Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Call-type use under simulated hawk and cat exposure in two Japanese quail (Coturnix japonica): a case study

Goun Park
Hoseo University
Kayeon Ham
Hoseo University
Seeun Park
Hoseo University
Chunghyun Kim
juda1974@hoseo.edu

Hoseo University

Case Report

Keywords: Japanese quail, Coturnix japonica, predator-specific calling, call-type composition, vocal repertoire, bioacoustics, pilot study

Posted Date: November 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11182043/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Japanese quail (Coturnix japonica) have a large vocal repertoire, but whether call types are used differently under aerial and terrestrial predator threat is unknown. This case study describes two adult female quail exposed to simulated hawk and cat stimuli (silhouette projection with matched sound) in four social contexts, with vocalizations recorded before, during and after stimulus presentation. Blind dual-observer review identified 18 spectrographically distinct call types (an exploratory estimate without a formal reliability statistic), of which 10 were acoustically characterized. Only one of 5,512 classified calls occurred during stimulus presentation, so analyses contrast pre- and post-exposure phases. Call-type composition differed between hawk and cat exposure in both birds (Cramér's V = 0.42 and 0.39), but calls are not independent observations, so p-values are descriptive. In a context-matched check, only call type 10 was cat-biased in every informative unit (7/7; exact sign test p = 0.016, uncorrected). The share of call type 9 rose after exposure in five of six matched comparisons. An earlier cohort of eight birds studied with the same paradigm produced high-pitched calls judged alarm-like in every bird, but background noise prevented measurement, so this is qualitative context only. With n = 2, these observations are hypothesis-generating and motivate a follow-up with 8–10 birds per predator condition.

Introduction

Domestic and wild Galliformes possess vocal repertoires that encode information about predator class, food availability, and social context [1, 2]. In the domestic chicken (Gallus gallus domesticus), playback experiments have established that acoustically similar call types can nonetheless carry distinct, functionally referential information: food calls and ground-alarm calls share comparable pulsatile acoustic structure yet elicit categorically different receiver responses [3], and alarm calling itself is modulated by the presence and identity of an audience [4, 5].

Vocal repertoire size and structure have been quantified across a range of avian taxa, including Korean passerines such as the Daurian Redstart (Phoenicurus auroreus), for which spectrographic classification has revealed an extensive song repertoire structured into distinguishable component parts [6]. The Japanese quail (Coturnix japonica) is reported to possess a comparably large vocal repertoire, historically described as comprising approximately two dozen discrete call types organized into four functional groups, including one linked to strong defensive responses toward interspecific threats such as predators [7]. Individual call types, most notably the male crow, have been examined for their role in mate recognition and subspecies discrimination [8, 9], and isolation-induced distress calling has been shown to be suppressed by visual social cues, including mirror images [10]. In the domestic chicken, an ecologically embedded mirror-audience paradigm, in which alarm calling toward a simulated aerial predator was compared across solitary, conspecific, and mirror conditions, found that roosters warned a live conspecific but not their own mirror reflection, even when a real conspecific was concealed behind the mirror [11]; notably, the same birds failed a classic mark test, illustrating that mirror-related behaviour can differ substantially depending on whether it is assessed ecologically or via the classic self-recognition paradigm. However, we are not aware of a study that has systematically classified the full

vocal repertoire of Japanese quail against predator class (aerial versus terrestrial) or examined how call-type composition changes across the pre- and post-threat period; even the interspecific defensive-call group described for European quail was not further differentiated by predator identity. This represents, to our knowledge, an unexamined gap for this species.

Our laboratory has previously used a simulated-predator paradigm (moving hawk and cat silhouettes presented in a dedicated arena) to demonstrate that rearing environment shapes separation-calling frequency in Japanese quail under threat (Park 2025, master's thesis, Hoseo University). Building on this apparatus and paradigm, the present pilot study asks whether specific, spectrographically defined call types within the broader quail vocal repertoire are differentially recruited depending on predator class, whether call-type composition differs before and after stimulus presentation, and whether any such pattern is reproducible across individuals despite the well-documented individual variability of galliform vocalizations [8]. We present the work as a case study of two birds, framed as hypothesis-generating, and place it beside qualitative observations from an earlier eight-bird cohort.

Materials and methods

Ethics statement

All experimental procedures were approved by the Institutional Animal Care and Use Committee (IACUC) of Hoseo University (approval numbers HSUIACUC-24-039, approved 23 December 2024, and HSUIACUC-25-014, approved 19 May 2025), consistent with the approval framework established for simulated-predator exposure research in this species and laboratory (Park 2025, master's thesis, Hoseo University). Predator stimuli were presented as silhouette projections with matched audio cues rather than live predators, and no physical contact between the test subjects and any predator stimulus occurred. No anesthesia, euthanasia, or animal sacrifice was performed as part of this study. Reporting follows the Animal Research: Reporting of In Vivo Experiments (ARRIVE) guidelines [12] where applicable to the scale of this case study.

Subjects

Two sexually mature female Japanese quail (individual identifiers 0.0.0 and 795), 6 weeks of age, were purchased from Join Farms Co., Ltd., a quail farm in Eumseong-gun, Chungcheongbuk-do, Republic of Korea. Neither bird had been exposed to a live predator before testing, and both had prior experience with the testing arena across all experimental sessions but no prior exposure to mirrors.

In accordance with the STRANGE framework (Social background, Trappability and self-selection, Rearing history, Acclimation and habituation, Natural changes in responsiveness, Genetic make-up, Experience) [13], we report the following sample characteristics. Both individuals were female and 6 weeks of age at testing and were sourced from a single commercial farm. Before testing they were housed under standard commercial stocking conditions typical of Korean quail farms, in cages measuring 50 x 40 cm

arranged in a seven-tier battery system with approximately 30 birds per cage. The identities of cage-mates, the capture method, and the experimental history beyond the present apparatus were not documented and are therefore unavailable.

Earlier cohort (qualitative context)

Before the two birds reported here, eight birds (four cage-reared and four free-range) were studied with the same simulated-predator paradigm and repeated measures (Park 2025, master's thesis, Hoseo University). Background noise in those recordings prevented reliable acoustic measurement, so no data from that cohort are analysed here. We use only the authors' qualitative impression from those sessions, described in Results, as context for the present case study.

Apparatus

Testing was conducted in an enclosed arena (2.0 x 1.2 x 0.8 m, L x W x H) constructed of waterproof plywood with a green PVC floor and a mesh-net top (8 cm mesh size), located centrally within a dedicated experimental room fitted with blackout curtains and non-flickering illumination to minimize uncontrolled visual and acoustic stimuli, following the design established for simulated-predator exposure in this species and laboratory (Park 2025, master's thesis, Hoseo University). Predator stimuli were presented as moving silhouettes projected onto a 1.4 x 1.0 m white panel suspended from the ceiling above the arena, accompanied by matched auditory cues; a hawk silhouette represented an aerial predator and a cat silhouette represented a terrestrial predator. Behaviour was recorded using a wall-mounted video camera positioned to capture the entire arena, and vocalizations were recorded separately via a microphone for subsequent acoustic analysis (Park 2025, master's thesis, Hoseo University).

Predator stimulus presentation and social context manipulation

Each individual was tested under two predator conditions (hawk, cat) and four social-context conditions: (A) alone, (B) exposure to a mirror image of the self, (C) exposure to a familiar live conspecific housed visibly on the opposite side of a transparent partition, and (D) combined exposure to a mirror image together with a live conspecific housed behind a visually opaque, sound-permeable partition, such that only auditory cues from the conspecific were available in this condition. Each experimental session consisted of two repetitions of a three-phase sequence: a 5-minute pre-exposure phase, a 5-minute during-exposure phase, and a 5-minute post-exposure phase, yielding approximately 15 minutes of observation for each phase category per session. Vocalizations were quantified separately for each phase within each predator-by-social-context combination. Extended analyses of conditions B, C, and D are reported in the supporting information (S1 File); the main text focuses on the pooled predator-type effect (conditions A-D combined) and its temporal dynamics.

Acoustic recording and call classification

Vocalizations were recorded and analyzed spectrographically using Raven Pro (Cornell Lab of Ornithology, Ithaca, NY, USA), following the call-classification approach used by Lee and Sung [6] for the spectrographic analysis of avian vocal repertoires in South Korea. Call types were first identified by visual inspection of their morphological, temporal, and frequency distinctiveness on the spectrogram, and this classification was subsequently confirmed by blind review from a second, independent observer, following the general procedure described in [6]. Eighteen spectrographically distinct call types were identified from the full recording set. For ten of these call types, sufficient exemplars were available to characterize their acoustic structure quantitatively, including call duration, highest frequency, lowest frequency, frequency range, and dominant frequency (mean ± SD).

Data coding and statistical analysis

Data were available as counts of classified calls for each combination of individual, predator (hawk, cat), social context (A-D), phase (pre, during, post) and call type. Of the 480 call-type-by-context-by-phase cells in the source tables, 356 (74%) were recorded as '-', and the source did not distinguish true zeros from periods that were not observed. For contingency analyses these cells were treated as zero counts, so all results are conditional on that assumption.

Because two individuals do not permit mixed-effects modelling with individual as a random effect, chi-square tests of independence were run separately for each individual. We tested whether call-type composition (i) differed between hawk and cat exposure and (ii) differed between the pre- and post-exposure phases (separately for each individual-by-predator combination). Standardized residuals identified call types driving each difference, and Cramér's V is reported as an effect size. Two limitations of these tests are important. First, individual calls within a session are not independent, so the nominal p-values are anti-conservative and should be read as descriptive indices of the size of a difference. Second, the pooled comparisons mix social contexts unequally across predators and phases, because the dataset is sparse and not every context contributed observations to every predator-by-phase cell.

To reduce reliance on pooled counts, we added two context-matched checks. (a) For each call type we compared the share of that call type under cat versus hawk exposure within each individual-by-context unit in which both predators had at least 20 classified calls, counted the units favouring each predator, and applied an exact two-sided sign test (ties excluded). (b) For call type 9, we compared its share before versus after exposure within each individual-by-predator-by-context combination in which both phases had at least 20 calls, followed by an exact sign test. These tests use few units and are uncorrected for the number of call types examined; they are intended as robustness checks, not confirmatory tests.

Correlations between acoustic parameters and predator-type bias were assessed with Pearson and Spearman coefficients across the ten quantified call types. Bias was defined as log2[(cat count + 0.5) /

(hawk count + 0.5)], with counts pooled across individuals. The threshold for significance was alpha = 0.05 unless otherwise specified; because five acoustic parameters were tested, the correlations were additionally evaluated against a Bonferroni-corrected threshold of alpha = 0.01. Statistics were computed in Python (SciPy).

Results

Data coverage

The dataset contained 5,512 classified calls (individual 0.0.0, 2,027; individual 795, 3,485) assigned to the ten quantitatively characterized call types. Only 1 classified call was recorded during stimulus presentation (individual 795, hawk), so the during-exposure phase could not be analysed and all temporal analyses contrast the pre- and post-exposure phases. Post-exposure calls were recorded in 9 of the 16 individual-by-predator-by-context combinations. Whether the near-absence of classified calls during stimulus presentation reflects genuine vocal suppression or a limitation of recording or classification cannot be determined from these data.

Overall calling frequency and cross-individual convergence by predator type

Total call counts for each of the ten call types (summed across social contexts and phases) are shown for both individuals in Table 1, together with the direction of the cat-versus-hawk difference and its consistency across individuals.

Table 1
Total call frequency by predator type and individual, and cross-individual pattern of the cat- versus hawk-exposure difference, for the 10 quantitatively characterized call types

Type	0.0.0 Hawk	0.0.0 Cat	795 Hawk	795 Cat	Pattern
1	283	131	0	1	Inconsistent
2	37	11	35	7	Convergent, hawk-biased
3	60	25	375	393	Inconsistent
4	103	13	55	101	Inconsistent
5	12	55	11	118	Convergent, cat-biased
6	0	0	3	0	Not evaluable
7	77	100	202	93	Inconsistent
8	102	156	21	59	Convergent, cat-biased
9	42	249	892	751	Inconsistent
10	226	345	4	364	Convergent, cat-biased

Three call types (5, 8 and 10) showed a cat-biased direction in both individuals and one (type 2) a hawk-biased direction in both. Five further call types differed in direction between individuals, and type 6 (n = 3) could not be evaluated.

Shift in call-type composition before versus after predator exposure

For each of the four individual-by-predator combinations, a chi-square test of independence was performed on the call type (10 levels) by phase (pre versus post) contingency table. All four tests were significant (Table 2); effect sizes were small to moderate (Cramér's V 0.21–0.28). Many cells had expected counts below 5 (17–50% of cells), so the chi-square approximation is imperfect, in addition to the dependence among calls noted in the Methods.

Table 2
Chi-square tests comparing call-type composition between the pre- and post-exposure phases, for each individual-by-predator combination

Combination	Chi-square (df)	p	Cramér's V	Pre n	Post n
0.0.0 hawk	75.0 (8)	< 0.0001	0.28	931	11
0.0.0 cat	49.9 (8)	< 0.0001	0.21	1007	78
795 hawk	77.7 (8)	< 0.0001	0.22	1114	483
795 cat	112.3 (8)	< 0.0001	0.24	1666	221

Call type 9 increased its share of total calling after exposure in all four combinations (Fig. 1 and Fig. 2): individual 0.0.0 hawk, 4.3% to 18.2%; 0.0.0 cat, 22.5% to 28.2%; 795 hawk, 52.8% to 62.9%; 795 cat, 36.7% to 63.3%. Several other call types (2, 3, 4 and 8) diminished or disappeared from the post-exposure repertoire in most combinations. The combination with the fewest post-exposure calls (0.0.0 hawk, n = 11) is unstable.

Because pre- and post-exposure observations were not drawn from identical sets of social contexts, we repeated the comparison within matched context units (Table 3). Call type 9 rose in 5 of 6 matched comparisons and was flat in the remaining one (exact sign test, p = 0.22). The direction is consistent with the pooled result, but with six comparisons, five of them from one individual, it does not demonstrate a general effect.

Table 3
Context-matched comparison of call type 9's share of calls before and after exposure (units with at least 20 calls in both phases)

Individual	Predator	Context	Pre share (n)	Post share (n)
0.0.0	cat	A alone	12.5% (64)	28.6% (77)
795	hawk	A alone	2.3% (44)	1.7% (59)
795	hawk	B mirror	34.7% (380)	61.0% (195)
795	hawk	D mirror + conspecific	67.7% (666)	80.3% (229)
795	cat	B mirror	50.7% (808)	59.9% (187)
795	cat	D mirror + conspecific	43.7% (348)	95.7% (23)

Predator-type composition differences and their acoustic correlates

Chi-square tests on the call-type-by-predator contingency table, run separately for each individual, were significant (individual 0.0.0: chi-square = 359.8, df = 8, $p < 0.0001$, Cramér's V = 0.42; individual 795: chi-square = 527.7, df = 9, $p < 0.0001$, Cramér's V = 0.39). Standardized residuals are shown in Table 4 and Fig. 3. Call types 5 and 10 were significantly cat-biased, and call type 2 significantly hawk-biased, in both individuals.

Table 4
Standardized residuals for call-type composition under hawk versus cat exposure, by individual. Positive residuals indicate overrepresentation under hawk exposure and negative residuals overrepresentation under cat exposure

Type	0.0.0	795	Convergent	Direction
1	6.53 **	-0.68	No	--
2	3.11 **	3.59 **	Yes	Hawk-biased
3	3.26 **	1.22	Directional only	Hawk-biased trend
4	6.69 **	-1.95	No	--
5	-3.43 **	-6.26 **	Yes	Cat-biased
7	-0.58	5.74 **	No	--
8	-1.63	-2.59 **	Directional only	Cat-biased trend
9	-8.02 **	5.05 **	No	--
10	-2.42 **	-12.68 **	Yes	Cat-biased

** Standardized residual beyond |1.96|

Pooled residuals can be inflated when social contexts are unevenly represented across predators, so we checked the direction of each effect within individual-by-context units (Table 5). Only call type 10 favoured the cat in every informative unit (7 of 7; exact sign test p = 0.016, uncorrected for ten call types). Types 5 and 8 favoured the cat in 5 of 7 and 5 of 6 non-tied units, and type 2 favoured the hawk in 4 of 5, but none of these reached nominal significance. Type 9 leaned toward the cat in 5 of 7 units, in contrast to its inconsistent direction between individuals in Table 1.

Table 5
Context-matched direction of the predator effect for selected call types (units: individual-by-context combinations with at least 20 calls under each predator; n = 7)

Type	Units favouring cat	Units favouring hawk	Ties	Exact p
2	1	4	2	0.375
5	5	2	0	0.453
8	5	1	1	0.219
9	5	2	0	0.453
10	7	0	0	0.016

As an exploratory follow-up, we asked whether acoustic structure predicted predator bias. For each of the ten quantified call types, the log2 cat-to-hawk ratio was correlated with each acoustic parameter (Table 6; Fig. 4). Maximum frequency was correlated with predator bias by Spearman's rank correlation (rho = -0.673, p = 0.033): call types with a higher maximum frequency tended to be relatively hawk-biased. Because five parameters were tested, this did not survive Bonferroni correction (alpha = 0.01) and is hypothesis-generating.

Table 6
Correlation between call-type acoustic parameters and predator-type bias (log2 cat-to-hawk ratio, pooled across individuals; n = 10 call types)

Acoustic parameter	Pearson r	p	Spearman rho	p
Duration	-0.580	0.079	-0.498	0.143
Dominant frequency	-0.229	0.525	-0.224	0.533
Frequency range	-0.562	0.091	-0.539	0.108
Low frequency	0.014	0.970	-0.006	0.987
High frequency	-0.505	0.136	-0.673	0.033

Qualitative observations from the earlier cohort

In the earlier eight-bird cohort, high-pitched calls could be heard above the background noise in all eight birds during the predator-exposure sessions, and the authors judged them to be alarm-like. Because of the noise, call durations and frequencies could not be measured and call types could not be reliably classified, and no counts or statistics are reported. These observations are anecdotal and are given only to indicate that high-pitched, alarm-like calling under simulated predator exposure was not limited to the two birds analysed here.

Discussion

This case study provides preliminary evidence that specific, spectrographically defined call types in the Japanese quail repertoire are differentially associated with predator class, and that the repertoire shifts toward a small number of dominant types once the stimulus has ended. Call type 10 was the most robust predator-associated signal: it was cat-biased in both individuals and in every informative context. Types 5, 8 and 2 showed the same direction in both individuals in pooled analyses but were less consistent across contexts. This is consistent with the broader principle, established for domestic fowl [1, 2] and functionally validated by playback [3], that avian repertoires encode distinctions among external referents through structurally specific call types rather than a single generic alarm response.

The post-exposure increase in the share of call type 9 was replicated in all four individual-by-predator combinations and in five of six context-matched comparisons. Because it was also the most frequent call type overall, and the matched comparison is small, we regard it as a candidate pattern rather than an established effect. Given its moderate duration and comparatively wide, mid-to-high frequency range, type 9 is a speculative candidate for a post-exposure signal; we do not claim a function.

A possible behavioural analogue is the vigilance trill described for European quail, which is reported to shift gradually from a short, high-pitched trill to a longer, lower-pitched trill as the bird moves from active defence toward a watchful state after an encounter [7]. The post-exposure rise of type 9 is broadly consistent with a transitional vigilance-related signal, although direct acoustic correspondence has not been shown here. Testing that correspondence requires formal comparison of sonograms and is the subject of a separate manuscript on the same dataset (see Declarations).

These observations should be read against the European quail literature, in which 24 calls are organized into four functional groups, one of which covers strong defensive tendencies in an interspecific context, with an almost total overlap reported between European and Japanese quail repertoires [7]. Calls in that interspecific defensive group were not differentiated by predator identity, which is the gap the present study addresses. Two caveats apply. First, Guyomarc'h and Guyomarc'h [7] characterized the European subspecies (C. c. coturnix), and their conclusion of near-total overlap with Japanese quail (C. c. japonica) rested on comparative observation rather than an equivalent spectrographic classification of the Japanese subspecies, so it does not establish a validated one-to-one correspondence. Second, correspondence between our 18 call types and their 24 calls cannot be established from textual

description alone. Acoustic timing parameters have, separately, been shown to discriminate between individuals and subspecies [8].

The near-absence of classified calls during stimulus presentation limits what can be said about the acute response. One interpretation, which we did not test, is that the birds were largely silent while the stimulus was present, as is often reported for anti-predator freezing, so that vocal responses appear mainly after the stimulus ends. An alternative is that calls during stimulus presentation were not recorded or could not be classified. Distinguishing these requires per-window recording logs and, ideally, synchronised behavioural scoring in the follow-up study.

The qualitative observation of high-pitched, alarm-like calls in all eight birds of the earlier cohort points in the same general direction as the tendency for hawk-biased call types to have a higher maximum frequency, but it was not measured and cannot test that tendency. Its value here is to suggest that the phenomenon is not specific to the two birds analysed and to justify the follow-up study.

The acoustic-correlate finding only partially matches the classic prediction that aerial-predator alarm calls should be narrow-band, high-frequency signals that are hard to localize (the 'seet call' hypothesis [14]): hawk-biased call types tended toward higher maximum frequency but also toward wider frequency range and longer duration. This may reflect species differences, the small number of call types and individuals, or the fact that these call types are not yet confirmed to function as anti-predator alarm signals rather than general arousal-linked vocalizations.

Complementary exploratory analyses of the social-context manipulations (mirror exposure and a concealed, audible-only conspecific) are reported in Online Resource 1. Using Bray-Curtis dissimilarity between call-type compositions, and restricting to contexts with at least 20 calls, composition under mirror exposure was closer to that under the live-conspecific condition than to the solitary condition in two of three evaluable individual-by-predator combinations, and the mirror-plus-concealed-conspecific condition was closer to the mirror-alone than to the conspecific condition in all three evaluable combinations. Correcting the index for its sample-size bias did not change these directions, although the difference for individual 0.0.0 under cat exposure was small (Online Resource 1). These patterns are descriptive and rest on few units. A directly analogous design in the domestic chicken found that roosters called an alarm to a real conspecific but not to their own mirror reflection, even when a real conspecific was concealed behind the mirror, while failing a classic mark test [11]. Our observations are not inconsistent with that precedent but should not be taken as evidence for or against mirror self-recognition, which requires a dedicated mark-test paradigm [15].

Limitations

This study has seven limitations that must be addressed before its findings can be generalized.

First, the sample is two individuals. Each contributed several thousand classified vocalizations, and the same directional effects (call-type-specific predator bias, post-exposure reorganization) appeared in

both individuals, but a repeated-measures single-case design cannot estimate between-individual variance. We evaluate this sample under the STRANGE framework as a source of unresolved sampling bias, and a confirmatory follow-up with 8–10 individuals per predator condition is planned. The earlier eight-bird cohort contributes only a qualitative impression because background noise prevented measurement.

Second, calls within a session are not independent. The chi-square p-values are therefore anti-conservative, many cells have small expected counts, and the context-matched checks, which use few units, cannot fully replace a model with random effects for individual and session.

Third, 74% of cells in the source tables were recorded as '-' without distinguishing true zeros from unobserved periods, and pre- and post-exposure observations were not drawn from identical sets of social contexts. Pooled pre-post and hawk-cat contrasts are therefore partly confounded with context.

Fourth, only 1 classified call was recorded during stimulus presentation, and post-exposure counts were much lower than pre-exposure counts. The protocol specified equal 5-minute windows, but we cannot verify from the dataset whether all windows were fully observed; the apparent post-exposure decline in calling should be treated with caution.

Fifth, the present results describe call production only; whether the call types carry functionally referential information remains to be tested with playback experiments [3].

Sixth, the acoustic-correlate analysis tested five parameters; only maximum frequency reached nominal significance, and it did not survive correction for multiple comparisons.

Seventh, although the 18-call-type classification was confirmed by blind review from a second observer, no formal inter-rater reliability statistic such as Cohen's kappa was computed. The size of the described repertoire should be read as a qualitatively cross-validated, exploratory estimate, not a definitive taxonomy; the follow-up study will include a quantitative reliability assessment.

Conclusions

In this two-bird case study, Japanese quail showed predator-associated differences in the use of specific call types within a broader 18-type repertoire, and post-exposure differences in composition that most consistently involved an increased share of call type 9. Call type 10 was the most robust cat-associated signal. These findings justify a fully powered follow-up that includes more individuals, complete STRANGE reporting, session-level recording logs, a quantitative reliability assessment of call classification, and playback validation, to determine whether the Japanese quail repertoire encodes predator-class-specific information in a manner analogous to that established in the domestic chicken.

Declarations

Funding

This work was supported by Hoseo University (Grant No. 2025-0165-01).

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval (animal)

Ethics approval: All experimental procedures were approved by the Institutional Animal Care and Use Committee (IACUC) of Hoseo University (approval numbers HSUIACUC-24-039, approved 23 December 2024, and HSUIACUC-25-014, approved 19 May 2025). No anesthesia, euthanasia, or animal sacrifice was performed as part of this study.

Ethical accordance: The study was conducted in accordance with the ARRIVE guidelines for reporting animal research [12] and with the animal ethics guidelines and regulations of the Institutional Animal Care and Use Committee of Hoseo University.

Consent to participate and to publish

Not applicable.

Data availability

The datasets analyzed during the current study, including the full tidy dataset and derived analysis workbook, are available from the corresponding author on reasonable request. The aggregated counts underlying Tables 1-6 and Figs. 1-4 are provided in Online Resource 2.

Author contributions

G.P. performed vocalization analysis, drafted the manuscript, and designed and constructed the device used for call recording and analysis. K.H. and S.P. performed vocalization (acoustic) analysis and data curation. C.K. revised and proofread the manuscript, organized study materials and data, and is the corresponding author. All authors read and approved the final manuscript.

Supplementary information

Online Resource 1 (Online_Resource_1.docx): extended analysis of the social-context conditions A-D, with call counts and within-context percentages for each individual-by-predator combination (Tables S1-S4) and sample-size-corrected Bray-Curtis dissimilarities between contexts (Tables S5-S6). Online Resource 2 (Online_Resource_2.xlsx): aggregated call counts by individual, predator, context, phase and call type underlying all tables and figures, with a README sheet describing the coding.

Related manuscript

A separate manuscript from the same group, which analyzes the same underlying acoustic dataset from a different angle (a sonogram-based comparison of the call types with a published European quail vocal catalogue), is under consideration at another journal. The two manuscripts address different questions, and no results, tables or figures are shared between them.

Acknowledgments

We thank Sonja Hillemacher for her valuable advice and materials during the design of the predator-exposure and mirror-audience experiments, and Ju Hyun Lee for providing the software and methodology used for vocalization analysis.

References

1. Collias NE, Joos M. The spectrographic analysis of sound signals of the domestic fowl. Behaviour. 1953;5:175–88.
2. Collias NE. The vocal repertoire of the Red Junglefowl: a spectrographic classification and the code of communication. Condor. 1987;89:510–24.
3. Evans CS, Evans L. Chicken food calls are functionally referential. Anim Behav. 1999;58:307–19. https://doi.org/10.1006/anbe.1999.1143.
4. Evans CS, Marler P. Food-calling and audience effects in male chickens, Gallus gallus: their relationships to food availability, courtship and social facilitation. Anim Behav. 1994;47:1159–70.
5. Karakashian SJ, Gyger M, Marler P. Audience effects on alarm calling in chickens (Gallus gallus). J Comp Psychol. 1988;102:129–35.
6. Lee JH, Sung HC. The song structure and repertoire size of Daurian Redstarts (Phoenicurus auroreus) in South Korea. Turk J Zool. 2019;43:393–9.
7. Guyomarc'h J-C, Guyomarc'h C. Vocal communication in European quail; comparison with Japanese quail. C R Acad Sci Paris. 1996;319:827–34.
8. Collins SA, Goldsmith AR. Individual and species differences in quail calls (Coturnix c. japonica, C. c. coturnix and a hybrid). Ethology. 1998;104:977–90.

9. Derégnaucourt S, Guyomarc'h J-C. Mating call discrimination in female European (Coturnix c. coturnix) and Japanese quail (Coturnix c. japonica). Ethology. 2003;109:107–19.
10. Hayashi I, Ono Y, Matsushima T. Visual cues for suppressing isolation-induced distress calls in quail chicks. Zoolog Sci. 2001;18:1065–71.
11. Hillemacher S, Ocklenburg S, Güntürkün O, Tiemann I. Roosters do not warn the bird in the mirror: the cognitive ecology of mirror self-recognition. PLoS ONE. 2023;18:e0291416. https://doi.org/10.1371/journal.pone.0291416.
12. Kilkenny C, Browne WJ, Cuthill IC, Emerson M, Altman DG. Improving bioscience research reporting: the ARRIVE guidelines for reporting animal research. PLoS Biol. 2010;8:e1000412. https://doi.org/10.1371/journal.pbio.1000412.
13. Webster MM, Rutz C. How STRANGE are your study animals? Nature. 2020;582:337–40. https://doi.org/10.1038/d41586-020-01751-5.
14. Marler P. Characteristics of some animal calls. Nature. 1955;176:6–8.
15. Gallup GG Jr. Chimpanzees: self-recognition. Science. 1970;167:86–7.

Figures

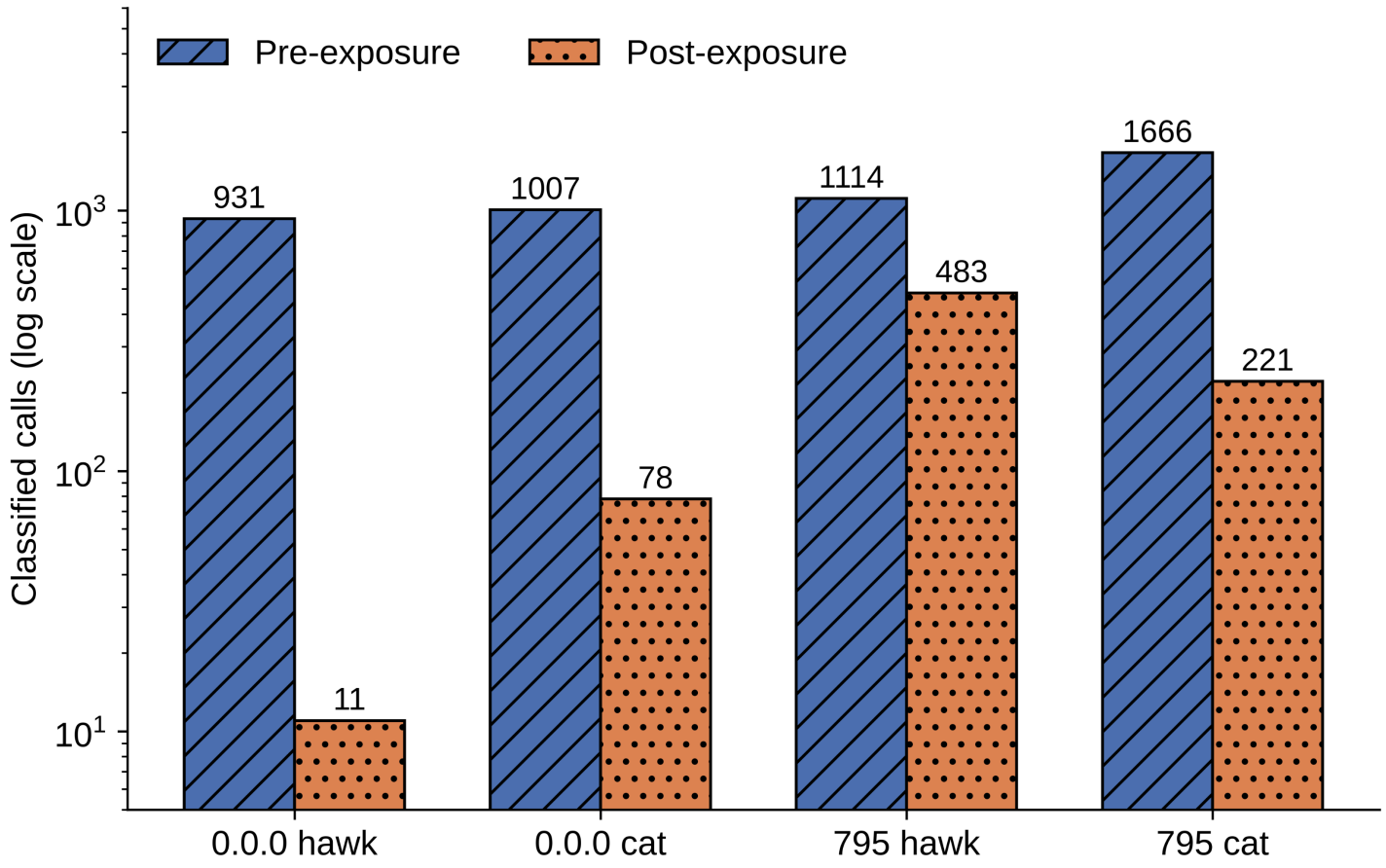


Figure 1

Classified calls before and after predator exposure for each individual-by-predator combination (log scale). Counts are printed above the bars

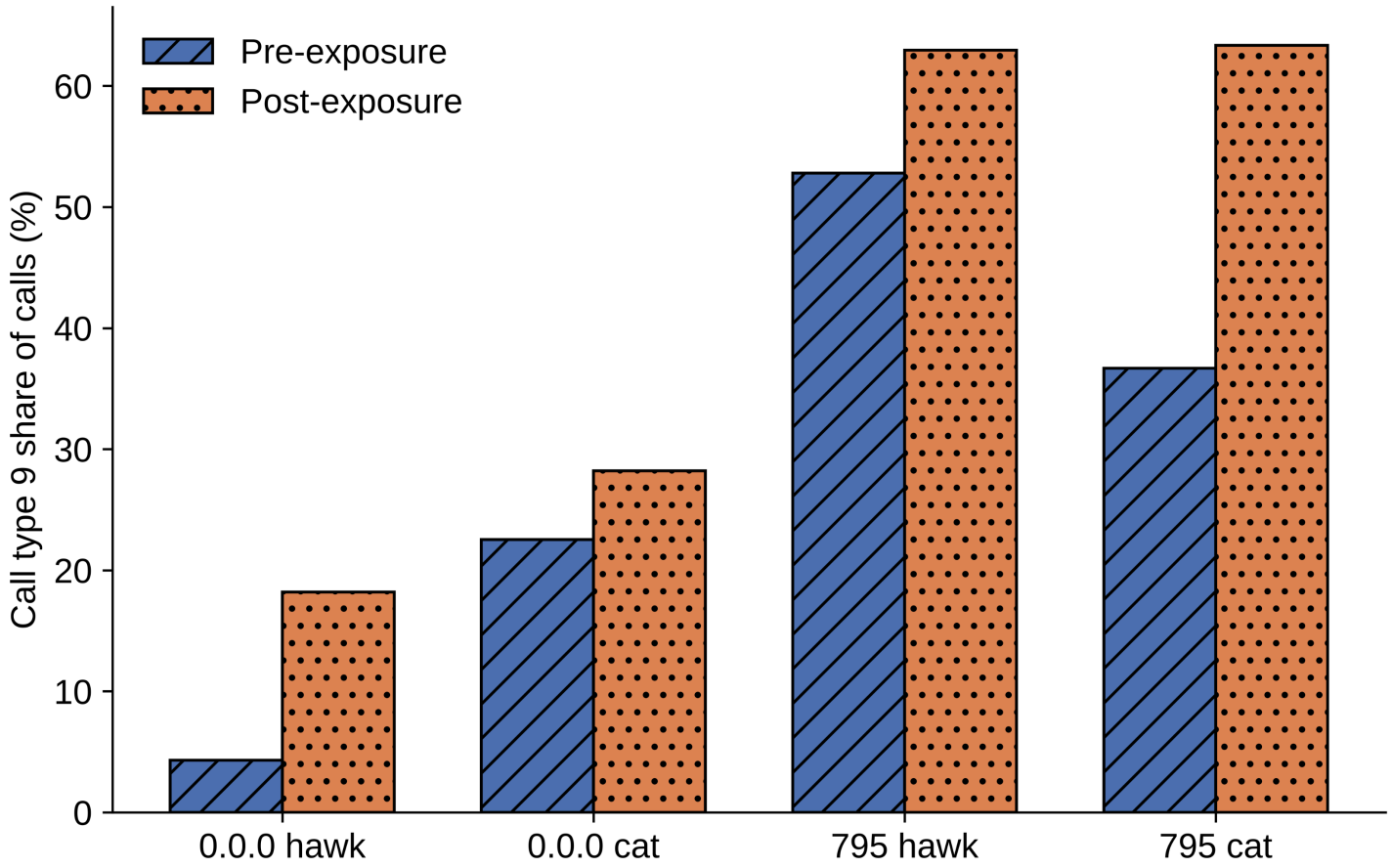


Figure 2

Share of call type 9 among all classified calls before (blue) and after (orange) predator exposure for each individual-by-predator combination

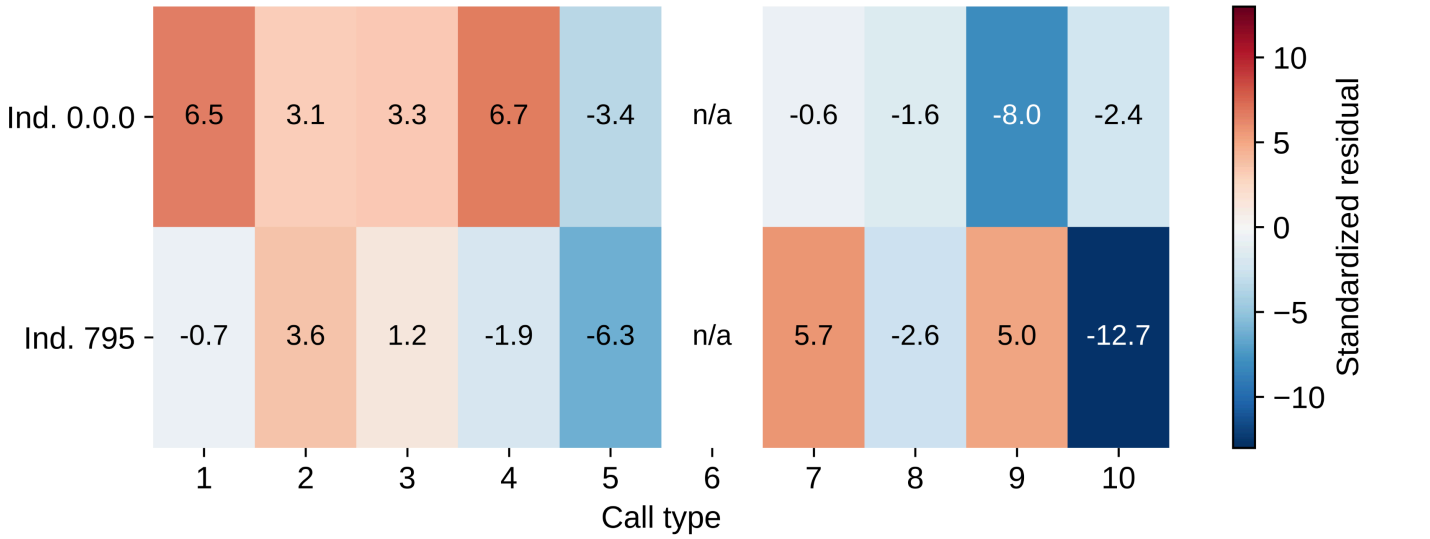


Figure 3

Heatmap of the standardized residuals in Table 4. Red indicates hawk-biased and blue cat-biased overrepresentation; type 6 was not evaluable

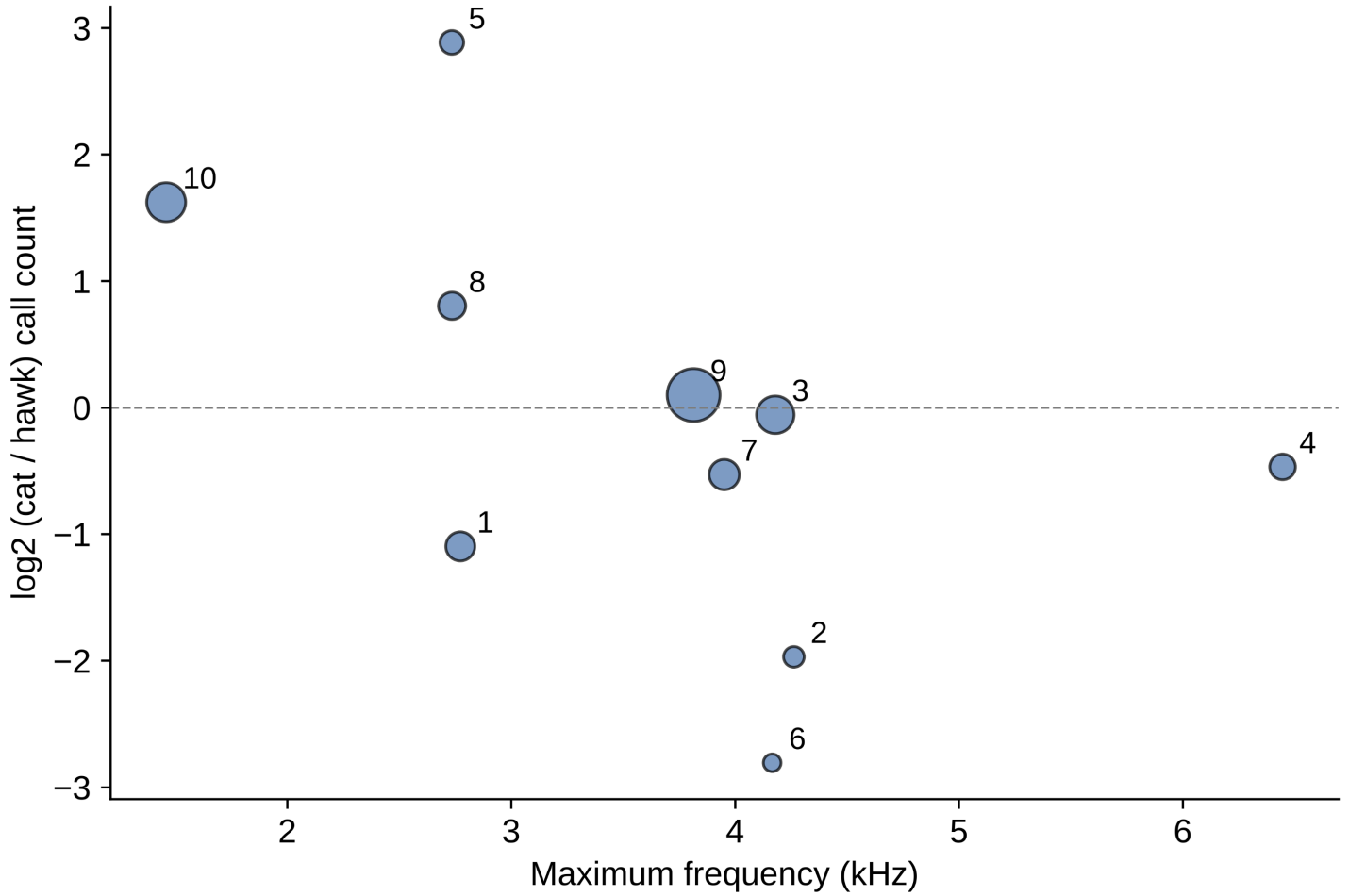


Figure 4

Relationship between a call type's maximum frequency and its predator-type bias (log2 of cat-to-hawk call counts, pooled across individuals). Marker size reflects the total number of calls of that type; labels are call-type numbers