



The CLEAN PAPER

WHAT THE PAPER SAYS · WHAT IT DOESN'T · WHY IT MATTERS

Zebra finches ñ treat calls gégé bí meaningful categories — ògbón èyí kì í ẹ language

Science study kan test bóyá zebra finches kan ñ gbọ different calls, tàbí wón organize own vocal repertoire sí categories tó carry behavioral meaning. Nínú laboratory discrimination tasks, birds learn gbogbo 11 call-types, generalize categories sí new vocalizers, wón sì ẹ systematic errors láàárín calls tí a lo ní similar contexts ju acoustic similarity nìkan yóò predict lọ. Èyí jẹ strong evidence fún categorical perception àti operational kind of meaning. Kì í ẹ evidence pé finches ní human-like language, syntax, open-ended words, tàbí channel fún conversation pèlú people.

Written by Laura Nesso · Cross-checked by Lucio Vaglio · Edited by Michele Renda · Figures by Laura Nesso and Nova Vela · AI-assisted, human-reviewed

Paper: *Categorical and semantic perception of the meaning of call-types in zebra finches*, Julie E. Elie, Aude de Witasse-Thézy, Logan Thomas, Ben Malit, and Frédéric E. Theunissen, *Science* 389, 1210–1215 (2025) · DOI: 10.1126/science.ads8482

Òrò “meaning” ní ẹ̀ ẹ̀ ẹ̀ tó ẹ̀ra nírí

Zebra finches kò nílò ìyònda wa kí wọn tó ní social life. Wọn máa ní pe nígbà tí ebi ní pa wọn, tí wọn yà kúrò lódò ẹ̀lẹgbé, ní courtship, ní alarm, ní contact pẹ̀lú partner, tàbí ní conflict. Ethologists lè pín àwọn sound wònyí sí **call-types**: practical categories bí alarm calls, contact calls tàbí begging calls, tí a define pẹ̀lú shape sound àti ohun tí bird ní ẹ̀ nígbà tí ó lo sound náà. Ìbèèrè tó nira jù ni bóyá birds fúnra wọn tún pín calls náà lònà yẹn.

Ìwé ìwádíí kan nínú Science ẹ̀ claim tó narrow ẹ̀gbọn tó ẹ̀ pàtàkì: adult zebra finches lè categorize call-types nínú vocal repertoire tiwọn, àwọn àṣìṣe wọn sì ní daba pé calls tí ìhùwàsí wọn jọ sún mó ara wọn nínú perceptual space birds ju ohun tí acoustics nìkan yóò predict lọ.

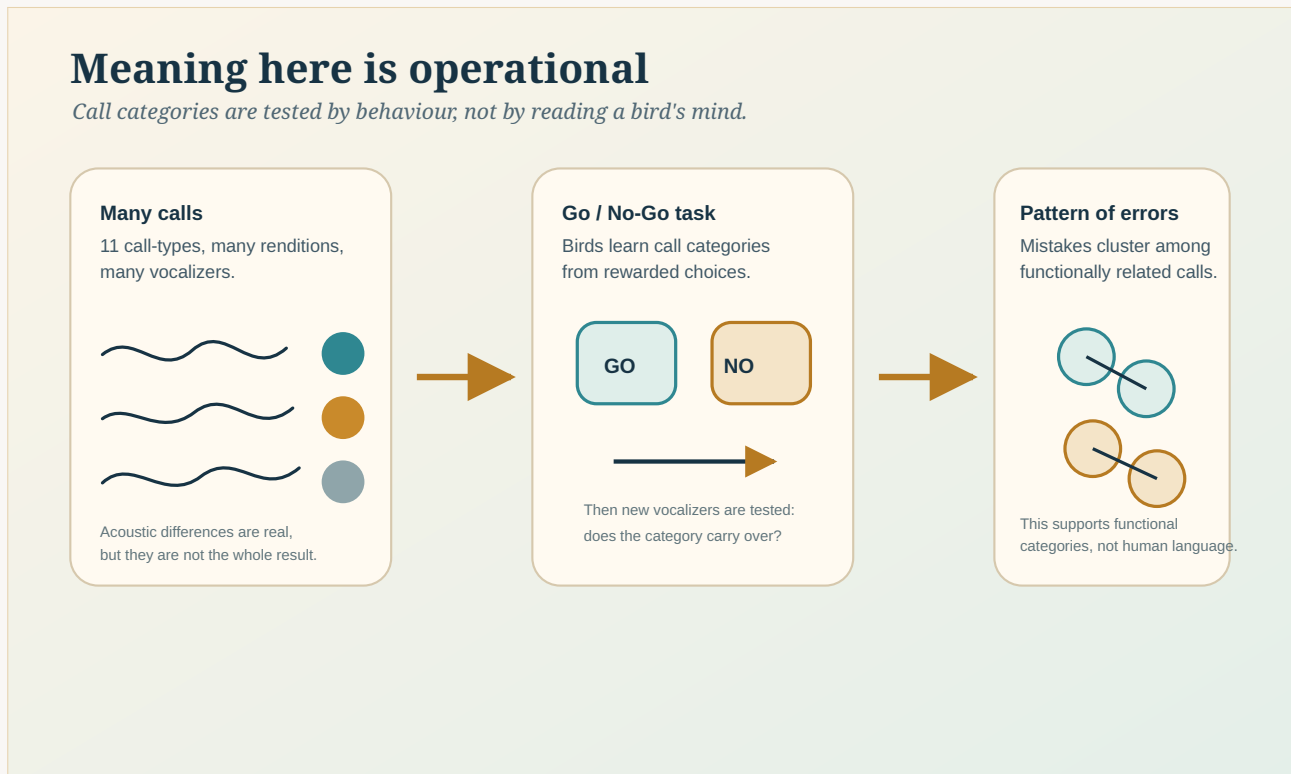
Níbi yí ni òrò **semantic** tí wọ ìwé ìwádíí náà. Kò tùmọ̀ sí pé birds ní words ní èniyàn sense. Kò tùmọ̀ sí syntax, conversation, tàbí dictionary kan tó farapamọ̀ nínú finch ọ̀pọ̀lọ̀. Níbi “meaning” jẹ̀ operational: tí calls méjì bá wúlò ní similar social contexts, tí birds sì confuse wọn ju ohun tí sound alone lè ṣàlàyé lọ, behavioral category dà bí ẹ̀ni pé ó ní shape perception.

Clean ẹ̀dà kì í ẹ̀ “birds ní ẹ̀dè.” Ó jẹ̀: zebra finches dà bí ẹ̀ni pé wọn ní treat own calls wọn gégé bí functional categories, àwọn category kan sì ní hùwà bí ẹ̀ni pé wọn carry meaning ní limited, testable sense tí ìdánwò náà.



Zebra finches (*Taeniopygia guttata*) jẹ̀ highly social songbirds pẹ̀lú rich repertoire ti calls, èyí tó mú wọn jẹ̀ useful àwòṣe fún studying bí animals ẹ̀ categorize vocal àmì.

Christoph Moning / iNaturalist CC BY 4.0



Draft evidence-chain slide fún review: many renditions ti 11 call-types wọ Go/No-Go discrimination işé-şişe; key èsì ni pé birds generalize categories sí tuntun vocalizers, àwọn àşişe wọn sì cluster nípa call function, kì í şe acoustic similarity nìkan.

The Clean Paper CC BY 4.0

Ohun tí àwọn olùkòwé idánwò

Àwọn olùkòwé bèrè láti existing ethological map ti zebra finch repertoire. Species nàà ní tó **11 ethogram-based call-types**: calls tó ní association pẹ̀lú contact, pair bonding àti nest ihùwàsí, alarm, aggression tàbí non-affiliative ihùwàsí, begging, àti male song.

Classification nàà ni èniyàn şe. Ó darapọ̀ acoustic àbùdá, context tí sound ti produced, àti ohun tí sound sáà ní şe nínú social life. Şùgbọ̀n èniyàn ethogram kì í automatically jẹ̀ animal mental map. ìwádíí nàà bèèrè linked ibèèrè mèta.

Àkókó, şe zebra finches lè discriminate gbogbo call-types wònyí?

Èlẹ̀kẹ̀jẹ̀, şe wọn generalize call-type category sí vocalizers tí wọn kò tì gbọ̀, dípò kí wọn memorize individual examples nìkan?

Èlẹ̀kẹ̀ta, nígbà tí wọn bá şe mistake, şe mistakes nàà ní tẹ̀ lé acoustic similarity nìkan, tàbí behavioral meaning ti calls tún ní ní ipa?

Point pàtàkì ní pé ìdánwò kò béèrè lówò bird láti sàlàyé ohun tí call túmò sí. Ó ní béèrè bóyá ìhùwàsí bird nínú controlled isẹ̀-ṣiṣe ní statistical footprint tí categories àti meaning.

Bí ìdánwò ẹ̀ ń ṣiṣe

Terms mètá ní wọn carry weight púpò nínú ìwé ìwádíí yí.

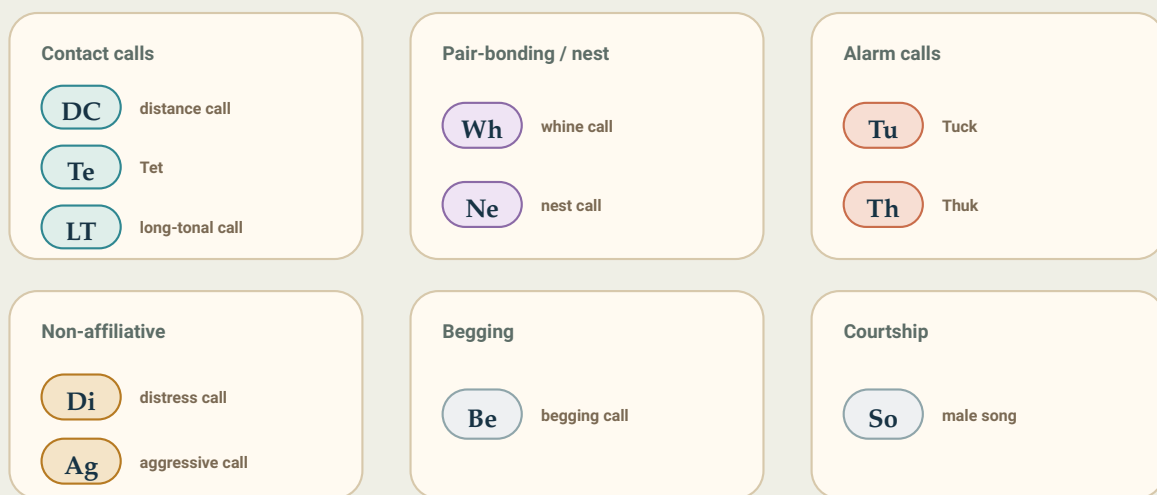
Call-type ni category tí zebra finch sound. ìwé ìwádíí lo **ethogram-based** call-types, ìyẹn categories tí a gba láti behavioral catalogue: acoustic appearance sound, igba tí birds produce rẹ̀, àti social situation tí ó jẹ́ apá rẹ̀. **Vocalizer** jẹ́ individual bird tí ó produce recorded call. **Acoustic shape** ni measurable sound àpẹẹrẹ̀; **behavioral function** ni ohun tí call sáà ń wúlò fún.

Call-types 11 tí wọn ìdánwò kì í ẹ̀ abstract labels. Wọn ni repertoire tí birds gbòdò discriminate:

- **Contact calls:** ìjinnà call (DC), Tet (Te), long-tonal call (LT).
- **Pair-bonding àti nest ìhùwàsí:** whine call (Wh), nest call (Ne).
- **Alarm calls:** Tuck (Tu), Thuk (Th).
- **Non-affiliative calls:** distress call (Di), aggressive call (Ag).
- **Begging:** begging call (Be).
- **Courtship:** male song (So).

The 11 call-types are concrete categories

The paper asks whether zebra finches sort these calls the way ethologists do.



These are ethogram-based labels: categories from sound shape plus social context, not human words.

Call-types 11 tí ìwé ìwádíí ìdánwò, grouped ní broad social function. Labels jẹ́ ethogram-based categories láti oríṣun ìwé ìwádíí: wọn kì í ẹ̀ “words”, ṣùgbón wọn fún olùkà ní concrete repertoire tí birds ní láti discriminate.

The Clean Paper CC BY 4.0

Main işe-şise jẹ **Go/No-Go auditory discrimination**. Bird peck lit key láti start six-second playback. Fún rewarded call, right move ni láti dúró: léyìn sound parí, food hopper gòkè, bird sì gba seed. Fún non-rewarded call, waiting kò şe nńkan; efficient move ni láti peck lẹ̀ẹkan sí i nígbà playback, interrupt sound, kí ó start ìdánwò mû. Nítorí náà bird interruptions fi hàn sounds wo ni ó treat gégé bí “not rewarded category.”

Fún ìdánwò kọ́ọkan, call-type kan ni rewarded, ten yòókù kò rewarded. Léyìn náà àwọn olùkòwé yí rewarded call-type padà, wọn sì kọ́já gbogbo repertoire. Wọn tún lo many renditions láti many vocalizers, pẹ̀lú few exact repeats. Èyí şe pàtàkì: bird kò lè memorize recording kan. Láti şe dáadáa, ó ní láti learn ohun tí ó count gégé bí call-type kọ́já voices birds tó yàtò àti examples tó yàtò.

“Perceptual space” tó tẹ̀ lẹ̀ e kì í şe ọ̀pọ̀lo scan tàbí literal map nínú animal. Ó jẹ̀ map tí a infer láti mistakes. Tí call-types méjì bá confuse often, a fi wọn sún mọ́ra nínú behavioral map. Àwọn olùkòwé fi èyí wé acoustic map tí a kọ̀ láti sound àbùdá nńkan. Claim náà interesting nńkan tí àşise map birds bá pulled toward call function, kì í şe toward similar sound nńkan.

Ohun tí wọn rí

Birds lè discriminate full repertoire. Adult zebra finches 12, six males àti six females, ni wọn ìdánwò kọ́já 11 call-types. Fere gbogbo ìdánwò succeeded: **127 nínú 131** call-type discrimination ìdánwò jẹ̀ significant. Few ìkùnà ní birds pàtò àti call-types pàtò; overall àpẹ̀rẹ̀ ni pé every call-type ni wọn discriminate above chance.

Èyí şe pàtàkì nítorí repertoire kì í şe neat set ti isolated beeps. Díẹ̀ call-types acoustically clustered, àwọn mû grade sínú ọ̀kan òmíràn. Birds sì learn categories.

Wọn generalize categories sí tuntun vocalizers. Nínú ìdánwò kejì, birds learn láti discriminate call-types méjì láti small set of vocalizers. Ọ̀jọ̀ kejì, tuntun vocalizers ni a fi kún un pẹ̀lú reward òfin kan náà. Birds classify tuntun calls correctly very early, şáájú kí wọn lè learn every tuntun example láti reward feedback. Èyí şe àtílẹ̀yìn fún categorical perception tí call-type, kì í şe memorization tí individual sounds.

Category lè override tuntun reward òfin. Strongest behavioral trick hàn nígbà tí işe-şise di incongruent. Calls láti tuntun vocalizers ni a assign opposite reward contingency láti eyi tí birds ti learn fún call-type yẹn. Tí birds kan ní follow tuntun acoustic examples, wọn yẹ̀ kí adapt immediately. Dípò bẹ̀, early ìdáhùn follow previously learned call-type category, wọn sì produce systematically wrong reward decisions. Bí ọ̀jọ̀ şe ní ọ̀, birds slowly learn arbitrary tuntun òfin. Èyí gan-an ni ohun tí a máa retí tí natural call-type category bá gidi tó láti get in the way.

Mistakes kì í şe acoustic nńkan. Àwọn olùkòwé fi acoustic space, tí a kọ̀ láti classifier confusions among call sounds, wé perceptual space, tí a kọ̀ láti behavioral àşise birds. Spaces méjèèjì related: sound sì matter. Şùgbọ́n call-types tí wọn jẹ̀ kan náà behavioral tàbí semantic hyper-category sún mọ́ra sí i nínú perceptual space birds ju nínú acoustic space ọ̀. ìwé ìwádíí pe èyí ní **semantic magnet ipa**.

Ní numbers, grouping ní semantic hyper-category jẹ̀ tó **2.43 times stronger** nínú perceptual map ju acoustic map ọ̀. Ní plain èdè: mistakes birds ni a pulled toward functional meaning, kì í şe similar sound nńkan.

Kí ni “semantic” túmò sí níbí?

Èyí ni apá tó nílò care jù. Nínú ordinary èdè, “semantic” ọrùn láti di “words.” Kì í ẹ̀ ohun tí ìwé ìwádíí yí fi ẹ̀rí múlẹ̀.

Ìwádíí lo “semantic” ní behavioral àti comparative-cognition sense. Call-type ní putative meaning nítorí ó associated pẹ̀lú social function: alarm, contact, begging, aggression, pair bonding, courtship. Tí birds confuse call-types méjì láti kan náà broad social category ju acoustics predict lọ, perceptual space wọn ní jẹ́ shaped nipasẹ́ functional category yẹn.

Èyí jẹ́ serious èsì. Ó daba pé bird kò kan ní gbọ spectrogram. Bird ní treat species-specific calls gégé bí behaviorally organized categories.

Șùgbọ̀n ó ẹ̀ indirect. Àwọn olùkòwé kò lè read animal mind, wọn sì sọ bẹ̀. Wọn infer internal representation láti ìhùwàsí: discrimination, generalization, àti systematic àṣṣẹ.

Analogy tó wúlò kì í ẹ̀ “finch words.” Ó sún mọ́ èyí: auditory ètò bird dà bí ẹ̀ni pé ó ní warp ijìnnà láàárín calls gégé bí ohun tí calls wúlò fún.

Ohun tí èyí kò fi ẹ̀rí múlẹ̀

- Kò fi human-like èdè hàn. Kò sí syntax, grammar, compositional meaning tàbí open-ended vocabulary nínú èsì yí.
- Kò fi hàn pé zebra finches ní “words.” Call-types jẹ́ species-specific vocal categories tied sí behavioral contexts, kì í ẹ̀ symbolic labels tí a lè recombine freely.
- Kò fi conversation pẹ̀lú ènìyàn hàn, tàbí decoded channel fún talking to birds.
- Kò access mental ipò taara. Meaning jẹ́ inference láti iṣẹ-ṣiṣe ìhùwàsí àti àṣṣẹ iṣètò, kì í ẹ̀ observed inside bird mind.
- Kò fi hàn pé birds understood tuntun meanings. Generalization sí tuntun vocalizers jẹ́ generalization ti call-type category across yàtò individual sounds.
- Kò settle bí categories wònyí develop. ìwádíí ìdánwò adult birds; bí exposure àti development ẹ̀ shape semantic magnet ipa jẹ́ future iṣẹ.

Báwo ni ẹ̀rí ẹ̀ lágbara tó?

Fún categorical perception ti call-types, ẹ̀rí lágbara. Design béèrè fún birds láti discriminate full repertoire, lo many renditions láti many vocalizers, ó sì ní generalization ìdánwò níbí tí newly heard vocalizers ti classified by call-type. Incongruent reward condition useful gan-an nítorí ó fi hàn pé category lè interfere pẹ̀lú tuntun arbitrary òfin.

Fún operational kind of semantic perception, ẹ̀rí dára șùgbọ̀n inferential sí i. Semantic magnet ipa kì í ẹ̀ metaphor nìkan: àwọn olùkòwé fi acoustic àti behavioral ijìnnà maps wé, wọn sì rí pé behaviorally related call-types cluster

strongly sí i nínú perception ju acoustics lọ. Èyí ẹ àtílẹ̀yìn fún idea pé call function shape perception.

Fún human-like meaning, ẹ́rí kò sí — kò sì nílò láti wà. ìwé ìwádíí nàà interesting sí i tí a bá jẹ́ kí ó remain specific. Animal communication kò di valuable nìkan nígbà tí ó resemble ènìyàn speech.

Kí nìdí tí ó fi ẹ̀ pàtàkì?

Public temptation hàn gbangba. Tí bird bá hear call gégé bí meaningful, àkọ̀lẹ́ tó tẹ̀ lẹ́ e fẹ́ sọ pé a ní decode animal èdè. Leap yẹn skip hard part of science.

Careful èsì dára ju. Ó fi hàn bí olùwádíí ẹ̀ lẹ̀ ìdánwò “meaning” láìpretend pé wọn translate animal mind. Wọn lẹ̀ béèrè bóyá animals agree pẹ̀lú ènìyàn ethologists categories. Wọn lẹ̀ béèrè bóyá tuntun examples sorted by category. Wọn lẹ̀ béèrè bóyá àṣìṣe follow acoustic similarity tàbí social function. Èyí jẹ́ ọ̀nà láti mú old ìbéèrè — ẹ̀ animal calls mean anything to animals? — sharp sí i experimentally.

Ó tún move discussion kúrò ní false ladder níbí tí ènìyàn ní èdè, gbogbo nìkan mún sí jẹ́ ariwo. Zebra finches ní small, species-specific vocal repertoire. Nínú repertoire nàà, ìwádíí yíi daba pé birds perceive structured categories tied sí social lò. Kí í ẹ̀ èdè wa. Ó jẹ́ communication ètò tiwọn, tested on its own terms.

Àkótán kedere

Science ìwádíí kan ìdánwò adult zebra finches lórí 11 call-types nínú vocal repertoire wọn. Nínú auditory Go/No-Go isẹ́-ṣìṣe, birds discriminate gbogbo call-types, generalize learned categories sí calls láti tuntun vocalizers, àti nínú incongruent condition initially follow call-type categories paapaa nígbà tí èyí produce wrong reward decisions. Àwọn olùkòwé fi acoustic similarity wé behavioral àṣìṣe, wọn sì rí pé call-types tí a lo ní similar social contexts cluster strongly sí i nínú perceptual space birds ju acoustic space lọ. Èyí ẹ̀ àtílẹ̀yìn fún categorical perception àti operational form of semantic perception: birds dà bí ẹ̀ni pé wọn organize own calls wọn nípa functional categories, kì í ẹ̀ sound nìkan. Kò fi human-like èdè, syntax, words, taara access sí mental ipò, tàbí conversation pẹ̀lú birds hàn.

Àyèwò láisí àṣejù

Ohun tí ìwé ìwádíí fi hàn: Adult zebra finches lẹ̀ discriminate 11 ethogram-based call-types repertoire wọn; wọn generalize call-type categories sí tuntun vocalizers; systematic àṣìṣe wọn sì shaped nipasẹ̀ behavioral tàbí semantic categories beyond acoustic similarity alone.

Ohun tó ẹ̀é gbà ṣùgbọ̀n tí a kò fi ẹ́rí múlẹ́: Pé zebra finches ní internal representations of call meaning; pé similar neural maps wà léyìn behavioral “semantic magnet” ipa; pé development àti exposure shape categories wònyí ní ways analogous sí learned perceptual categories mún.

Ohun tí kò fi hàn: Human-like èdè; grammar; open-ended words; symbolic reference ní ènìyàn sense; ẹ́rí taara

of subjective mental ipò; way fún èniyàn láti talk pèlú zebra finches.

Main limitations: Laboratory operant isẹ-ṣiṣe pèlú **12 adult birds**, kì í ẹ natural field interactions; “semantic” jẹ inferred láti ihùwàsí àti àṣiṣe isètò; development ẹ open; èsì jẹ nípa fixed species-specific repertoire, kì í ẹ flexible compositional èdè.

Confidence wo ni gbogbogbò reader yẹ kí ó ní? Gíga pé zebra finches lè categorize àti discriminate call-types nínú isẹ-ṣiṣe yí. Dáa pé àṣiṣe wọn reflect functional categories, kì í ẹ acoustic similarity nìkan. Kéré pé èyí jẹ ẹrí fún bird èdè ní èniyàn sense. Ipò tó yẹ: lágbára animal-cognition èsì nípa meaningful vocal categories, kì í ẹ Dolittle moment.

Àwọn orísun

Science 389, 1210-1215 (2025)

<https://doi.org/10.1126/science.ads8482>

Author manuscript in PMC — PMCID PMC12721838

<https://pmc.ncbi.nlm.nih.gov/articles/PMC12721838/>

Behavioral data and analysis code — Zenodo

<https://zenodo.org/records/13623969>

Zebra finch acoustical database — Figshare

<https://doi.org/10.6084/m9.figshare.11905533.v1>