resource. However, the fish are only available bimonthly at the lowest tides (Shepherd 1988). In our study area, these lowest tides (<0 m) occur for 4–8 successive days and last approximately 30–60 minutes each day.

From a more general point-of-view, this resource is unusual in that it is highly valuable and limited, but predictable in its temporal distribution. Most food resources that are highly rewarding and of limited duration are unpredictable in their occurrence (e.g., insect molting swarms). Perhaps this unusual combination of characteristics explains why the resource produces such intense intra- and interspecific competition and has been exploited by crows (and through the foraging abilities of crows, other predators) in both the Kodiak Archipelago (Shepherd 1988) and the Puget Sound region.

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Long-term memory of an auditory stimulus for food in a natural population of the Mexican Jay.—The role of learning and memory in the development of foraging skills should be especially important in species that utilize a wide variety of food, as do many members of the family Corvidae (Goodwin 1976). Jays and other corvids can be easily conditioned in the laboratory to respond to various kinds of stimuli (usually visual) that signal the probable presence of food (Pietrewicz and Kamil 1981). For natural populations it is common knowledge that birds learn the locations of food and feeders, and experimental evidence of memory of locations of food is available (Kamil and Balda 1990, Shettleworth

1990). However, evidence for the learning and long term memory of auditory stimuli associated with food under natural conditions has received little attention (Kamil and Roitblat 1985, Kamil 1989). This note describes evidence for a long term memory of an auditory stimulus and suggests a mechanism for its cultural transmission.

The observations were made during a long-term study on a color-banded population of the Mexican Jay (*Aphelocoma ultramarina*) at the Southwestern Research Station of the American Museum of Natural History in the Chiricahua Mountains of Arizona. A review of the behavior and ecology of this population and a description of the study area may be found elsewhere (Brown and Brown 1990, Brown 1994).

From 1979 through 1994 my colleagues, assistants and I studied dominance interactions at bait stations in up to ten flocks of the Mexican Jay in winter (Barkan et al. 1986, Craig et al. 1982). After a few seasons of observation we suspected that the jays were associating the investigator's arrival at the observation station with food, since some would fly to the site and call when they saw one of us coming. Moreover, some individuals would occasionally spread their wings in a begging posture as the observer approached. To begin observations a small amount of food was put out by the observer to induce dominance interactions. The food was generally gone by the end of the observation period.

To test the hypothesis that the jays would learn to associate a simple auditory stimulus with food we blew a "police whistle" a few times just before putting out the food. It did not take long for each flock to learn this association. It would come to the whistle even when the flock was far away and out of sight. After training it was only necessary for us to blow the whistle once or twice to elicit a response from the jays. A response invariably began with some calling, wherever the jays were at the time. Then the flock, or part of it, would fly directly to the bait site and land in the surrounding trees, calling in flight and after alighting. The response seemed to fail in two situations, (1) when a flock was beyond hearing range for the whistle, as on windy days or when they were far away on the other side of a hill, or (2) when they were in imminent danger from a nearby accipiter hawk. We soon came to depend upon the whistle to bring in our subjects whenever we wanted to observe them or trap them.

The jays responded to the whistle not only in winter, but also during the breeding season and in warm weather, especially in drought years when food was short. The usual interval between observation sessions in winter was three to five days. In the winter of 1991–92, however, we did not study dominance, and we were not present on the study area. Soon after I arrived at the study area, 13 March 1992, I tested the hypothesis that the jays would respond to the whistle in the usual manner on the first trial, without any experience with the whistle at bait stations since June 1991, an absence from the conditional stimulus of eight and a half months.

The test was simple. For each of ten flocks I blew the whistle in the usual way at the bait site. I then observed whether some birds called and approached in the next two minutes. Eight of the ten flocks met this criterion. Usually some birds called in the distance within a few seconds and the flock began to appear. Typically all or most of the flock came. In the spring of 1992, however, there were 39 jays on the study area that had hatched in 1991 and were, therefore, inexperienced with the whistle stimulus and seed reward. These naive individuals did not respond to the whistle in the first few days of exposure to it. There were also several recent, unbanded immigrants to the study area, who presumably had little or no such experience. Since the older, longtime residents on the territory probably led the flocks, the inexperienced members would quickly be exposed to the reward if they followed the flock. In spring 1992, since yearlings had not been trained directly during the preceding winter months, their introduction to the whistle-seed association must have been first learned from older members of their flock. Cultural transmission from older and experienced to

inexperienced flock members could, therefore, have occurred. Direct, non-cultural learning could also have occurred, but it would have followed and been facilitated by the responding behavior of experienced older birds. In some flocks there were individuals who responded consistently to the whistle and others who disregarded it altogether. Thus although a flock often responded more or less as a unit it was clear that there was variation among individuals.

In 1997 the same procedures were followed. At all eight flocks tested the jays responded by calling. The latency to first call was 1–2 sec for six flocks and 8 sec for two. In seven flocks some flock members flew directly to the bait site last used in June 1995.

Although each flock was trained with the same whistle, it responded only in its own territory and typically flew to its habitual feeding site where the whistle was blown in its own territory. This site-specificity is easily explainable on the basis of the territorial behavior of the birds and the difficulty of hearing the stimulus in other territories. In 1996, however, some individuals of one flock responded to the whistle in a neighboring flock. These individuals would sneak in while the home flock was absent. Jays in untrained flocks are not attracted to the sound of a police whistle. In spring before the first tests we did not make systematic observations, but birds in trained flocks rarely visited the bait site in the absence of the whistle or of bait; hours or days might pass before seeing one visit the site. We did not systematically record data on the frequency of visits.

Although social learning in the traditional sense (Zentall and Galef 1988, Heyes and Galef 1996; Nicol and Pope 1994) is not proven by these observations, they are consistent with the social foraging habit in this species and with a previous report of "communal harvesting of a transient resource" (Brown 1983). Although many cases of "socially transmitted foraging behavior" have been reported (Lefebvre and Palameta 1988), none describes the use and possible cultural transmission of a conditioned auditory cue.

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