happening? All above is prox; now moving onto ULT
- Remeber: not just gn products but interplay btw gns and envt

Ultimate Factors

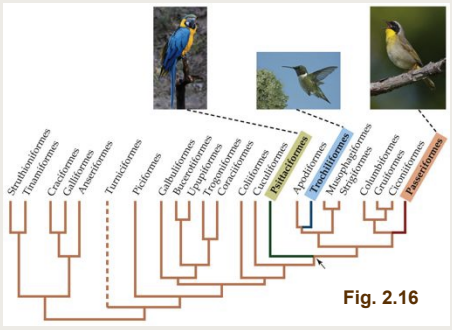


Fig. 2.16

- Tinbergenn's four q's:
where did bhvr come from? i.e. evltn, how many times did it evolve, etc.??
- only three grps of birds that evolved song
- a lot of birds that don't sing (songs are cmplx dif vocalizations that need to be learned)
- reg vocalizations don't need tutors
- hyp evltn story that lead to three grps singing: common ancestor to all three?
- but did bhvr devo three times independently or did it evolve at common lower ancestor and get lost in many along the way?
- parsimony- mapping traits on phylo tree to determine where trait comes from?
- most parsimonious is that evolved three separate times- 3 times vs. evolved and lost three times- 4 times
- to understand why, need to understand fxn

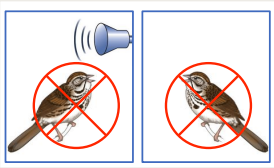
Reproductive Benefits

- **Song allows female to find male but why variation?**
- **1) Species identity announcement hypothesis**
- **2) Mate attraction hypothesis**

- (1) tells all other that mls are present and ready to mate; establishing territory- so keep away if you don't want a challenge
(2) fmls can find important mls and eval for future progeny

Experiments

- 1) Remove males and replace ½ of territories with recording of songs
- 2) Remove males and replace with recordings of correct or similar songs



- mls already established territory
- study: remove mls and put speakers in half territories had speaker of songs back in there...

Species Identity Announcement

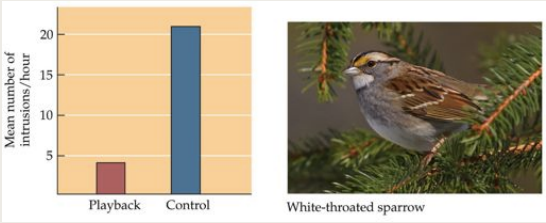


Fig. 2.19

- in control, w/ no sound = many birds! Lots of protrusions in attempt to seise for own
- when sound of bird from speaker = bird protrusion way down
- thus, species ID going on; song tells males that he is there and when remove that bird's song, attempt to claim territory way up
- benefits of fitness for singing song: keeping males out of territory

Mate Attraction

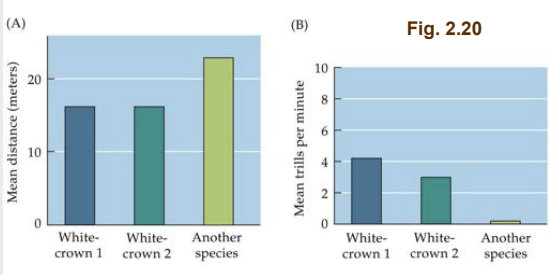
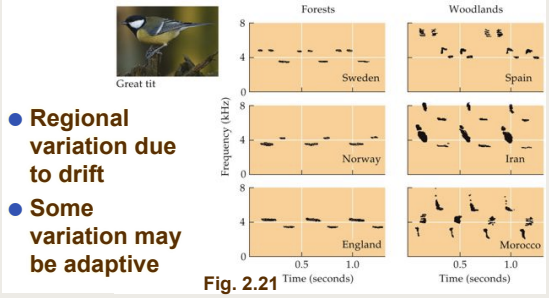


Fig. 2.20

- now looking at singing to fmls
- two dif songs of same species or speakers play songs of another species
- fmls coming into one of three areas
- mean dist she approaches = approaching dists
- mean thrills = exciting thrills
- thus, fmls are using songs to ID mls as pot mate choice
- so we know some reasons for learning songs, but why learn dialects?

Benefits of Learning a Dialect I



- Regional variation due to drift
- Some variation may be adaptive

Fig. 2.21

- chickadees from dif parts of Europe
- do know that dif in dialects, could be genetic drift, etc. but is there an adaptive benefit?
- those in more northern countries, live in forests
- those in mediteranean, etc. in scrubby, brush areas
- sound travels in much dif ways btw envts
- in forests, high trees cut out high freqs very easily since it will get trapped in envt filters
- so in forest areas, birds have lowered songs = ADAPTIVE BENEFIT
- so bhvr adaptive in one context and not so much in another envt

Benefits of Learning a Dialect I

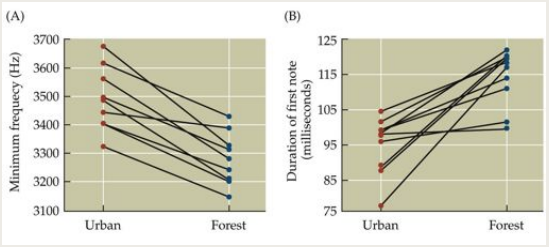


Fig. 2.22

- cities have very low rumble to it; many low freqs
- so in urban areas, use dif sound freqs compared to use in rural freqs
- duration of first note much shorter in urban; better to have short punctuated notes so as to not get lost in surroundings noises

Female Preference

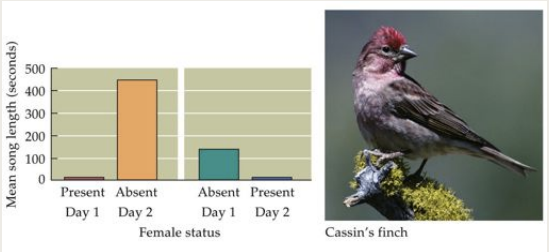


Fig. 2.27

- but are fmls listening to mls' songs?
- when fml not there, needs to sing a lot and when fml is there, needs to sings less
- however, when fml leaves again needs to sing a lot again
- so clear indication that ml is singing to fml

Effect of Dialect on Fitness

- Regional adaptation hypothesis
  - Local dialect is best adapted to local conditions
  - Correlation between deviation from song and parasite load and low fecundity
- But: females do not prefer songs similar to their fathers nor are males singing the songs of their birthplace

- again, so why the dialect?
- again, could be a regional explanation (i.e. freq sound travel in dif envts)
- there are correlation btw ability to do something and overall fitness lvl
- hyp: fmls prefer songs of own area
- however, fmls don't prefer songs that originate from local area (i.e. songs of fml birds father is not a preference)

Alternate Hypothesis

- Females evaluate male song diversity as an indicator of his quality
- Studies have shown positive correlations between male song diversity
  - # offspring
  - HVC size
  - Fat reserves
  - Robust immune systems
  - Invest more parental care

- another hyp: fmls eval quality of ml
- so by choosing ml w good songs, getting more qualities??
- the fact that song is learned, is very important!!
- ^ gives fml something to eval (i.e. how well someone can learn the song); displays how gd gns are; if healthy, gd devo history when singing gd songs b/c indvls who are not healthy, cannot sing song
- when indvl stressed (i.e. gntcs, etc.) or envt stressed, cannot learn song properly

Good Genes Hypothesis

- Learning ability in males reflects developmental quality
- Learning difficult to sustain if stressed (genetics or environment)

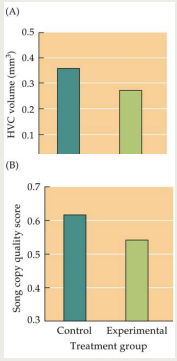
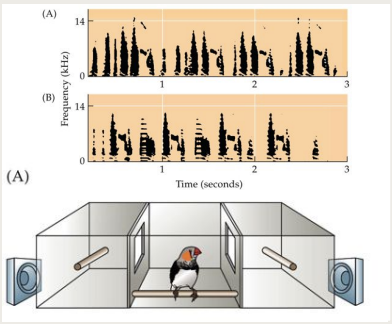


Fig. 2.28

- when exp stress indvl (indvl of surroundings), HVC vol smlr and decrease ability to produce gd song

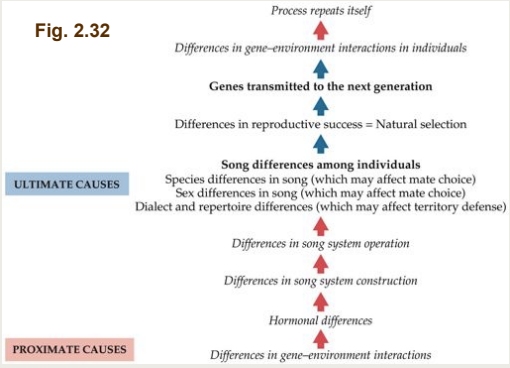
Do Females Listen?

Fig. 2.30



- study: songs of healthy or stressed indvl; fmls fly over to songs of healthy
- so fmls are listening for difs!!

Fig. 2.32



- gradient and intrxn btwn prox and ult causes!
- so song difs in indvls: can ID btw species, difs btw indvls to eval btw ea other, and to determine territories
- ^all go into dif lvls of fitness!

Questions?