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Book Review -- Spontaneous Alternation Behavior

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BOOK REVIEWS

Spontaneous alternation behavior edited by W. N. Dember & C. L. Richman. Springer-Verlag, New York, 1990, XII + 211 pp.

If an adult rat is placed in the start stem of a T-maze, allowed a choice of one of the arms, and then placed immediately back into the maze and allowed a second choice, about 80% of the rat's second choices will be the arm opposite to that entered in the first trial. This is named *spontaneous alternation behavior*, or *SAB*, and was first observed by Hunter (1914) in a study on discrimination learning. Why would comparative psychologists be interested in such a simple phenomenon?

I started my reading of Dember & Richman's (D&R) book with some expectations I usually experience when reading a collection of chapters, i.e., that heterogeneity of topics and styles will prevail, that it will be hard to find a common theme, and that there will be a lot of "unpublished results" which may not be appropriate for publication in major journals. I was glad to discover that I had been wrong. D&R had put together a very coherent set of chapters which does more than merely review the literature; it conveys a sense of accomplishment uncommon in the animal learning and behavior field. The authors have successfully avoided the further-research-is-necessary cliché, to concentrate on making sense of the impressive amount of information that has been obtained about SAB after several decades of research.

The historical overview presented by W. N. Dember reminds us of some important connections between the early literature on SAB and learning theory. SAB was initially conceptualized in terms of an *exploratory tendency* that would presumably drive rats toward novel places. It was Hull's notion of *reactive inhibition* what shifted attention from the environment to the animal's response. Reactive inhibition was conceptualized as an aversive, temporary state induced by the occurrence of a particular response; within Hull's theory, reactive inhibition was designed to account for some extinction phenomena, such as spontaneous recovery, but its relevance to SAB was obvious. Some early data on the dependence of SAB on relatively short intertrial intervals seemed to confirm the role of reactive inhibition because this aversive state was thought to spontaneously decay in time. SAB entered therefore the *place vs. response* controversy that dominated the field of animal learning during the 1950s. The crucial ex-

periments were those in which the maze was reoriented 180° between the first and second trials. They revealed that intra- and extra-maze stimuli are far more important determinants of SAB than response-produced stimuli; the story is fully described in Chapter 2, also by Dember. Drawing mostly from the research of Douglas and his associates, Dember concludes that odor trails are the most important intra-maze cues determining SAB, and that the direction of movement relative to cues in the room where training takes place is the most important extra-maze cue for SAB. These two sources account for virtually all the alternation behavior of rats in typical laboratory situations.

The third chapter by R. N. Hughes deals with the interspecies generality of SAB and turn alternation, a related phenomenon—at least at the behavioral level—which seems particularly prominent in invertebrates. One interesting outcome of this review is the limited species generality of SAB: it has not been found in a number of invertebrates, with the possible exception of some cockroach species, in teleost fish, in turtles, or in domestic chicks. There is some evidence of SAB in marsupials, lagomorphs, rodents (in addition to rats), and carnivores. Unfortunately, very little has been done in these species beyond the basic demonstration of SAB. What do we want from a comparative study of SAB? We certainly do not want a survey of SAB in hundreds or thousands of species, but rather a systematic research program with a few carefully selected species which may give us an idea of the generality of the processes involved in the SAB observed in rats. The book so clearly illustrates the dependence of SAB on procedural aspects that it would seem naive to think that we can treat SAB as a morphological trait that is or is not present in a particular species.

SAB was discovered in the course of discrimination experiments and therefore it seems appropriate to ask for the potential relation between these two phenomena. C. L. Richman takes over this task in Chapter 4, pointing out the connections between SAB and such notions as *selective attention, response competition*, and *drive level.* Although it may appear on a first approximation that SAB may interfere (or enhance, depending on the training conditions) with discrimination learning, the relation is not so clear upon closer examination. SAB seems to depend on conditions which are not typically found in learning experiments. For example, food deprivation disrupts SAB and it is, of course, an omnipresent manipulation in learning experiments in which food is used as a reinforcer. Indeed, following Estes (1958), Richman suggests that food deprivation may increase acquisition rate "by eliminating an animal's initial tendency to alternate" (p. 62). It may be the case that SAB is not so influential a factor in discrimination learning, as compared to other sequential

effects, such as position habits, as a number of experiments seem to suggest (e.g., Papini, Mustaca, & Affanni, 1985).

The next two chapters review the neurobiological (Chapter 5 by R. J. Douglas) and neurochemical (Chapter 6 by L. Kokkinidis) correlates of SAB. The neurobiological research reviewed by Douglas points to two sets of structures within the brain. First, the *hippocampal system* involving the entorhinal cortex, the subiculum, the hippocampus, the dentate gyrus, the fimbria and fornix, and the septal region. Douglas develops a parallel between the effects of hippocampal lesions in humans and rats, and suggests that when a lesion in a particular structure in the rat's brain abolishes SAB, a lesion in an analogous structure in the human brain will disrupt short-term memory. The second set of structures involves the *vestibular system*, including the labyrinth in the internal ear, the vestibular nerves and nuclei, the cerebellum, and the corpus striatum. Lesions in these areas significantly disrupt SAB, and may sometimes completely abolish it. Kokkinidis' chapter treats SAB as an example of the more general phenomenon of habituation, and suggests that drugs that disrupt habituation should also decrease alternation behavior. Anticholinergic drugs, such as *scopolamine* and *atropine*, reduced SAB levels to chance, whereas *amphetamine*, which blocks the reuptake of norepinephrine, eliminates SAB and induces perseverative movements.

The ontogeny of SAB in the rat was described in Chapter 7 by N. E. Spear and J. S. Miller. As they point out, SAB increases as a function of age in the rat, as well as in other species such as the Guinea pig, a precocial rodent with an almost complete development of the nervous system at birth. The central question that Spear and Miller try to answer is "why does the developing animal increase its probability of alternation?" After rejecting some alternatives (i.e., that infants alternate less than adults because they are less curious and less active), they describe the contribution of *emotional reactions to novelty, length of stimulus exposure*, and *forgetting rate*. For example, 16-day old rats, which would not normally alternate, may show adult levels of SAB if odors from their home cage are present during the test. Apparently, these familiar odors eliminate competing responses elicited by the experience of being isolated from the nest area. Additionally, and at least in the rat, some structures which are known to be important for SAB to appear in the adult, develop gradually during the initial weeks of life. For example, a unilateral lesion to the hippocampus, which produces no effect on SAB if performed in an adult, disrupts SAB in the adult animal if performed between 12 and 31 days of age.

The final chapter by R. J. Douglas reviews some personal experiences accumulated over years of SAB research, and is meant as "ad-