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Decision-making in Foraging Wild-caught Jungle Crows in Response to Auditory Stimuli: A Pilot Study

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ABSTRACT: In Japan, the jungle crow (*Corvus macrorhynchos*) is a common problematic bird, causing significant economic damage. Previous attempts to mitigate conflict between crows and humans have generally been unsuccessful. Furthermore, it is not clear whether successful mitigation outcomes can be attributed to the effectiveness of control techniques. To directly examine the sensitivity of wild-caught jungle crows to a control technique, we observed their foraging behavior when auditory stimuli were applied to a single feeding patch (no-choice trial) or to one feeding patch but not the other (two-choice trial) in an outdoor cage. The auditory stimulus consisted of a low tone in the crow's audible range (1 to 10 kHz), based on pink noise. In the no-choice trial, one feeding site was set up in a U-shaped experimental cage, and experiments were conducted under two conditions: 1) experimental sound presented at an 80 dB sound pressure level and 2) silence (i.e., control). In the two-choice trial, feeding sites were set up at both ends of the cage, and the auditory stimulus was presented at a sound pressure of 80 dB at only one of the feeding sites. All experiments were conducted with one individual at a time. The results of the no-choice trial showed that in the sound condition, as well as in the silent condition, all individuals started foraging in the presence of the sound, and there was no clear difference in foraging behavior between the two conditions presented. However, in the two-choice trial, the amount of food foraged in the feeding area under the silent condition was significantly higher than that in the feeding area under low-tone stimulus conditions. Our results suggest that jungle crows have relatively high noise tolerance; however, auditory stimulus is effective when an alternative foraging site is available. Further development of more complex experiments in captivity will elucidate the effectiveness of bird control techniques.

KEY WORDS: acoustic communication, acoustic deterrence, *Corvus macrorhynchos*, jungle crow, noise, non-lethal techniques, tolerance

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INTRODUCTION

With increasing urbanization globally, the urban environment creates novel challenges for wildlife owing to habitat loss, food scarcity, and increased human disturbance (e.g., pedestrian traffic, vehicular traffic, and industrial noise) (Fernandez-Juricic and Jokimäki 2001, Seress and Liker 2015). The urbanized environment has excluded many wildlife species, but has provided favorable habitats for others, leading to expansion of these species into urban areas.

Crows (*Corvus* spp.) are common urban birds. The jungle crow (*C. macrorhynchos*), which breeds in Japan, inhabits rural, suburban, and urban areas (Higuchi 1979, Ueta et al. 2003). As with other urban birds, conflicts between crows and humans are often considered problematic. For example, the scattering of garbage by crows at collection sites is common, resulting in local governments receiving complaints from residents (Kurosawa et al. 2003). In addition, jungle crows negatively impact the human environment by nesting in transmission towers thereby causing electrical power outages (Takeuchi and Kobayashi 2012), attacking people during the breeding season (Kurosawa et al. 2003), and causing bird-dropping nuisance (Shirai and Sasano 2020). Owing to the social concern caused by jungle crows in several parts of Japan, effective non-lethal control techniques against this species are required.

Numerous technologies have been developed to deter jungle crows from inhabiting socioeconomically important areas. For example, population control methods include trapping and removal and physically preventing foraging using nets and lines (Honda 2012, Fujioka 2020). In addition, sound and visual stimuli have also been used to deter this species (Takayama et al. 2011, 2017). Although these techniques sometimes deter crows successfully, it is unclear whether they are fully effective. When control techniques are implemented in the field, it is difficult to isolate their effectiveness, excluding the influence of environmental fluctuations like food availability. Captive experiments are required to determine a more exact relationship between control techniques and responses in jungle crows.

In this pilot study, we employed an auditory stimulus designed to overlap with the hearing range of crows and investigated the effect of this stimulus on jungle crow foraging behavior.

METHODS

Subjects and Conditions

Nine wild-caught jungle crows were used in this study. All individuals were caught in Niigata Prefecture, Japan, using baited weld mesh cages between 2020 and 2022, and were released within one year of completion of the experiment. For more than two weeks before the experiment, they were group-housed in large outdoor cages (6 × 6 × 2.5 m) with *ad libitum* access to pet food (Vita-one, Nippon Pet Food Co., Ltd.), drinking water, and perches. The housing cage was on a remote part of the Akagi Testing Center of the Central Research Institute of Electric Power

Industry, Gunma Prefecture, Japan, where the crows were generally disturbed only by animal care and research staff. The housing cage was visually and acoustically isolated from the experimental cage. We used numbered leg rings for identification of individual crows.

Experimental Procedure

Each experimental trial was performed on one individual at a time during the non-breeding season (July-February) between 2020 and 2022. Twelve hours prior to the beginning of the experimental trial, each crow was introduced to the experimental cage: a U-shaped enclosure comprising two end spaces (2 × 4 × 2.5 m) connected by a corridor space of 2 × 2 × 2.5 m (Figure 1), to allow the individual to acclimate to the cage and speakers.

On the day following acclimation, we commenced a stimulus treatment day wherein an auditory stimulus was presented at the food patch. The experimental auditory stimulus, consisting of an artificial broadband pink noise ranging from 1 kHz to 10 kHz, was generated (created in Audacity 2.2.2) and broadcast using an MP3 player attached to a portable directional speaker (AIO-2GEN, JD Solution Co., Ltd.) placed 0.5 m from the food patch of the U-shaped cage (Figure 1). The tone at least partially overlapped with the best hearing range in corvids (0.7 to 2.8 kHz; Jensen and Klokker 2006). The sound pressure levels (SPL, Z-weighted) were set to approximately 80 dB using a digital sound level meter (NL62A, RION Co., Ltd.). The high directionality of the stimulus produced by the speaker allowed us to subject one side of the cage to an auditory stimulus, with minimal sound leakage to the opposite side.

Each experiment started at 0600 h because the jungle crows are mainly diurnal species (Kuroda 1984). The subjects were weighed to the nearest gram using a spring balance (No. 11000, Pesola AG) immediately prior to the start of each trial. The U-shaped cage allowed the birds access to a food patch at each end and the food patches were connected by a space that offered only water. At the beginning of each experimental trial, we placed 100 g of pet food in a tray in a single patch (hereafter referred to as the no-choice trial, Figure 1A) or two patches (hereafter referred to as the two-choice trial, Figure 1B). The tray was large enough to catch food spilled by the birds. We recorded the birds' presence and foraging choices at the food patches using a digital video camera recorder (HDR-CX7, Sony Corporation). Each experiment ended at 1800 h, and we weighed the mass (to nearest gram) of food eaten from patch(es) using an electronic balance (KD-184N, Tanita Corporation).

Of the nine subjects, six birds were subjected to the no-choice trials and three were subjected to the two-choice trials. In the no-choice trials, three of the six birds were tested with the auditory stimulation turned off (i.e., control group), and the remaining birds were tested with the auditory stimulation turned on (i.e., treatment group).

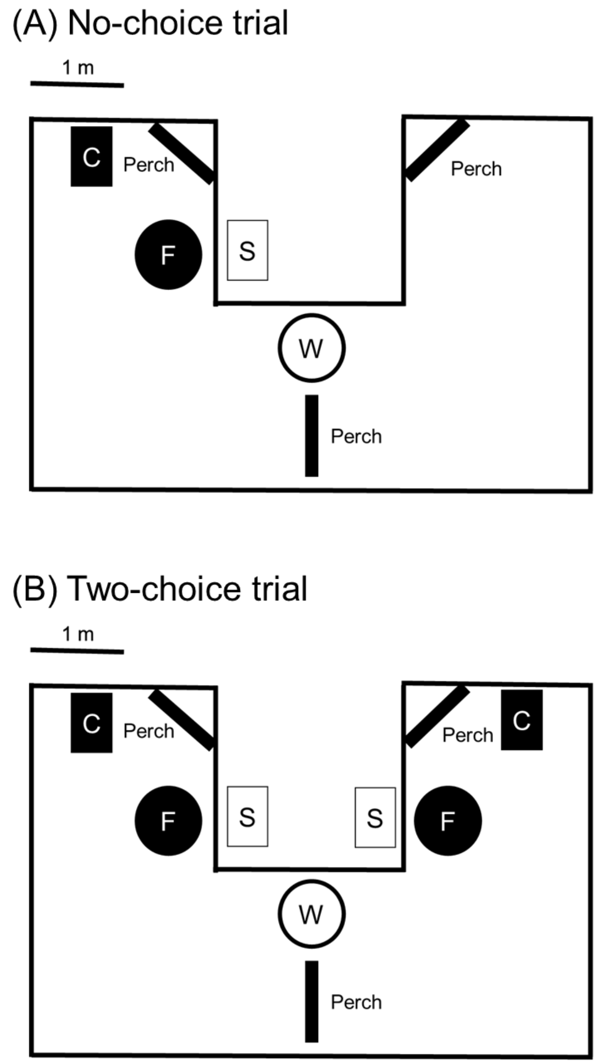

Figure 1. Plan view of the U-shaped experimental cage and experimental setting of (A) the no-choice and (B) two-choice trials. Closed (F) and open circles (W) indicate the positions of food patches and the water dish, respectively. Closed (C) and open (S) squares indicate the position of video cameras and directional speakers, respectively.

Data Analysis

We calculated the amount of food consumed in the 12-h trials by subtracting the weight of food remaining in the food dish at the end of the trial from the initial 100 g provided initially. Using video records, we also investigated the time taken for the jungle crow to begin feeding during the no-choice and two-choice trials.

We tested whether the auditory stimulus during the no-choice trials affected the feeding behavior of crows and the amount of food consumed using a two-tailed Student's *t*-test. Similarly, the amount of food consumed at each of the two patches during the two-choice trials was compared using a two-tailed paired *t*-test. Statistical significance was set at $P < 0.05$.

RESULTS

In the no-choice trial, the body masses of the experimental birds were not different between the control (747 ±63 g) and treatment groups (664 ±84 g) (t_4 = 1.38, P = 0.240). Individuals in the control group (no auditory stimulation) consumed 37 ±5 g of food during the experimental period, whereas those in the treatment group consumed 52 ±23 g, with no significant differences between the groups (t_4 = 1.10, P = 0.332; Figure 2). The crows in the control and treatment groups took 62.2 ±54.3 and 21.3 ±12.8 minutes to start feeding, respectively, and there were no significant differences between the groups (t_4 = 1.27, P = 0.273).

In the two-choice trial, the average body mass of jungle crows was 674 ±37 g. All three individuals began feeding on the food patch, apparently unaffected by the auditory stimulus. The time taken for the crows to begin foraging was 124.1 ±60.4 minutes. On average, the crows foraged 3 ±6 g in the food patch affected by the auditory stimulus and 59 ±8 g in the unaffected food patch, with significant differences between the two treatments (t_2 = 14.08, P = 0.005; Figure 3).

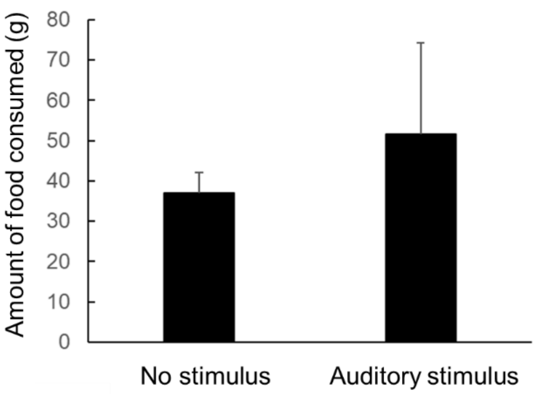

Figure 2. Food consumption of wild-caught jungle crows in the control and treatment groups during the no-choice trial.

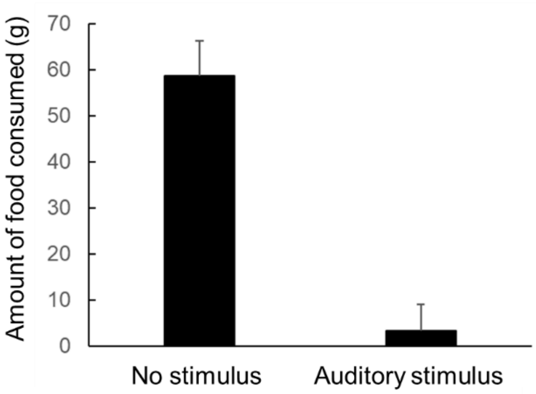

Figure 3. Food consumption of wild-caught jungle crows at treated and untreated food patches during the two-choice trial.

DISCUSSION

In this study, when only one food patch was available, the presence of auditory stimuli of 80 dB did not cause jungle crows to avoid food patches or delay the onset of foraging behavior. Among corvids, tolerance to noise varies among species. For instance, while noise is unlikely to affect the habitat distribution of carrion crows (*Corvus corone*) and western jackdaws (*Coloeus monedula*), the habitat distribution of common ravens (*Corvus corax*) tends to vary in response to noise (Patón et al. 2012). Of corvids that are year-round residents in Japan (i.e., jungle and carrion crows), jungle crows are abundant in urban centers as well as suburban areas (Higuchi 1979, Ueta et al. 2003). Given the relatively high noise levels in urban areas (e.g., >70 dB in city centers, >60 dB near railroads; Sueoka et al. 2009), jungle crows are exposed to noise daily. Although the sample size was small, our results suggest that jungle crows are relatively noise tolerant, facilitating their presence in urban areas.

However, when an alternative feeding patch was available, the jungle crows preferred the unstimulated feeding patch to the noisy patch. Similar reactions have been observed in other songbirds, such as starlings and finches. For example, a previous study examined the presence and feeding behavior of wild-caught European starlings (*Sturnus vulgaris*) in a large aviary with artificial noise introduced in one of the two food patches and found that noise treatment reduced the presence of starlings in the treated food patch by an average of 46% (Mahjoub et al. 2015). Similarly, in a preference test where zebra finches (*Taeniopygia guttata*) could move freely between noisy and quiet aviaries, the birds spent significantly more time in the quiet aviary during high-amplitude traffic noise playback (Liu et al. 2020). Birds experiencing auditory stimuli showed reduced responses to the playback of conspecific alarm calls (Mahjoub et al. 2015) or increased time spent being vigilant and reduced time foraging (Evans et al. 2018), suggesting that auditory stimuli mask the signaling space of songbirds and diminish their ability to gather acoustic information from the environment. Because jungle crows use acoustic communication, such as contact and recruitment calls for recognizing conspecifics and establishing foraging flocks, respectively (Soma and Hasegawa 2003, Kondo et al. 2010), the biased foraging behavior observed in our study suggests that jungle crows respond to the negative effects of auditory stimuli on acoustic communication.

CONCLUSION

In this study, we observed the behavioral responses of captive jungle crows to auditory stimuli in different feeding settings. Although the sample size was limited, the findings suggest that jungle crows responded differently depending on the presence or absence of alternative sites, even when the same stimuli were used as a control technique. Thus, the installation of bird control techniques may be more effective in areas where alternative food sources are available than in areas with no alternatives.

Evaluating control techniques only in terms of responses in captivity can be misleading, as wild bird behavior is often highly context-specific (Dingemanse and

De Goede 2004). Behavior may also change as wild individuals adapt to the captive environment (Butler et al. 2006). Although only two experimental conditions were evaluated in this study, there are other factors that might affect the response of wild crows to auditory stimuli (e.g., food preferences and the presence of other individuals). In addition, because this experiment was conducted over a short period (12 h), habituation to the stimuli could not be well assessed. Therefore, further captive experiments that simulate conditions in the wild are necessary to evaluate whether auditory control techniques contribute to jungle crow deterrence in the field in the long-term.

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