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Short communication

Free-ranging angora goats: left- or right-handed tendencies while grazing? ☆

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Abstract

Knowledge of an animal's tendencies, including their directional biases, can aid in design of handling facilities and enhance our understanding of livestock and livestock:environment interactions. Recent work suggests that goats consistently prefer to turn left in mazes. The objective of this research was to determine if free-ranging angora goats (*Capra hircus*) exhibit left- or right-hand tendencies when grazing in paddocks supporting randomized arrays of forages. This was accomplished during two 3-day sampling periods by compiling successive feeding station locations of individual goats as they grazed and evaluating frequencies of left, right, forward, and reverse movements. Analyses revealed no significant ($P \geqslant 0.01$) evidence of a left- or right-hand bias by either individuals or the sampled population of goats. Changes in direction, however, were not always independent or random events. In two instances, extended series of left- or right-turns occurred suggesting these data can at times be clustered ($P \leqslant 0.01$). Conversely, in four instances, animals systematically ($P \leqslant 0.01$) shifted between left- and right-hand turns as they grazed. While the potential for non-random turning behavior suggested that extended observations be used to quantify directional tendencies of free-ranging goats, there were no indications of left- or right-handed inclinations by the animals in unconfined conditions.

Keywords: Livestock; Handedness; Foraging behavior; Grazing behavior

1. Introduction

Knowledge of inherent behavioral tendencies is of prominent importance in both management and research of animals. Grandin (1993a) emphasized an awareness of livestock's behavior patterns can make handling more efficient and safe for operators and similarly enhance the animals's productivity and welfare by reducing stress (Hixon et al., 1981).

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Among livestock some observations of lateral tendencies have been noted, but only recently have they been seriously investigated. Lynch et al. (1992) noted that the circling behavior exhibited by some breeds of sheep may be used to advantage in herding, but they provided no comment on directional inclinations of their animals. These same authors also noted that on flat terrain, herbivores in Australia tend to drift south-east in response to the prevailing winds (Lynch et al., 1992). Grandin (1993b) indicated that cattle handled in choice testing facilities often develop a strong preference for turning either left or right, and others (Hosoi et al., 1992; Espach et al., 1993) have detected lateral biases in cattle, horses, goats, and sheep in maze settings. Among 11 goats, all were consistently left-handed (Hosoi et al., 1992), while among the other species lateral tendencies appeared to be animal-specific. A remote possibility with the goats was that they sensed some extra-maze cues that affected their perceptions or movements.

Causes and consequences of left-right asymmetries remain obscure (Coren, 1990), but recent evidence in mice suggests that handedness may be a separate genetic trait (Biddle et al., 1993). Disease (listeriosis) or brain injury may also affect turning propensities in some animals (Scott, 1970). Learning and memory also influence animal movements (Senft et al., 1987). Kovalcik and Kovalcik (1986) established that cattle quickly learn which side of a T maze contains food, and Bailey et al. (1989) demonstrated that cattle can retain spatial memory of food depletion in maze settings for up to 8 h. Deer are also able to learn complex food distributions and subsequently forage more efficiently (Gillingham and Bunnell, 1989). Because animals can learn patterns or in fact have directional preferences, Grandin (1993b) has suggested naive animals be used in directional choice tests to ensure accuracy.

Folse et al. (1989) suggest models based on random walks (Berg, 1983) are not appropriate to represent animal movements involving decision rules contingent on a spatially heterogeneous and temporally dynamic habitat. Although spatial distribution and movement patterns have been described for many large herbivores, the mechanisms or behaviors that contribute to their development must be determined before we can exploit their habits in management scenarios and construct accurate simulations of animal movement or resource use (Bailey et al., 1989). Given this lack of information, the objective of this research was to determine whether free-ranging angora goats exhibited left- or right-hand tendencies as they grazed in paddocks supporting randomly arranged arrays of forage. Null hypotheses investigated were that goats made left- and right-turns with equivalent frequencies and that runs of left- and right-turns were not clustered but randomly distributed throughout grazing sessions. This was accomplished by quantifying the frequencies of left, right, forward, and reverse movements of goats as they grazed.

2. Study area and methods

The study was conducted on the Northern Great Basin Experimental Range, 72 km west-southwest of Burns, OR. Data were collected from seven dry, non-pregnant ewes (randomly withdrawn from a group of 30 angoras, 3–10 years of age and 40 kg weight) as they progressively grazed in six separate 0.1 ha paddocks supporting an array of eight grasses. Three successive days of sampling occurred in three paddocks in June and 3 days in three

paddocks in August 1991. Each paddock supported 98 replicates of eight selections of grasses (total N per paddock, 784 plants) established in a 28×28 matrix with 0.76 m spacings between rows and columns. Positioning of each plant in each matrix was determined by random drawings of X and Y coordinates. Selections of grasses included: two cultivars of basin wildrye (*Leymus cinereus* (Scribner & Merrill A. Löve)), 'Magnar' and 'Trailhead'; two selections of thick-spiked wheatgrass (*Elymus lanceolatus* (Scribner & J.G. Smith) Gould), selection no. 9021076 and 'Secar' Snake River wheatgrass; one cultivar of bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Löve), 'Goldar'; the 'Bozoisky' cultivar of Russian wild-rye (*Psathyrostachys junceus* (Fischer) Nevsk); 'Nordan' crested wheatgrass (*Agropyron desertorum* (Fischer ex Link) Schultes) and a crested wheatgrass cross called 'Hycrest II', a product of *Agropyron desertorum* and *Agropyron cristatum* (L.) Gaertner. Among selections the crested wheatgrasses were clearly preferred by the goats.

Before each grazing trial, two sets of cards (numbered 1–28) were arranged on the ground, outside an enclosing electric fence, to facilitate rapid determination of row and column designations of plants as they were successively foraged upon. The goats were well experienced with electric fences, and apart from not touching it, they showed no aversion to its presence. Prior to each trial, the animals were held overnight without feed to assure active foraging the following morning. A trial began with two randomly selected goats entering a paddock. One animal was selected for monitoring, and the row and column designations of each grazed plant recorded by technicians as the animal foraged. The objective was to obtain 250 observations each day distributed equally among five animals. Some animals ceased grazing earlier than anticipated, and the actual number of observations per goat on a given day ranged between 35 and 103. The goal of 250 observations per day was accomplished by recording additional data from other animals. As sampling progressed, randomly selected animals were progressively released until a total of six goats were foraging in the paddock and visits to at least 250 plants recorded. Earlier trial runs had shown that a single animal would not graze, and that a mass release of the goats resulted in satiation of some animals before sufficient data could be recorded

The series of X and Y coordinates portraying the successive positions of feeding stations visited by the goats were analyzed in a graphic display program written and executed in QBasic by the author. The program progressively depicted an initial and subsequent line of travel between feeding stations on a monitor, and directions were tallied into one of four categories. These were: (1) forward, where the animal continued on a straight ahead course; (2) right turns; (3) left turns; (4) reversals, where the animal returned along the same line it had used to approach the feeding station. There are two possible sources of error in this procedure. The first involves actual turns greater than 180° which would be assigned to the incorrect side. Second is the violation of the assumption that goats traversed straight-line paths between feeding stations. While both of these most certainly occurred, they are thought to be random violations with no effect on subsequent interpretation.

Two analyses were conducted. Data for each goat on each day were subjected to a runs test (Sokal and Rohlf, 1969) of left and right turns, which is an evaluation of randomness of occurrence. A run is a consistent and continuous series of events, and the procedure requires counting the number of 'runs' observed in a single sample. For instance, the succession l l l r r r l l contains a total of three runs consisting of three left, three right, and

two left turns. Too few runs, for instance a sample consisting of l l l l l l r r r r r r with two runs in 12 events, is indicative of clustering or a general dependence among data. Too many runs (e.g. l r l r l r l r l r with ten runs in ten events) indicates systematic or cyclic transitions. Forward (f) and reverse (b) transitions within the data were ignored in the runs analyses (e.g. l l f l l r b r l was interpreted as three runs of length four left, two right and one left turn).

The second set of analyses were single degree of freedom χ^2 goodness of fit tests examining the null hypothesis that left and right turns occurred with equal frequencies. These were conducted on the data from each goat on each day, across goats on the totals for each day, across days on the totals for each goat, and on the grand total across all goats and days. Given the large number of simultaneous analyses conducted, statistical significance was assumed at $P \leqslant 0.01$ to reduce the likelihood of a Type 1 error.

3. Results and discussion

A total of 1490 observations was gathered over the 6 days of trials. The overall ratio of forward:right:left:reverse transitions was 6:45:43:6. Although the majority of transitions were either left or right turns, the general direction of travel was typically forward. Runs tests revealed two instances of low numbers of runs ($P < 0.01$) in the distributions of left and right turns by one goat on 2 successive days (goat 6 on days 2 and 3; Table 1). This implies clustering of left and right turns in roughly 13% of the data. Conversely, a significantly high number of runs occurred in four instances or 15% of the data (goat 2 on days 1, 2, and 6, and goat 6 on day 6). In these instances, the animals were nearly systematic in their shifts between left and right directions.

Out of 26 simultaneous χ^2 analyses conducted, no indications of a significant ($P \geqslant 0.01$) left- or right-hand bias occurred for any of the goats (Table 1). Findings were similar across individuals on specific days and across days and individuals for the entire data set. Quite possibly, in this sampling design, there was some loss of the individual's behavior patterns as the goats typically moved about and foraged as a flock. However, since dry matter biomass of available herbage in the paddocks ranged between 100 and 113 kg, and distance traversed between feeding stations averaged only 1.7 m (SE = 0.3), the goats did not appear to be expediting their foraging or travel to maintain contact with companions. The data do, however, represent movement patterns typical of individuals as they moved about in a group.

As this effort describes behavior of free-ranging animals, readers are advised that these findings are not in contradiction with Hosoi et al. (1992) whose work occurred in extremely controlled and confined conditions. While others have also observed handedness by livestock in testing facilities (Espach et al., 1993; Grandin 1993b) no suggestions have been offered to explain its derivation or function.

In conclusion, no evidence was found suggesting that individual goats, or that goats in general, exhibited left- or right-hand preferences when grazing in randomly arranged arrays of forage. This implies that turning preferences need not be considered in assembly of decision-based models of grazing activities of goats. Roughly 28% of the data, however, indicated that runs of left- or right-hand turns are at times clustered or systematic. This

Table 1
Number of forward, right, left, and reverse movements and number of runs by angora goats grazing in paddocks supporting arrays of randomly positioned forages. Underlined values exhibited significant ($P<0.01$) clustering of left or right turns (a low number of runs), and double underlined values contained high numbers of runs denoting systematic left:right transitions ($P<0.01$)

Day	Movements and runs	Goat no.							Total
		1	2	3	4	5	6	7	
1	Forward	–	6	–	9	–	11	1	27
	Right	–	16	–	16	–	40	24	96
	Left	–	25	–	13	–	34	21	93
	Reverse	–	1	–	10	–	10	4	25
	Runs	–	25	–	16	–	35	24	
2	Forward	0	5	3	–	–	6	–	14
	Right	12	32	36	–	–	32	–	112
	Left	21	22	30	–	–	51	–	124
	Reverse	0	4	2	–	–	7	–	13
	Runs	17	36	35	–	–	33	–	
3	Forward	0	–	–	4	–	4	2	10
	Right	15	–	–	29	–	40	27	111
	Left	15	–	–	22	–	54	22	113
	Reverse	0	–	–	8	–	3	2	13
	Runs	18	–	–	23	–	41	25	
4	Forward	–	11	–	3	–	5	0	19
	Right	–	39	–	23	–	18	25	105
	Left	–	48	–	21	–	26	17	112
	Reverse	–	0	–	1	–	9	6	16
	Runs	–	47	–	24	–	19	19	
5	Forward	–	2	–	0	4	1	0	7
	Right	–	25	–	24	20	23	24	116
	Left	–	20	–	22	19	27	23	111
	Reverse	–	1	–	2	5	2	1	11
	Runs		19		26	15	21	20	
6	Forward	–	3	–	4	1	5	5	18
	Right	–	26	–	23	24	24	25	122
	Left	–	16	–	20	22	15	18	91
	Reverse	–	3	–	2	3	4	0	11
	Runs	–	25	–	21	26	24	21	
Total	Forward	0	27	3	20	5	32	8	95
	Right	27	138	36	115	44	177	125	662
	Left	36	131	30	98	41	207	101	644
	Reverse	0	9	2	22	8	35	13	89

would dictate that sampling of this behavior involve extended observations, since there are brief periods when non-random turning patterns may be exhibited by free-ranging animals.

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