1968

Counting and Communication in Crows

Nicholas S. Thompson
Clark University, nthompson@clarku.edu

COMMUNICATIONS IN BEHAVIORAL BIOLOGY, Part A, 2: 223-225, Abstract No. 11680070 (1968)

COUNTING AND COMMUNICATION IN CROWS

Nicholas S. Thompson

Department of Psychology and Education
Swarthmore College
Swarthmore, Pennsylvania 19081

ABSTRACT

The counting performances of captive corvids and the sequences of cawing observed in free-ranging common crows both imply an ordinal numerical scale with lower limit at one and upper limit at or just above six. Some primitive form of counting may thus be the mediator by which crows encode messages into sequences of cawing.

INTRODUCTION

Like the probelm-solving abilities of chimpanzees, the counting abilities of crows and their close relatives seem to exceed the demands which survival makes for such abilities. In a series of experiments, O. Koehler demonstrated a primitive number sense in various corvid subjects, showing that they could discriminate variable temporal or spatial displays on the sole basis of the number of their elements (see Thorpe, 1956, pp. 340-349). That such numerical abilities are much in demand in the day-to-day life of corvids seems – on first consideration – to be highly unlikely.

One interesting possibility is that some primitive number sense forms the basis of a complex communication system. The familiar cawing of crows has many properties which suggest that it may be a number-based communication system. The cawing crow typically perches in a prominent place and emits caws in bursts of from one to several caws per burst. These bursts have a duration of a few seconds each and are separated by intervals of several seconds or more. Bursts are normally strung together in sequences of from a few to several dozen bursts per sequence. Sequences appear to differ from one another in many ways – in the pitch, speed, and timbre of their caws and notably in the number of caws per burst.

METHOD AND MATERIALS

One hundred and thirty-five sequences were collected from wild birds in the field. Each sequence was rendered – regardless of the speed, pitch, or timbre of the caws which made it up – as a string of numbers corresponding to the number of caws in each of its bursts (Table 1). These sequences were then subjected to computer analysis in order to determine their structure.

TABLE 1

Sample of 10 sequences from the 135 recorded. Each digit represents the number of caws per burst of one of the bursts of the sequence. Sequences were selected for the sample to illustrate some of the properties of sequences discussed in the text.

22121121221322121221
11211111212222222222
4444323333444333333
333333333333333
313221334343533333333333333333356554429
213151443429821
34343434
6546565546555545
11112
322322

TABLE 2

The effects of median burst length (i.e., the number of caws in a burst) on the frequency distribution of the burst lengths in the sequence. Shows the relative frequency (%) of burst lengths from one to 7+ in sequences with medians from one to 6+. Note that in most cases, the median burst length is also the modal burst length and that burst lengths progressively further from the median have progressively smaller relative frequencies.

Relative frequency (%) of bursts in sequences with medians equal to:	Burst length: No. of caws in a burst							Total Bursts
	1	2	3	4	5	6	7+	
Median = 1	79.0	17.7	0.0	1.6	0.0	1.6	0.0	62
Median = 2	16.3	62.7	17.4	2.8	0.3	0.2	0.3	576
Median = 3	2.7	17.4	60.4	14.7	3.5	0.5	0.9	661
Median = 4	1.2	6.4	22.1	51.5	11.9	4.1	2.8	344
Median = 5	0.0	1.1	4.3	23.5	46.5	18.2	6.4	187
Median = 6+	0.0	0.0	0.0	0.0	7.7	30.8	61.5	13
Any Median	9.0	27.7	31.6	18.2	8.4	3.1	1.9	1843

Considering all sequences, burst length (that is, the number of caws in a burst) varies from one to nine. Some burst lengths are much more common than others. Bursts of 2, 3 or 4 caws make up almost 80 percent of all bursts, and bursts of seven caws or more amount to barely 2 percent of the total (Table 2, final row).

Sequences differ among each other very reliably in the lengths of their bursts. A non-parametric analysis of variance of the 135 sequences shows conclusively that their median burst lengths are unequal (H = 1064, p less than 0.0001, Kruskall-Wallis test) (Siegel, 1956). Separate relative frequency analyses were done on the sequences of each median value. Except for those 13 bursts which belonged to sequences with medians equal to or greater than six, the number of caws per burst bore some very uniform relationships to the median number of the sequence in which they occurred. The relative frequency was always greatest for the median burst length, next greatest for burst lengths one smaller or one larger than the median, and decreased almost uniformly with increasing distances from the median along the numerical scale from one to six.

DISCUSSION

The data suggest that the cawing of crows is based on a simple number scale with a lower limit at one and an upper limit, for most purposes, at six. The scale is ordinal in the sense that it permits no fractional caws and in the sense that its six values are not only different but in order. Apparently the cawing crow adopts a value on the scale and tends to stick to it or near it throughout his sequence of cawing.

The numerical scale underlying the cawing of crows is similar to that underlying the counting performances of Koehler's jackdaws and ravens. Like the cawing corvid, the counting corvid uses an ordinal scale with an upper limit at or just above six. This correspondence may be fortuitous or it may occur because the counting abilities which enable captive corvids to solve numerical problems are used by free-ranging birds to encode and decode messages. Proof of this suggestion will await a rigorous demonstration that number itself, not some correlate of number, is the meaning-bearing element in sequences of cawing.

BIBLIOGRAPHY

Siegel, S. Nonparametric Statistics for the Behavioral Sciences. (McGraw-Hill, New York), 1956.

Thorpe, W.H. Learning and Instinct in Animals (Harvard University Press, Cambridge, Massachusetts), 1956.

ACKNOWLEDGEMENTS

I am most grateful to Peter Marler and Tom Struhsaker of Rockefeller University for their encouragement of the research and their apt criticism of earlier versions of the manuscript.