

Spontaneous alternation behavior in *Paramecium*

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Spontaneous alternating behavior (SAB), the tendency of an organism to successively turn left and right in a maze, is a standard metric of short-term memory in developmental and psychopharmacological studies. Although SAB is perhaps the most phylogenetically widespread behavior in motile lifeforms, conflicting data on SAB exist for several sets of closely related taxa. For example, previous studies provide contradictory evidence concerning the existence of spontaneous alternation behavior in the protozoan *Paramecium*. However, these studies tested different species, using very different experimental designs. Using a single, factorial design for both previously tested species, *P. multicaeruleum* and *P. caudatum*, we found that, in fact, the two species do not differ in their alternation behavior; specifically, they alternate in mazes with short tracks, but not in mazes with long tracks. These results are in accord with alternation studies on other taxa, and they fully resolve the apparent contradictions in the earlier studies on *Paramecium*. They also indicate that caution should be used in interpreting variable results across species tested with different experimental designs and suggest that, in at least some taxa, SAB may not be strictly dependent on the use of short-term memory.

Spontaneous alternation behavior (SAB) is the nonrandom tendency of an organism to choose to turn in the direction opposite to that of its previous turn in the absence of reward or reinforcement (Dember & Richman, 1989). Although the underlying mechanism of SAB has been controversial over the years, most researchers agree that the ability to alternate choices requires that the organism remember its previous choice (Hughes, 2004). As a result, SAB is a standard metric of short-term memory that has been used in hundreds of psychopharmacologic and developmental studies in mice and rats (Lalonde, 2002). Recently, however, some authors have begun to question the utility of SAB and other maze-based measures of memory (Wolfer, Stagljar-Bozicevic, Errington, & Lipp, 1998), noting the potential for noncognitive factors such as thigmotaxis and residual odor cues to influence subject behavior in mazes.

Perhaps the most phylogenetically general behavior of motile life forms, SAB has been reported in animals ranging from primitive flatworms (Adelman & Dawson, 1970; Shinkman & Hertzler, 1964) to mammals (Dashiell & Bayroff, 1931), in protozoans (Lepley & Rice, 1952), and even in sperm cells (Brugger, Macas, & Eblemann, 2002). It is unusual for closely related species to differ in such an apparently conservative (and fundamental) trait, and yet there are several instances in which SAB has been reported in one species but not observed in a close

relative. Some examples include paramecia (Lachman & Havlena, 1962; Lepley & Rice, 1952), planarians (Adelman & Dawson, 1970; Rice & Lawless, 1957; Shinkman & Hertzler, 1964), and chickens (Cogan, Jones, & Irons, 1979; Hayes & Warren, 1963; Hughes, 1989a). To date, little attention has been paid to this curious situation, whose interpretation is further complicated by the extreme diversity of experimental designs used to study alternation behaviors.

For example, Lepley and Rice (1952) and Lachman and Havlena (1962) used paramecia to test Hull's (1943) model of reactive inhibition. Although neither study found support for reactive inhibition, Lepley and Rice did find unambiguous evidence for SAB in *P. multicaeruleum* (84.7% alternation, $N = 1,115$, $\chi^2 = 535.9$, $p < .001$), whereas Lachman and Havlena reported equally compelling evidence that SAB does not occur in *P. caudatum* (47% alternation in single-forced-turn trials, $N = 100$, $\chi^2 = 0.36$, $p = .55$; 48.5% alternation in multiple-forced-turn trials, $N = 800$, $\chi^2 = 0.72$, $p = .40$). Lester (1968) and Hughes (1989b) noted the conflicting evidence provided by these studies but, like Lachman and Havlena, did not comment on the basis of this discrepancy. Shinkman and Hertzler (1964) speculated that the differences might have been due to differences in the experimental design of the two studies.

It is thus unclear whether or not these species truly differ in SAB. Not only did Lepley and Rice (1952) and Lachman and Havlena (1962) use different species of *Paramecium*, but, as Shinkman and Hertzler (1964) noted, their experimental designs differed in numerous other ways as well (Table 1). Of these many parameters, only track length and, to a limited extent, runway length have been systematically tested with respect to SAB (see Figure 1 for the maze terminology used in this article). SAB

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Spontaneous Alternation Behavior

Lawrence Weiskrantz



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Spontaneous Alternation Behavior William N. Dember, Charles L. Richman, 2012-12-06 A wide variety of species including human beings exhibits a remarkably reliable behavior pattern known as spontaneous alternation behavior SAB that has intrigued researchers for over seven decades Though the details may vary depending on species and setting SAB essentially entails first choosing one member of a pair of alternatives and then the other without instructions or incentives to do so Spontaneous alternation is manifested even in the early trials of a discrimination learning experiment where only one of the choices is reinforced Indeed that was the setting in which SAB was first noted Hunter 1914 Reinforcement contingencies evidently are superimposed not on a random sequence of choices but on a potent systematic behavior pattern This book is the first to be devoted entirely to SAB and closely related phenomena such as habituation and exploration The literature on SAB is vast covering a host of questions ranging from the cues that guide alternation to its phylogenetic and ontogenetic generality its relation to learning and motivation and its neurochemical substrates In separate chapters we take up each of the major issues reviewing what is known about the several facets of SAB and revealing areas of ignorance The chapter authors were encouraged to discuss their own research where pertinent some of it as yet unpublished indeed some conducted specifically for this volume

Spontaneous Alternation Behavior William N. Dember, Charles L. Richman, 2011-11-06 A wide variety of species including human beings exhibits a remarkably reliable behavior pattern known as spontaneous alternation behavior SAB that has intrigued researchers for over seven decades Though the details may vary depending on species and setting SAB essentially entails first choosing one member of a pair of alternatives and then the other without instructions or incentives to do so Spontaneous alternation is manifested even in the early trials of a discrimination learning experiment where only one of the choices is reinforced Indeed that was the setting in which SAB was first noted Hunter 1914 Reinforcement contingencies evidently are superimposed not on a random sequence of choices but on a potent systematic behavior pattern This book is the first to be devoted entirely to SAB and closely related phenomena such as habituation and exploration The literature on SAB is vast covering a host of questions ranging from the cues that guide alternation to its phylogenetic and ontogenetic generality its relation to learning and motivation and its neurochemical substrates In separate chapters we take up each of the major issues reviewing what is known about the several facets of SAB and revealing areas of ignorance The chapter authors were encouraged to discuss their own research where pertinent some of it as yet unpublished indeed some conducted specifically for this volume

Advances in Neuroregulation and Neuroprotection Catherine Collin, Masaru Minami, Hasan Parvez, Hideya Saito, Simone Parvez, Qureshi, Claude Reiss, 2005-04-15 Neuroregulation is a challenging and rapidly developing field that holds the key to many currently intractable medical conditions from nervous and mental diseases to stress related disorders *Advances in Neuroregulation* mirrors the broad scope of research in this area with topics ranging from new concepts on the immune system and on the

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Neuropsychology Michael S. Gazzaniga, 2012-12-06 As the Handbook of Behavioral Neurobiology moves into a second volume it is appropriate to take into general account the scope and content of this series In its broadest sense behavioral neurobiology is the study of the behaviors of animal organisms with reference to their neurological bases The overall objective of this handbook series is to assemble in ten volumes a comprehensive and up to date treatment of the major areas that comprise behavioral neurobiology Within such a framework it is possible to provide the fundamental concepts methods and substantive advancements in these fields in a manner that will be useful to and that will also serve as a reference source for researchers educational programs who desire a well balanced overview of the component areas of neurobiology The intent in each volume has been to bring together a spectrum of approaches and disciplines that focuses upon the topic at hand The first volume presented and discussed the problems of sensory integration the present work is concerned with the neurobiology of cognitive processes and forthcoming volumes will include the topics of motor coordination learning and memory biological rhythms motivation sexual behavior social behavior and communication and the evolution of nervous systems and behavior Thus the purpose of the editors in planning this series has been to offer a distinct handbook employing the many varied and prevailing avenues of attack upon current problems in behavior and neurological processes that should prove of unique value and usefulness to professionals and students alike

The Effect of Stimulus Differentiation and Intertrial Interval on Spontaneous Alternation Behavior in Rats Vernon Stephen Bisese, 1961

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Further Analysis of the Direction of Movement Cue in Spontaneous Alternation Behavior Michael Floyd Sherrick, 1969

Blood Cell Terry E. Moschandreu, 2012-09-21 The editor has incorporated scientific contributions from a diverse group of leading researchers in the field of hematology and related blood cell research This book aims to provide an overview of current knowledge pertaining to our understanding of hematology The main subject areas will include blood cell morphology and function the pathophysiology and genetics of hematological disorders and malignancies blood testing and typing and the

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Attention Deficit Hyperactivity Disorder (ADHD) Research Developments Michelle P. Larimer, 2005 ADHD is characterised by learning and behavioural problems including short attention span impulsivity hyperactivity and impairments in perceptual language and motor skills Between 4 10 per cent of school age children are believed to have it with boys outnumbering girls 2 3 to one An adult form is also now recognised The symptoms of Attention Deficit Disorder are caused by a neurological dysfunction within the brain The underlying physiological mechanism which causes Attention Deficit Disorder is still not thoroughly understood and remains under intense scientific study It is presumed that brain chemistry is out of balance and that specific chemicals called neurotransmitters may be lacking in individuals with Attention Deficit Disorder Leading edge research from around the world is presented in this new volume Neuromodulation of Exercise: Impact on Different Kinds of Behavior Henning Budde, Bruna Velasques, Pedro Ribeiro, Hideaki Soya, 2021-07-14

Instinctive Computing Yang Cai, 2017-01-09 This book attempts to connect artificial intelligence to primitive intelligence It explores the idea that a genuinely intelligent computer will be able to interact naturally with humans To form this bridge computers need the ability to recognize understand and even have instincts similar to humans The author organizes the book into three parts He starts by describing primitive problem solving discussing topics like default mode learning tool making pheromones and foraging Part two then explores behavioral models of instinctive cognition by looking at the perception of motion and event patterns appearance and gesture behavioral dynamics figurative thinking and creativity The book concludes by exploring instinctive computing in modern cybernetics including models of self awareness stealth visual privacy navigation autonomy and survivability Instinctive Computing reflects upon systematic thinking for designing cyber physical systems and it would be a stimulating reading for those who are interested in artificial intelligence cybernetics ethology human computer interaction data science computer science security and privacy social media or autonomous robots

Pharmacology, Biochemistry and Behavior, 1998-07 *Animal Behaviour Abstracts*, 1999 Behavior Genetics, 1989 **Spontaneous Alternation and Exploratory Behavior in Blind and Anosmic Rats** Danny Klein, 1968 *A Control Theory of Sequential Response Production* Sjoerd Wiegersma, 1982 Animal Learning & Behavior, 1984 **The Hippocampus** Robert Isaacson, Karl H. Pribram, 1975 These books are the result of a conviction held by the editors authors and publisher that the time is appropriate for assembling in one place information about functions of the hippocampus derived from many varied lines of research Because of the explosion of research into the anatomy physiology chemistry and behavioral aspects of the hippocampus some means of

synthesis of the results from these lines of research was called for We first thought of a conference In fact officials in the National Institute of Mental Health suggested we organize such a conference on the hippocampus but after a few tentative steps in this direction interest at the federal level waned probably due to the decreases in federal support for research in the basic health sciences so keenly felt in recent years However the editors also had come to the view that conferences are mainly valuable to the participants The broad range of students of all ages of brain behavior relations do not profit from conference proceedings unless the proceedings are subsequently published Furthermore conferences dealing with the functional character of organ systems approached from many points of view are most successful after participants have become acquainted with each other s work Therefore we believe that a book is the best format for disseminating information and that its publication can be the stimulus for many future conferences

Analysis of Behavioral Change Lawrence Weiskrantz,1968

The American Journal of Psychology Granville Stanley Hall,Edward Bradford Titchener,Karl M. Dallenbach,Madison Bentley,Edwin Garrigues Boring,Margaret Floy Washburn,1971

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