

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. multicaudatum* 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, Staglar-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, & Bilemann, 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. multimicronucleatum* (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

Christian P. Muller, Barry Jacobs



Spontaneous Alternation Behavior:

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

Further Analysis of the Direction of Movement Cue in Spontaneous Alternation Behavior Michael Floyd Sherrick, 1969 *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 action of antidepressants to the evolution and development of the autonomic nervous system. In addition, the latest research findings are presented for behavioural disorders and medical conditions such as Parkinson's disease, Alzheimer's disease, epilepsy, and attention deficit hyperactivity disorder. Another area of emphasis is the body's responses to stress and the effect of neuroactive agents in the treatment of stress-related conditions. Many chapters are devoted to the progress being made at the cellular and molecular level, including areas such as the conditions for culture of different types of neural cells, conformational diseases, and the protein folding problem; vasoactive intestinal polypeptide release from pancreatic islets; the effect of melatonin and corticosterone on macrophages. Here, in a book that expands the frontiers of neuroscience, researchers into neuroregulation at the molecular and cellular levels, as well as those working at the clinical and systemic levels, will find important results relating to their field.

The Effect of Stimulus Differentiation and Intertrial Interval on Spontaneous Alternation Behavior in Rats Vernon Stephen Bisese, 1961 *Handbook of the Behavioral Neurobiology of Serotonin* Christian P. Müller, Barry Jacobs, 2009-12-30

Serotonin (5-hydroxytryptamine, often cited as 5-HT) is one of the major excitatory neurotransmitters, and the serotonergic system is one of the best studied and understood transmitter systems. It is crucially involved in the organization of virtually all behaviours and in the regulation of emotion and mood. Alterations in the serotonergic system induced by, e.g., learning or pathological processes underlie behavioural plasticity and changes in mood, which can finally result in abnormal behaviour and psychiatric conditions. Not surprisingly, the serotonergic system and its functional components appear to be targets for a multitude of pharmacological treatments; examples of very successful drugs targeting the serotonergic system include Prozac and Zoloft. The last decades of research have not only fundamentally expanded our view on serotonin but also revealed in much more detail an astonishing complexity of this system, which comprises a multitude of receptors and signalling pathways. A detailed view on its role in basal but also complex behaviours emerged and was presented in a number of single review articles. Although much is known now, the serotonergic system is still a fast-growing field of research contributing to our present understanding of the brain's function during normal and disturbed behaviour. This handbook aims towards a detailed and comprehensive overview over the many facets of behavioural serotonin research. As such, it will provide the most up-to-date and thorough reading concerning the serotonergic system's control of behaviour and mood in animals and humans. The goal is to create a systematic overview and first-hand reference that can be used by students and scholars alike in the fields of genetics, anatomy, pharmacology, physiology, behavioural neuroscience, pathology, and psychiatry. The chapters in this book will be written by leading scientists in this field. Most of them have already written excellent reviews in their field of expertise. The book is divided into 4 sections. After an historical introduction illustrating the growth of ideas about serotonin function in behaviour of the last forty years, section A will focus on the functional anatomy of the serotonergic system. Section B provides a review of the neurophysiology of the serotonergic

system and its single components In section C the involvement of serotonin in behavioural organization will be discussed in great detail while section D deals with the role of serotonin in behavioural pathologies and psychiatric disorders The first handbook broadly discussing the behavioral neurobiology of the serotonergic transmitter system Co edited by one of the pioneers and opinion leaders of the past decades Barry Jacobs Princeton with an international list 10 countries of highly regarded contributors providing over 50 chapters and including the leaders in the field in number of articles and citations K P Lesch T Sharp A Caspi P Blier G K Aghajanian E C Azmitia and others The only integrated and complete resource on the market containing the best information integrating international research providing a global perspective to an international community Of great value not only for researchers and experts but also for students and clinicians as a background reference

The Hippocampus Robert Isaacson, 2012-12-06 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

Translation and Processing of Light by the Non-Image Forming Visual System - Context, Mechanisms and Applications Fabian-Xosé Fernandez, Shadab Rahman, Manuel Spitschan, 2021-10-18 **Handbook of Behavioral Teratology** E.P. Riley, C.V. Vorhees, 2012-12-06 This book was developed in response to a need in behavioral teratology for a comprehensive set of reviews of the field's many topics brought together in a single source This volume represents the first effort to synthesize and integrate research in the field since 1969 when Justin Joffe wrote *Prenatal Determinants of Behaviour* Joffe's book became a standard reference for many years particularly for the experimental design of animal investigations It has become increasingly evident however that some aspects of design once considered inviolate have changed and become part of a more flexible approach In current research the emphasis is on a set of prioritized but focused experimental questions rather than on designs which factor all possible variables into every experiment Also new design considerations have arisen over the last 15 years not appreciated when Joffe wrote Moreover the sheer volume of new

experimental evidence generated since 1969 has increased the content of the field several fold These considerations made a new review and critical appraisal of the field compelling The book is divided into four major sections Part I contains four chapters These chapters provide discussions of the general principles of behavioral teratogenesis and information on the historical governmental and methodological contexts in which the field operates The purpose of these chapters is to provide the framework within which the review chapters in the remainder of the book may best be understood

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

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Table of Contents Spontaneous Alternation Behavior

1. Understanding the eBook Spontaneous Alternation Behavior
 - The Rise of Digital Reading Spontaneous Alternation Behavior
 - Advantages of eBooks Over Traditional Books
2. Identifying Spontaneous Alternation Behavior
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Spontaneous Alternation Behavior
 - User-Friendly Interface

4. Exploring eBook Recommendations from Spontaneous Alternation Behavior
 - Personalized Recommendations
 - Spontaneous Alternation Behavior User Reviews and Ratings
 - Spontaneous Alternation Behavior and Bestseller Lists
5. Accessing Spontaneous Alternation Behavior Free and Paid eBooks
 - Spontaneous Alternation Behavior Public Domain eBooks
 - Spontaneous Alternation Behavior eBook Subscription Services
 - Spontaneous Alternation Behavior Budget-Friendly Options
6. Navigating Spontaneous Alternation Behavior eBook Formats
 - ePub, PDF, MOBI, and More
 - Spontaneous Alternation Behavior Compatibility with Devices
 - Spontaneous Alternation Behavior Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Spontaneous Alternation Behavior
 - Highlighting and Note-Taking Spontaneous Alternation Behavior
 - Interactive Elements Spontaneous Alternation Behavior
8. Staying Engaged with Spontaneous Alternation Behavior
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Spontaneous Alternation Behavior
9. Balancing eBooks and Physical Books Spontaneous Alternation Behavior
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Spontaneous Alternation Behavior
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Spontaneous Alternation Behavior
 - Setting Reading Goals Spontaneous Alternation Behavior
 - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Spontaneous Alternation Behavior
 - Fact-Checking eBook Content of Spontaneous Alternation Behavior
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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