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Anti-predator Responses of the Black-tailed Gull (*Larus crassirostris*) Flock to Mobbing and Mew Call Playbacks

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ABSTRACT: We studied the functional roles of two types of calls, mew calls and mobbing calls, of the black-tailed gull (*Larus crassirostris*) by examining responses of mixed flocks of gulls to the playback calls. Playback experiments were conducted on four days between 11 May and 5 June 2007 at 16 sites in Sinjindo-ri and Dowhang-ri, Taean-gun, Chungnam province and Imjado, Sinan-gun, Jeonnam province, South Korea. We examined the anti-predator responses of the gulls to the playback trials. We found that gull flocks initially responded to mew call playbacks by mobbing in less than half of playback trials (6/14) while all trials involving playbacks of the mobbing call and control (group mobbing) call evoked mobbing. When trials in which no response was recorded were excluded, we found that the gulls' responses to mobbing and group mobbing call playbacks was more intense than their response to mew call playbacks, in that gulls mobbed longer, more gulls responded, and gulls took flight after a shorter time interval. However, the intensity of the gulls' response did not differ in mobbing call and group mobbing call playbacks. The results of this study suggest that the mixed-species flocks of gulls discriminate between the mew calls and the mobbing calls.

Key words: Avian communication, Black-tailed gull, *Larus crassirostris,* Mobbing call

INTRODUCTION

Mobbing is a group display functioning as an anti-predator defense behavior, and is widespread in many colonial breeding birds, including the black-tailed gull (*Larus crassirostris*). Mobbing behavior includes mobbing calls that are usually characterized by a wide frequency range, abrupt onsets, and rapid repetition, making them easy to localize (Marler 1955, 1959, Marler and Hamilton 1966). From a comparative study of passerine mobbing calls, Ficken and Popp (1996) suggested that the similarities in the mobbing call structures of different species result from selection pressure in interspecific flocking rather than locatability. Either way, mobbing attracts the participation of neighbors in monitoring or repelling the potential predator (Curio 1978, Shalter 1978, Bradbury and Vehrencamp 1998). As a result, mobbing responses may increase the reproductive success of the caller, while increasing the predation risk for mobbing birds (Curio and Regelmann 1986, Sordahl 1990, Doran et al 2005).

On the other hand, several researchers have described mew call as a "cat-like mewing sound" produced by many gull species (Tinbergen 1953, Hand 1981, Mierauskas and Buzun 1998). The mew call is used as a contact call between parents and chicks and between members of breeding pairs; thus, the call is mainly produced during the breeding season.

In previous studies, we examined the acoustic structures and behavioral contexts of black-tailed gull calls. For example, Park and Park (1997) identified eight different signals grouped into three functional classes: contact calls (three call types), alarm calls (two call types), and aggressive calls (three call types). Recently, Chung and Park (2006) found that gull chicks in captivity hid more rapidly and took a longer time to resume normal behavior in response to mew calls with an inter-call interval of 0.5 sec (produced by shortening the inter-call interval of natural mew call units) than calls with an inter-call interval of 2 sec, and that adult gulls showed mobbing behaviors in response to the 0.5 sec calls. The mew call was identified by Park and Park (1997) as call type 1. An additional vocalization, a mobbing call, of the black-tailed gull was subsequently identified during a study of anti-predator responses to alarm calls (Park et al. 2007): playbacks of these alarm calls provoked mobbing behaviors and calls from gull flocks regardless of species during the post-breeding season. In Chung and Park's (2006) playback experiments, mew call playbacks induced mobbing, and the behavioral responses to alarm and mew calls differed in degree. The differences in responses may result from differences in acoustic structures and functions of the calls, but it is not yet clear why and to what extent the mew calls evoke the mobbing behaviors.

Klump and Shalter (1984) defined the general term "alarm calls" as including four categories of calls, which may have different functions: 1) mobbing calls, 2) alarm calls (warning calls and pursuit-

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inhibition or pursuit-invitation), 3) distress call or defense calls, and 4) distraction calls. The structural and functional differences among mobbing calls and alarm calls in this study and a previous study (Park et al. 2007) appear to be consistent with the terminology. Park et al. (2007) described the two calls as "flee alarms" and "mobbing alarms".

In this study, we investigated mixed flocks of gulls' responses to playbacks of mew calls and mobbing calls to evaluate the roles of the two types of calls. Specifically, we tested the following questions: 1) Do mixed flocks of gulls differ in the intensity of their responses to the two calls? 2) How does the mobbing behavior produced in response to mew calls compare with that produced in response to mobbing calls? From preliminary research on the structure of the two calls, we found they are quite similar in structure compared with other types of calls, such as alarm calls, yet differ in some duration and frequency measurements. Thus, we assumed that the mixed groups of gulls are able to distinguish mew calls from mobbing calls in the absence of other stimuli (context-independent perception; Marler et al. 1992), and designed our experiments to compare the anti-predator responses of the mixed gull flocks to mobbing and mew calls, using group mobbing calls as control vocalizations. We predicted that if the mobbing calls function as a referential act of communication indicating the approach of a predator, and requesting assistance in repelling the predator, then the calls should lead the group to approach the sound source while producing mobbing calls. In addition, we predicted that intensity of the mobbing effect would be higher in response to group mobbing calls from several individuals than to mobbing calls produced by a single individual, and will be lowest in response to mew calls.

MATERIALS AND METHODS

Playback experiments were performed on populations of black-tailed gulls near Sinjindo-ri and Dowhang-ri, Taean-gun, Chungnam province and Imjado, Sinan-gun, Jeonnam province, South Korea (Fig. 1). The experiments were conducted on groups of tens of resting and foraging immature and mature individuals, including gulls of other species (e.g. *L. argentatus*).

We recorded mobbing calls and control calls (group mobbing calls) produced in response to the presentation of a stuffed hawk and mew calls produced spontaneously, without any stimulus, in captivity. To conform that the mobbing calls differed from the mew calls in acoustic structure, we also recorded natural group mobbing calls produced in response to playbacks of alarm calls in the field. Recordings were made using a Marantz PMD222 tape recorder, a condenser microphone (type MKH 816 P48, AKG c1000s), and a

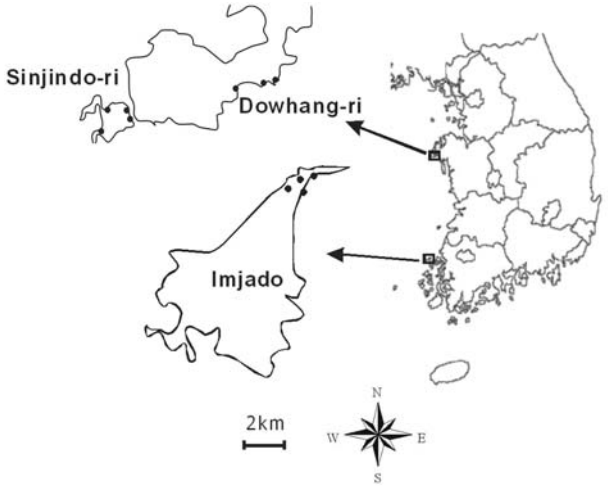

Fig. 1. Map of Sinjindo-ri and Dowhang-ri (above), Taean-gun, Chungnam province and Imjado (below), Sinan-gun, Jeonnam province. Dots indicate the locations of playback experiments in this study.

Telinga parabolic microphone. Playback tapes for the experiments were prepared with Raven 1.2 (Cornell Laboratory of Ornithology 2004) with sampling rate 44.1 kHz and Cool Edit Pro. 1.5 (Adobe® Audition™ software). High quality calls were selected and digitized, and background noise filtered out. Eleven different stimulus playback calls from different individuals (five mobbing calls, five mew calls, and one group mobbing calls from at least four individuals) were used. Each call type was played for 60 seconds. Playbacks contained 53 mobbing calls with 0.5 sec inter-call intervals and 0.423 ± 0.09 (n = 5) sec call duration, 17 mew calls with 3 sec inter-call intervals and 0.391 ± 0.03 (n = 5) sec call duration, or group mobbing calls with various inter-call intervals and call durations (Fig. 2). Inter-call intervals of the two mobbing and mew calls on the playback tapes are close to the natural rates of call emission from the sampled individuals.

We designed the playback experiments to test whether the gull flocks discriminate among the mobbing call, the mew call, and a control vocalization, the group mobbing call. We used the group mobbing call as an experimental control because this call was produced by many gulls in the presence of predators. The three kinds of calls were presented in random order with a 10 min gap between trials if there was no response. We established 16 playback sites in areas that gulls frequently gathered, and we then randomly chose sites for 36 playback trials (14 trials each for the mew call and the mobbing call, and 8 for the group mobbing call) from the established sites. Playback trials were conducted on four days from 11 May to 5 June 2007.

Playback experiments followed the procedures of Park et al.

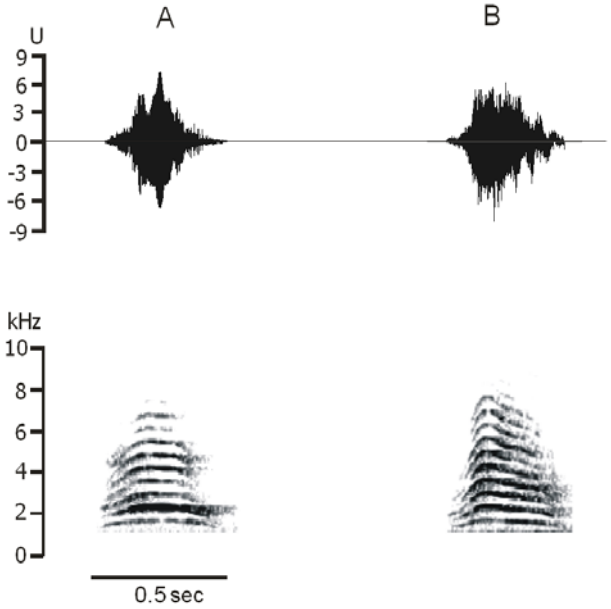

Fig. 2. Parts of black-tailed gull mew calls (A) and mobbing calls (B) used for the playback experiments. The calls were repeated with 3 sec inter-call intervals for mew calls and 0.5 sec inter-call intervals for mobbing calls. Above - waveform; Below - sonogram.

(2007). Prior to testing, mixed groups of gulls were observed for several minutes to count the number of mature and immature flock members regardless of the species. We started the experiments after confirming the absence of any natural disturbance. When natural disturbances occurred, we stopped and moved to another site. We used a Marantz portable recorder (PMD660) for the call playbacks, and placed the speaker (JBL-Pro III) in various places at a distance of 91.4 m ± 36.3 (range: 45～164, n = 36) from the resting gulls. As the time from first flight until the first gull approached the speaker (sec; latency to approach) was not correlated to the distance of the speaker from the gulls, we assumed that there was no effect of the playback distance. The average intensity of the playbacks was 80 dB (Larson-Davis Lab. Model 800B) at 20 m. We adjusted the volume of the playback calls depending on the distance from the resting gulls.

We measured the responses of the gull flocks using the following variables (Park et al. 2007): 1) latency to first flight (sec; time from the start of the experiment to the first response); 2) latency to call (sec; time from the start of the experiment to the first mobbing call), 3) latency to approach, 4) time mobbing (sec; duration of time gulls spent flying over short distances, turning sharply back and forth between the speaker and the resting site, starting from the first gull's arrival at the speaker); 5) number of mobbing calls given while mobbing; 6) number of gulls responding (obtained by subtracting the number of birds remaining after playbacks from the initial number of flock members). We videotaped the whole playback session with a Sony 8 mm Hi-Fi camcorder for further detailed analysis of the response patterns of the flock members.

We analyzed data using SPSS statistical software (v.12.0; SPSS 2004), and tested the data for deviation from normality prior to the use of parametric statistical tests (One-Sample Kolmogorov-Smirnov Test, $p < 0.05$). If the data met the assumption of normality, then we used one-way ANOVAs with multiple post-hoc tests (Tukey test) to compare the responses of flock members in experimental treatments. As the response variables are likely to be correlated, we employed principal component analysis (PCA) to summarize most of the variance in the original variables and to create composite scores for each treatment. PC factor loadings were extracted by default and the PC scores for the first three PCs were compared among three experimental groups. Numerical data in the text are presented as mean ± SD.

RESULTS

Subject flocks of gulls did not mob the speaker in response to mew call playbacks for 8 of 14 trials. All other trials evoked typical mobbing behaviors, and 2 of 14 trials using the mobbing call playback and 2 of 8 trials using the control stimulus induced mobbing and excretion over the speaker emitting the stimulus. For further quantitative analyses, we excluded the data from trials that did not induce behavioral responses.

The responses of gulls to the three treatments significantly differed in two response variables (Fig. 3): time mobbing ($F_{2,25}$ = 3.697, p = 0.039) and number of young gulls responding ($F_{2,25}$ = 3.805, p = 0.036). Post-hoc pairwise comparisons between treatments revealed that the responses of gulls significantly differed (Post-hoc test, $p < 0.05$) between to the mew call and to mobbing call only (time mobbing, Fig .4E; number of young gulls responding, Fig. 4F).

Three principal components (PCs) with eigenvalues were extracted based on the seven behavioral variables (Table 1). PC1 explained 33.19% of the total variance with high positive loadings of number of adult and young gulls responding and time mobbing and with a negative loading of latency to first fly, and scores significantly differed among the three treatments ($F_{2,25}$ = 3.997, p = 0.031). Post-hoc comparisons revealed significant pair-wise differences between the mew call and the mobbing call as well as between the mew call and the control call (Tukey test, $p < 0.05$; Fig. 5A), but not between the mobbing call and the control call playbacks. PC2 and PC3 explained 20.57% and 17.54% of total variance respectively, but no significant differences appeared among the three treatments.

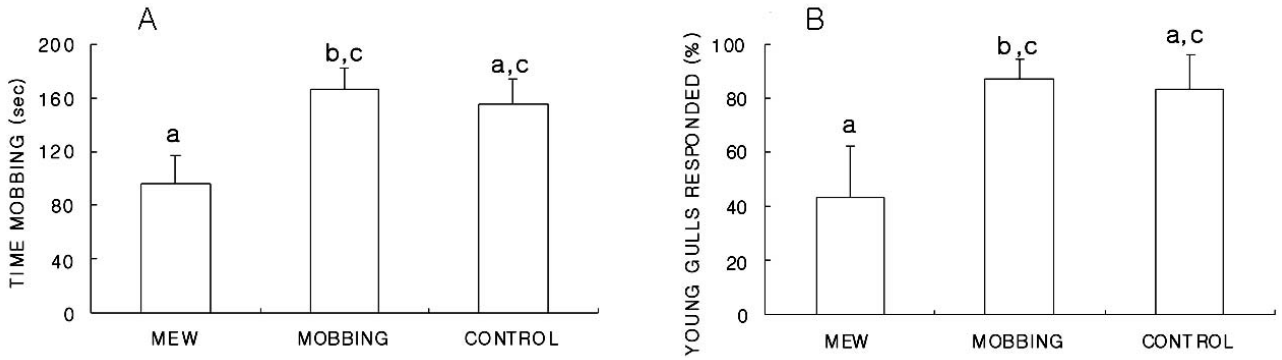

Fig. 3. Behavioral responses of gull flocks to mew calls, mobbing calls, and group mobbing calls (control). Bar represent mean ± SE. Significant differences among the three playback treatments were detected for two of seven response variables; the use of the same superscript letters indicates that there were no significant differences in post-hoc pairwise comparisons (Tukey test, $p > 0.05$).

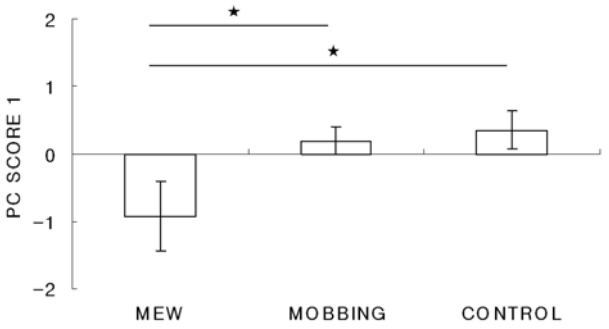

Fig. 4. Mean (± SE) values of principal components for behavioral responses of gulls to playbacks of mew calls, mobbing calls, and group mobbing calls (control). The first component scores significantly differed among the three playbacks; Asterisks indicate significantly different responses to playback calls in post-hoc pairwise comparisons (Tukey test, $p < 0.05$).

Table 1. Loadings of the response variables on the two principal components

Response variables	Loadings		
	PC1	PC2	PC3
Latency to first fly (s)	−0.625	0.300	0.486
Latency to call (s)	0.080	0.721	−0.346
Latency to approach (s)	−0.042	0.493	0.725
Time mobbing (s)	0.690	0.400	0.160
No. of mobbing calls	0.098	−0.634	0.521
Adult gulls responding (%)	0.888	−0.139	0.026
Young gulls responding (%)	0.807	0.074	0.220
Variance explained	33.19%	20.57%	17.54%
Eigenvalue	2.416	1.440	1.228

DISCUSSION

Our results showed that the mixed-species flocks of gulls discriminate between mew calls and mobbing calls. All playback trials using mobbing calls or the control calls induced mobbing, while only about 43% (6/14) of playback trials with mew calls resulted in mobbing. In trials in which the gulls responded to the stimulus by mobbing the speaker (data from 6, 14, and 8 trials for mew, mobbing, and the control calls respectively), the responses of gulls to playbacks of mobbing and control calls were more intense than those to playbacks of mew calls: gulls mobbed longer, more gulls responded, and gulls started flying sooner. However, our prediction that the response intensity would be highest for the control (group mobbing) calls and lowest for mew calls was not supported by our playback experiments. The intensity of the response was similar in playbacks of mobbing calls and the control calls, but lower for playbacks of the mew calls. As the stimulus for the mobbing call playbacks consisted of a single mobbing call recorded from one individual in captivity while the control calls consisted of group mobbing calls from at least 4∼5 individuals, this result indicates that a single mobbing calls from one individual should be sufficient to elicit anti-predator behaviors in the absence of a predator.

In this study, about 50% of mature and immature gulls responded to playbacks of mew calls while about 80% responded to playbacks of mobbing and control calls. Similarly, playbacks of mew calls with natural 5 sec inter-call intervals induced mobbing with about 50% of gulls responding, and the intensity of the response to the mew calls was much lower than that to the alarm calls (Park et al. 2007). Although we can not directly compare the response intensity in the previous trials to the mew calls from this study because we used stimulus calls of different duration and conducted experiments in different seasons, we observed stronger mobbing responses to

both alarm and mobbing call playbacks than to mew call playbacks. As a result, the former two calls might be functionally connected in the context of predation. The structure and function of the mobbing alarm call of black-tailed gulls is similar to the "plaintive yeow call" of western gulls (*L. livens* and *L. occidentalis*; Hand 1981), the "charge call" of herring gulls (*L. argentatus*; Pierotti and Good 1994) and great black-backed gulls (*L. marinus*; Good 1998). Tinbergen (1960) considered this type of call to be a modified long- call note, but Hand (1979) viewed it as more similar structurally to the mew call.

Unlike mobbing and alarm calls, mew calls were identified as contact calls by Park and Park (1997), and are used more frequently than any other call between parents and chick as well as between pairs. Nevertheless, the calls induced mobbing. One possible explanation is that these responses may result from the acoustic similarity between mew call and mobbing calls. Surprisingly, Chung and Park (2006) found that in response to playbacks of mew calls with an artificially shortened inter-call interval of 0.5 sec, adult gulls started mobbing and chicks hid in the corner, whereas chicks approached the speaker in the control playback calls (with an inter-call interval of 2 sec). Thus, the inter-call interval of mew calls may play a role in determining whether they evoke mobbing, and if the call interval of mew calls is short enough, the response intensity may be similar to that for mobbing calls. When we quantitatively compared sonograms of the two call structures, we found possible structural similarities as well as differences in some duration and frequency measurements. More detailed comparisons of the acoustic structures of the two calls will be described elsewhere. Another possible explanation is that the mew call may function to promote aggressive behaviors when gulls encounter intruders (Park and Park 1977). Our playback calls may present the mixed-species flocks with unusually strong reactions to a potential intruder. Further research with well-designed playback experiments will be necessary to fully understand the functional relationship between mew calls and mobbing calls.

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LITERATURE CITED

Bradbury JW, Vehrencamp SL. 1998. Principles of animal communication. Sinauer Associates, Sunderland, Massachusetts.

Chung H, Park SR. 2006. A study on alarm call of Black-tailed Gulls (*Larus crassirostris*) for bird strike program. J Korean Aeronautical Sci and Flight Operation 14: 87-93.

Curio E. 1978. The adaptive significance of avian mobbing. I. Teleonomic hypotheses and predictions. Z. Tierpsychol 48: 175-l 83.

Curio E. Regelmann K. 1986. Predator harassment implies a real deadly risk: A reply to Hennessy. Ethology 72: 75-78.

Doran PJ, Gulezian PZ, Betts MG. 2005. A test of the mobbing playback method for estimating bird reproductive success. J Field Ornithol 76: 227-233.

Ficken MS, Popp J. 1996. A comparative analysis of passerine mobbing calls. Auk 113: 370-380.

Good TP. 1998. Great Black-backed Gull (*Larus marinus*). In: The Birds of North America, No. 330 (Poole A, Gill F, eds). The American Ornithologists' Union. Philadelphia, Washington, D.C.

Hand JL. 1979. Vocal communication of the Westem Gull (*Larus occidentalis*) (PhD dissertation). University California, Los Angeles.

Hand JL. 1981. A comparison of vocalizations of Western Gulls (*Larus occidentalis occidentalis* and *L. o. livens*). Condor 83: 289-301.

Klump GM, Shalter MD. 1984. Acoustic behaviour of birds and mammals in the predator context. Z Tierpsychol 66: 189-226.

Marler P, Evans CS, Hauser MD. 1992. Animal signals: Motivational, referential, or both? In: Nonverbal vocal communication: comparative and developmental approaches (Papousek H, Jurgens U, Papousek M, eds). Cambridge University Press, Cambridge, pp 66-86.

Marler P, Hamilton WJ. 1966. Mechanisms of animal behavior. John Wiley and Sons, New York.

Marler P. 1955. Characteristics of some alarm calls. Nature 176: 6-8.

Marler P. 1959. Developments in the study of animal communication. In: Darwin's biological work (Bell P, ed). Cambridge Univ. Press, New York, pp 150-206.

Mierauskas P, Buzun V. 1988. Acoustic signaling of the Great Black-headed Gull *Larus ichthyaetus* Pallas. Bioacoustics 1: 49-56.

Park SR, Chung H, Cheong S, Lee SY, Sung HC. 2007. Anti-predator responses of Black-tailed Gull (*Larus crassirostris*) flocks to alarm calls during the post-breeding season. J Ecol Field Biol 30: 9-15.

Park SR, Park DS. 1997. Acoustic communication of the Black-tailed Gull (*Larus crassirostris*): the structure and behavioral context of vocalizations. Korean J Biol Sci 1: 565-569.

Pierotti RJ, Good TP. 1994. Herring Gull (*Larus argentatus*). In: The Birds of North America, No. 124 (Poole A, Gill F, eds). The American Ornithologists' Union. Philadelphia, Washington, D.C.

Shalter MD. 1978. Localization of passerine seet and mobbing calls by goshawks and pygmy owls. Z Tierpsychol 59: 338-350.

Sordahl TA. 1990. The risks of avian mobbing and distraction behavior: an anecdotal review. Wilson Bull. 102: 349-352.

Tinbergen N. 1953. The herring gull's world. Collins, London.

Tinbergen N. 1960. The Herring Gull's world, second ed. Basic Books, New York.

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