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Introduction to Molar Behavior Analysis

Introducción al análisis molar de la conducta

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Abstract

Traditional molecular mechanics relied on discrete events and contiguity to try to explain behavior in terms of immediate causes. The molecular concepts of reflex and association eventually proved inadequate and were replaced by ones less reliant on immediate causes. Thorndike's law of effect represents a step in this direction, because it emphasized a response's past consequences, a factor that transcended momentary events. Skinner further departed from reliance on contiguity by introducing the ideas of operant behavior and stimulus control. Instead of S-R connection, he proposed that the unit of behavior is a population of responses and that a discriminative stimulus defines the context in which this population occurs. He proposed to explain novel and complex behavior by a history of selection by consequences, in analogy to biological evolution. For a dependent variable, he proposed response rate, a molar variable in the sense that it can be measured only over some interval of time. Molar behavior analysis takes the further step of defining environmental variables as similarly molar. Behavior is thought of as under the control of relations that extend through time. Together, behavior and environment constitute a feedback system in which behavior flowing from the organism is fed back by the environment in a flow of consequences which affects the flow of behavior. Such a view has more explanatory power that contiguity-based views and opens the possibility of a quantitative science. Further extensions move entirely away from discrete responses to considering behavior as composed of patterns of activities that extend through time. Such patterns tend to persist, but may be changed by consequences. This conception frees molar behavior analysis from dependence on immediate causes and establishes it as an evolutionary science.

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Key words: molar versus molecular analysis, response-reinforcer rates, correlation, functional units.

Resumen

La mecánica molecular tradicional depende de eventos discretos y contigüidad para explicar la conducta en términos de causas inmediatas. Los conceptos moleculares de reflejo y asociación demostraron no ser adecuados y fueron reemplazados por conceptos que no dependen de causas inmediatas. La ley del efecto de Thorndike representó un paso en esta dirección debido a que enfatizó las consecuencias pasadas de las respuestas, trascendiendo así los eventos momentáneos. Skinner se alejó todavía más del concepto de contigüidad al introducir las ideas de conducta operante y control de estímulos. En lugar de una conexión S-R, Skinner propuso que la unidad de la conducta consiste de un conjunto de respuestas y que el estímulo discriminativo define el contexto en el cual dicho conjunto ocurre. Propuso, de manera análoga a la evolución biológica, la explicación de conducta nueva y compleja por una historia basada en selección por consecuencias. Skinner propuso utilizar una variable molar, la tasa de respuesta, como variable dependiente. Se considera a la tasa de respuesta una variable molar debido a que solamente puede medirse en intervalos de tiempo. El análisis molar de la conducta llevó el razonamiento de Skinner un paso adelante al definir al medio ambiente también en términos molares. En la perspectiva molar, la conducta es controlada por relaciones extendidas en el tiempo. La conducta y el medio ambiente constituyen un sistema de retroalimentación en el cual la conducta que fluye del organismo es alimentada al medio ambiente, el cual a su vez regresa al organismo un flujo continuo de consecuencias que controlan la conducta. La visión molar tiene un mayor poder explicativo que la visión basada en la contigüidad, además abre la posibilidad de establecer una ciencia cuantitativa. Desarrollos posteriores de la visión molar se alejan de respuestas discretas y se aproximan a una visión en la cual la conducta es conceptualizada como compuesta por patrones de actividades que se extienden en el tiempo. Esta clase de patrones tienden a persistir, sin embargo pueden ser modificados por sus consecuencias. Esta conceptualización libera al análisis conductual molar de su dependencia de las causas inmediatas y lo establece como una ciencia evolutiva.

Palabras clave: análisis molar versus análisis molecular, tasas respuesta-reforzador, correlación, unidades funcionales.

Traditional molecular mechanics

Psychologists of the nineteenth century tried to turn the study of mind and behavior into a science by pursuing a mechanical model. They reasoned that if they could identify basic units and specify the laws by which these units combined to form more complex wholes, they might create explanations of mental and behavioral phenomena that would be scientifically acceptable because they would omit any mysterious inner soul, but instead would be purely mechanical. In the study of mental phenomena, this thinking gave rise to associationism. In the study of behavioral phenomena, it gave rise to reflexology. Taken together, as a style of thinking, associationism and reflexology are called connectionism. The key ideas in connectionism are that mental life and behavior can be divided into discrete events and that these events can be explained by immediate causes.

Discrete Events

A discrete event is an event with a distinct beginning and end. It is either present or not, and typically it is treated as either having no duration or a fixed duration. In associationism, discrete events were ideas and sensations. In reflexology, they were stimuli and responses.

The word stimulus is Latin for "goad", and the word response is synonymous with "reply". The earliest conception of the reflex gave it its name: the notion that the energy in the stimulus was reflected by the spinal cord into a response in the muscles. Attempts to explain learning and complex behavior held that new connections could be formed between stimuli and responses. Although creatures came into the world with just a handful of basic reflexes, these provided a base for new stimuli, such as words (for humans), to connect to old and new responses, such as utterances.

The key principle for explaining these developments, made possible by the momentary nature of discrete events, was contiguity. When two events occur simultaneously or one right after the other, they are said to be contiguous.

Contiguity was considered to explain learning. If two ideas occurred repeatedly in contiguity, then one idea would call up the other because a connection would have formed between them. Similarly, if a stimulus and a response occurred in contiguity, a connection was thought to bind them, with the result that when the stimulus recurred it would call forth the response. Learning was considered to consist of the formation of such connections, principally as a result of contiguous pairings.

Immediate Causes

In analogy to a machine, each movement of which derives from an immediately prior movement, the mechanical model seeks to explain the occurrence of each idea or each response as the result of an immediately prior event. As the turning of an axle leads to the turning of a wheel, so the stimulus produces the response. Such a conception, in which every response that occurs is explained by an immediately preceding stimulus, is often called "S-R psychology." As we shall see, this was the notion that Skinner emphatically rejected.

The trouble with the mechanical model lies in its requirement of immediate causes. For a science of behavior, this is both unwieldy and implausible. Skinner pointed out its unwieldiness by arguing that if we tried to find a stimulus for every response, a science of behavior would just accumulate great long lists of stimulus-response pairs. Such a science would be dull and pretty useless for understanding behavior if it offered no general principles beyond contiguity.

The implausibility of S-R psychology arises from the absence of any observable immediate cause, any stimulus, preceding most responses. When a rat presses a lever or a person hunts for a parking space, there is no obvious stimulus calling out each behavioral event. Psychologists of the nineteenth century who thought to establish psychology as a science by applying the mechanical model failed to consider other possibilities equally acceptable scientifically, but more versatile and more plausible. There were some exceptions, such as the Gestalt psychologists, who tried to explain mental phenomena as wholes, not dissected into discrete events, and explainable, but not by the crude cause-effect explanations of the mechanical model. In the study of behavior, a more dynamic view began to develop in the twentieth century with the recognition of the importance of consequences to behavior— that is, with the introduction of the law of effect.

Thorndike's Law of Effect

Thorndike suggested that behavior might often be understood to depend on pleasant and unpleasant consequences— he called them satisfiers and annoyers. When a response leads to something satisfying, like food, that response will tend to recur, and when a response leads to something annoying, like electric shock, that response will tend to disappear; that was Thorndike's law of effect.

Thorndike still cast his idea about consequences in terms of stimulus-response bonds. He thought that satisfiers and annoyers worked by strengthening and weakening these connections. He studied cats' escapes from puzzle boxes that required a particular response to open a door, and argued that getting out of the box was a satisfier that strengthened the response's connection with the stimuli in the box. When the cat finally operated the catch that opened the door, the satisfier insured that the next time the cat was put in the box, the response would tend to repeat, and the more this process went on, the more the response would tend to repeat.

Thorndike still thought in terms of discrete events and contiguity. In his formulation of the law of effect, stimulus, response, satisfier, and annoyer all were discrete events, and the crucial relations among them were temporal contiguities. The response bonded to the stimulus because it was contiguous with it; the satisfier or annoyer strengthened the bond because it was contiguous with the stimulus and response.

Subtly, however, the law of effect represented a departure from the earlier mechanistic thinking, because it changed the explanatory role of time. A consequence has to act backward in time, because it strengthens the response that precedes it. Explaining a response required looking back at its previous occurrences and their consequences. Such thinking led naturally to Skinner's explanations of behavior based on history of reinforcement.

Skinner's Innovations

Skinner argued that the S-R model of behavior embodied in the reflex was a poor model of the behavior of intact complex organisms such as birds and mammals. Most of their responses occurred without any obvious stimulus to provoke them. A dog scratching an itch is different from a dog hunting. Whereas the itch might seem like a stimulus provoking scratching, the varied and prolonged behavior of a dog on the hunt allows no easy identification of stimuli. A great deal of sniffing and searching may precede the picking up of a scent or sighting of a quarry. The same would be true of a person scratching or hunting. Whether we are observing a dog or a person, it is hard to see any contiguous stimulus that might provoke each act of sniffing and searching.

Operant Behavior and Reinforcement

Such behavior, which refused to conform to the S-R model, Skinner called operant behavior. He considered it to be under the control of a stimulus context, which he called a discriminative stimulus, and consequences, which he called reinforcers and aversive stimuli, in place of Thorndike's satisfiers and annoyers.

Although superficially Skinner's conception of operant behavior resembled Thorndike's stimulus-response-consequence model, there were fundamental differences. In the connectionist view, breaking behavior up into reflexes, a response was taken to be a particular movement or sequence of movements, specified by the muscular contractions involved. Rejecting any such mechanistic connectionist model, Skinner conceived of an operant response (or simply an operant) as a class of movements defined by their all performing the same operation on the environment. The connectionist's response became for Skinner a specific instance belonging to a category of such instances. His first example was the lever press: Regardless of the muscles a rat might use to press a lever, all that mattered was that the movements resulted in depression of the lever. The rat might press with the left paw, right paw, or nose— each depression of the lever counted as an instance of the operant.

Functional Units

In rejecting the S-R view, which may be called structural, both because it defined responses in terms of the structure of the body and because it held complex behavioral units to be built up out of many simple responses, Skinner may be said to have adopted a view that is functional, because it focuses on what an operant accomplishes— its effect, its use, or its function. The shift in definition from muscle movements to functional class did more than rationalize the use of switches to record behavior and automated equipment to run experiments (although it did both of these); it made possible a shift from mechanical explanations of behavior to selectionist explanations resembling those of evolutionary theory.

Conceiving of behavior as grouped into functional units gave a central place to behavioral variation. In the S-R view, there was no role for variation in the response; it had to be ignored or explained away. In the functional view, variation is an essential property of behavior and the field on which consequences act to shape behavior.

A functional category of behavior is analogous to a species. Within each, there are many different forms (phenotypes). Variation in the consequences of these different forms, in reproductive success or reinforcement, can either maintain the composition of the functional class or cause it to change over time. When a change in composition is large enough, it results in a new species or new behavioral category.

Viewing behavior as composed of functional categories had two implications that Skinner emphasized. First, his explanations of novel and complex behavior openly relied on a history of selection by consequences, in analogy to evolutionary explanations of novel and complex species. Historical explanations offer an alternative to the mechanistic explanations that characterized early psychology in its efforts to be more scientific. Skinner pointed out that, although mechanisms and immediate causes underlying behavior might be found eventually in the nervous system, such discoveries would still never remove the need to understand the origins of behavior in a history of shaping by consequences. Second, since no discrete stimuli preceded operant responses, the standard measure of the reflex, the latency from stimulus onset to response, had to be replaced with a measure assuming no discrete stimuli— response rate. Skinner proposed that the standard measure of an operant should be the rate of occurrence of instances of the class. In the study of lever-pressing, for example, this would mean counting the number of lever presses over a sufficient period of time and dividing number by time.

Stimulus Control

Viewing the response as a functional class, Skinner had no use for the notion of a stimulus-response bond; there was no sense in which a stimulus could be mechanically bonded to a category of indefinite structure, defined only by its effects. Instead, he thought of the discriminative stimulus as controlling the rate of a behavioral class or operant. If lever-presses produced food in the presence of a light and not in its absence, then the light would come to control a high rate of lever-pressing.

Skinner thought of discriminative stimuli as modulating the frequency or likelihood of certain types of behavior, depending upon past consequences. If a type of behavior produced favorable consequences (reinforcement) in the presence of a stimulus, then that type of behavior would be likely in the presence of that stimulus. One could say that the notion of stimulus control is "looser" than the idea of a S-R bond. Although such a conclusion is correct, the larger conceptual change consists of a move from a mechanistic view to a dynamic view of behavior.

The Molar View

Skinner's shift to measuring response rate represented a move away from the earlier mechanical accounts that depended on discrete events and contiguity. Since a response rate cannot be measured at a moment in time, it neither constitutes a discrete event nor is it contiguous with any discrete event. Since response rate requires an aggregate of time and responses, it is a molar variable.

Although Skinner made the step to a molar behavioral variable, he never took the next logical step of characterizing the environment also in molar terms. For him, a consequence— a reinforcer or aversive stimulus— derived its power over the frequency of a response by closely following— being contiguous with— particular instances of the response class. His conception of reinforcement remained the same as Thorndike's: contiguity between response and consequence.

The Trouble with Contiguity

There are at least three weaknesses of a contiguity-based notion of consequences: (1) it can be demonstrated to be false empirically, (2) it engenders unsatisfactory explanations based on hypothetical constructs, and (3) it fails to explain some of the most basic effects of schedules of reinforcement.

It is untrue that the acquisition of behavior requires that responses be closely contiguous with reinforcers. K. A. Lattal and his associates, for example, found that naive rats came to press a lever when reinforcers followed presses even at intervals of 30 seconds. In my own research, i have found that pigeons continue to peck a key even if the delays between pecks and reinforcers are long and highly variable.

Even a little reflection shows that the behavior of humans requires no close contiguity either for acquisition or maintenance. Acquisition may be facilitated by arranging immediate reinforcement, but normal children learn to read in schools where reinforcement is casual at best. An office worker need not receive payment after every task completed, or even at the end of every day. Payment once a week, every two weeks, or even once a month will do. Yet this payment is crucial, for without it, the office worker would quit the job. When I stop my car at a red light, no contiguous reinforcer appears to strengthen the behavior, but a plausible explanation is near at hand in the past avoidance of disasters like collisions and traffic tickets. We demonstrate every day that human behavior responds to long-term consequences, as, for example, when we save money instead of immediately spending it or forego a tasty, high-calorie dessert for the sake of health and appearance.

When attempts are made to explain avoidance and long-term reinforcement with notions of contiguous consequences, the results are unsatisfactory. For example, the reason i stop at a red light is said to be that the light engenders fear in me and stopping reduces that fear, the fear reduction being a form of negative reinforcement of stopping. This is the so-called two-factor theory of avoidance. There is little evidence that i am afraid or a dog in a shuttle box is afraid at the signal to stop or jump. The fear, nevertheless, has to be postulated for the sake of imagining a contiguous reinforcer, fear reduction. A plausible explanation that requires no imaginary fear points to the molar relation between the behavior and the lowered likelihood of unfavorable consequences. Similarly, it is unsatisfactory to imagine a reinforcer like "feeling good" to explain why a person turns down a piece of chocolate cake. As with the inner fear of the contiguity-based account of avoidance, it remains unclear how one could determine whether someone feels good or not, and it seems implausible that someone who repeatedly declines high-calorie foods has to feel good on any of these occasions.

Even with such hypothetical fears and feelings, a contiguity-based theory fails to explain even the most elementary phenomena, such as the maintenance of moderate response rates by interval schedules of reinforcement and of high response rates by ratio schedules. The attempted explanation usually offered points to the likelihood that long interresponse times (IRTs) tend to have a higher probability of being followed by reinforcement on interval schedules but not on ratio schedules. Such an account fails in two ways. First, it offers no explanation as to why response rates on ratio schedules should be as high as they are. Although a ratio schedule reinforces a one-hour IRT with the same probability as a one-second IRT, IRTs of a second or less predominate. Without some additional factor, there is no reason to expect response rate to be so extreme. Second, since on an interval schedule, the longer the pause the higher the probability of reinforcement, the account suggests that IRTs should grow longer and longer, until the probability of reinforcement for a response approaches 1.0. Of course, no such lengthening occurs; response rates on interval schedules remain fairly high, and the contiguity-based view offers no reason why they should be so high.

The Correlation-Based Law of Effect

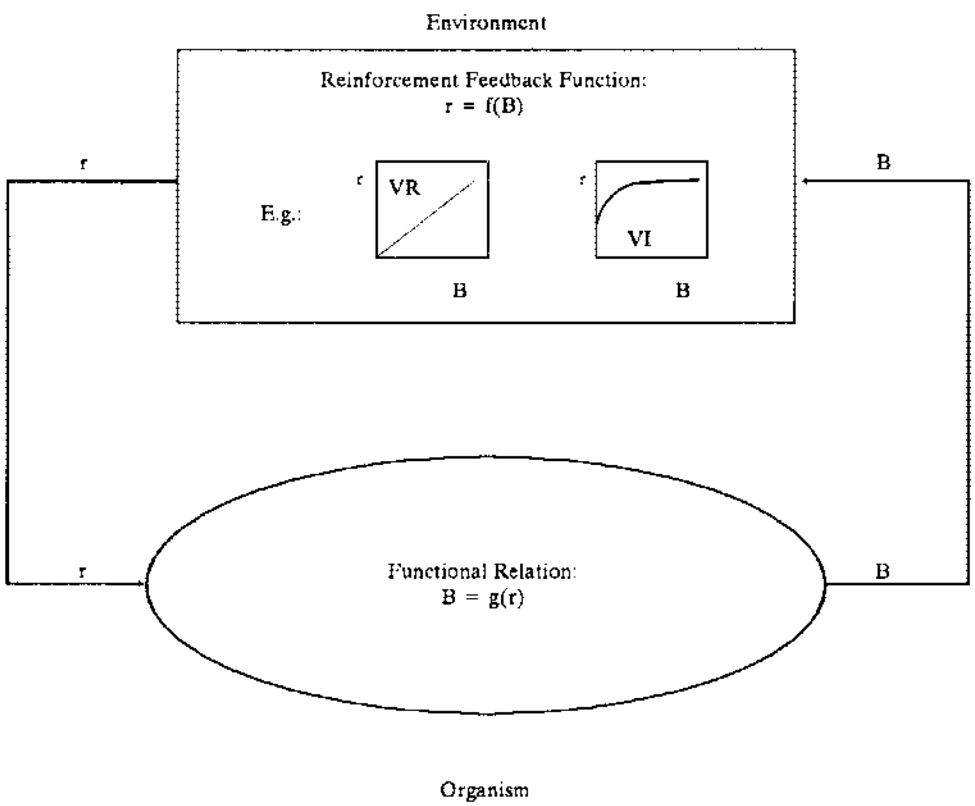
A more adequate explanation is near at hand, if we allow ourselves to consider relations that extend beyond moments in time— molar relations. On a ratio schedule, the higher the response rate the higher the rate of reinforcement. Differential reinforcement of high rates (but not differential reinforcement of short IRTs, which is absent) insures that response rates on a ratio schedule, when they are maintained, will be as high as possible. On an interval schedule, although the upper limit to rate of reinforcement (e.g., one per minute on a variable-interval 1-minute schedule) renders rate of reinforcement independent of response rate at high response rates, when response rate gets low rate of reinforcement declines, even on an interval schedule (e.g., one response per hour will produce about one reinforcer per hour on a variable-interval 1-minute schedule). Thus, even on interval schedules, differential reinforcement of response rate tends to increase responding, but only at low response rates.

Figure 1 diagrams the organism and environment as a feedback system. On the environment side (rectangle), we have arrangements (natural or contrived) that prescribe consequences (labeled r for reinforcement) for behavior. At the molar level, r stands for rate of reinforcement, and the environment imposes a dependency, the feedback function, f, of rate of reinforcement on response rate, B. Two examples are shown, the direct proportionality of a variable-ratio (VR) schedule and the curve with its upper limit of a variable-interval (VI) schedule.

The dependence of rate of reinforcement on response rate enforced by a schedule— the feedback function— tells nothing about what the organism brings to the situation, the dependence of response rate on rate of reinforcement— what Skinner called a functional relation. This appears in Figure 1 as an ellipse. The organism functions in such a way that response rate (B) depends on rate of reinforcement (r) according to a functional relation g. The arrows symbolize that a feedback function and a functional relation together constitute a closed feedback system, the organism-environment feedback system. Responding affects rate of reinforcement via the feedback function, and reinforcement affects responding via the functional relation.

The idea of an organism-environment feedback system constitutes both a theory and a research program. We expect a feedback system to show certain kinds of dynamic properties; for example, it should sometimes come to equilibrium, other times go to extremes, and other times oscillate. If it is the sort to come to equilibrium, it should return to equilibrium when disturbed. First, it should be possible to describe behavioral phenomena in such terms. Second, it should be possible to explain the patterns observed by specifying feedback functions and functional relations. Feedback functions may be deduced (e.g., rate of reinforcement must be directly proportional to response rate on a ratio schedule) and then verified empirically. Once the feedback function is specified, the functional relation can be derived from change in performance with change in the feedback function.

Figura 1



The organism and environment together constitute a feedback system. The environment arranges feedback functions that provide consequences (r; e.g., rate of reinforcement) for behavior (B; e.g., response rate); the line for a VR schedule and the curve for a VI schedule are examples. The organism brings in functional relations that produce behavior as output from consequences as input.

Molar Stimulus Control

The idea of the organism-environment feedback system allows also a more refined idea of context, because each feedback system occurs in a particular context. Different contexts contain different feedback functions and, possibly, different functional relations. The molar analog to Skinner's three-term contingency of discriminative stimulus, response, and reinforcer is the combination of discriminative stimulus, feedback function, and functional relation, which may be called the behavioral situation. Creatures may be conceived to move from one behavioral situation to the next, sometimes independently of their own behavior, as night follows day, and sometimes as a result of their own behavior, which would mean that one situation includes a feedback function controlling transition into the next situation, as in a chain schedule.

The molar view also changes the concept of discriminative stimulus. Skinner regarded stimuli, as well as responses, as functional classes. Regarding the stimulus as a class means recognizing that each specific instance of the stimulus differs from every other. This is relatively obvious with stimulus classes like person or chair, because no two persons and no two chairs are exactly alike, even if we treat them alike. It is true also, however, of stimuli considered "simple," like a red keylight, because the light fluctuates in intensity and comes on in different relations to the pigeon and the pigeon's behavior on different occasions. On one occasion, the pigeon may be standing near it, on another far from it. On one occasion, the pigeon may have just pecked a key, on another, it may have just pecked the floor. Whether simple or complex, a stimulus consists of a class of diverse instances.

As with the concept of response, Skinner thought of the stimulus class as defined by its function. Regardless of any formal or structural definitions, the stimulus class is defined by whatever attributes are necessary for stimulus control over the behavior. For example, in an experiment by George Reynolds, pigeons were trained to peck at a white triangle on a red background and not to peck at a white circle on a green background. When presented with the shapes and backgrounds separately, one pigeon pecked at the white triangle but not the red background, and one pigeon pecked at the red background but not at the white triangle. Most people have difficulty picking out the functional stimulus classes that control their own behavior; it often takes a therapist to point to a class like "women who remind you of your mother."

The molar view further expands the notion of stimulus to allow it to extend through time. For example, when a pigeon is trained to match to sample, a sample is presented (say, a red or green key), and then some time later a choice is offered between two stimuli, one of which is the same as the sample (say, a red and a green key). The discriminative stimulus for pecking the left key is something like "red sample plus red on the left." Part of the stimulus occurred at an earlier time. If you make an appointment on Monday to meet a friend on Friday, part of stimulus making it likely you will go to the meeting spot on Friday occurred on Monday. Present circumstances are often insufficient to specify what behavior is likely. The sight of a friend may control your behavior, but exactly how you respond may depend on what happened the last time you were together, whether you argued or got along. Under such circumstances the mentalist or the theorist committed to discrete stimuli resorts to notions like memory to try to keep all stimuli contiguous with the behavior controlled; the sight of the friend is combined with the memory of the argument you had last week; the red key on the left is combined with the memory of the red sample. The "memory" is invented just to maintain contiguity. The molar view, because it allows environment and behavior to be viewed over spans of time, allows one simply to specify the stimulus as a combination of several events at different times without having to resort to hypothetical memories.

Hypothetical Constructs Versus Quantitative Science

The view presented here points the way to a quantitative science free from vague hypothetical constructs, such as fear and its favorable counterpart, conditioned value. Skinner replaced the reflex with the operant because no obvious stimulus could be observed preceding each response; to insist on a reflex model meant inventing hypothetical stimuli. Similarly, to insist on immediate consequences following responses means inventing hypothetical reinforcers and punishers.

On examination, these hypothetical constructs turn out to be nothing but surrogates for molar environmental variables. A stimulus becomes fearful, for example, because it is frequently paired with electric shock. The hypothetical fear stands as a surrogate for the frequency of electric shock. This is not to say that creatures are never afraid; it is only to disparage the idea of an inner hypothetical fear as an explanation of behavior. Similarly, in the theory that a discriminative stimulus functions as a conditioned reinforcer because it has acquired conditioned value, the conditioned value (conditioned pleasure?) stands as a surrogate for the aggregate of past reinforcement that occurred in its presence; it is a surrogate for rate of reinforcement. Since more recent reinforcers have more effect on behavior than ones longer-ago, computation of rate of reinforcement may require that recent reinforcers carry heavier weight than older ones. The concept of short-term memory (a hypothetical construct) stands as a surrogate for this required variation in weighting.

The molar view offers two obvious advantages. It allows the experimental analysis of behavior to be quantitative, and it avoids hypothetical constructs, such as make-believe reinforcers, punishers, and memories. There is at least one other advantage: It affords a plausible account of complex behavioral patterns.

Rachlin's Molar Behaviorism

Although Skinner rejected the reflex model, conceived of operant behavior, and advocated molar response rate as the measure of behavior, his failure to depart from a contiguity-based conception of reinforcement confined him to conceiving of behavior as broken into discrete responses, a view that accords poorly with the coherent and extended nature of behavioral patterns that occur naturally. When a robin hunts for worms in an open field, it moves and stops, moves and stops, and occasionally grabs a worm. It is hard to see how each hop or even each sequence of moving and stopping should be taken as a discrete unit or how the payoffs for its efforts apply to the pattern in some piecemeal way. As the teller in a bank services customers, it seems artificial to try to break up the patterns of the different transactions— deposits, withdrawals, robberies— into smaller discrete events. When two people are having a conversation, where would the discrete events be? Syllables, words, sentences? Even standard operant responses fail to occur exactly as discrete events. Both lever-presses and key-pecks appear to occur in clumps, rarely as isolated events, and they appear to occur rhythmically, as well.

A possible alternative would be to think of behavior as divided among activities. A robin hunts worms for a while, feeds its young for a while, patrols its territory for a while, and so on. In a conversation, one person talks for a while, then the other talks for a while, and so on. Since each bout of an activity lasts a while, the measure of an activity would be the time spent in it; there would be no need to break each activity up artificially into discrete events. Each activity has its consequences, and the consequences determine how time is divided among the activities, but the consequences need follow no particular discrete event in an activity. Both activities and consequences are conceived of as extended in time, rather than as discrete events. For example, a researcher could examine the relationship between work and salary without dividing it up into bits of work and bits of salary.

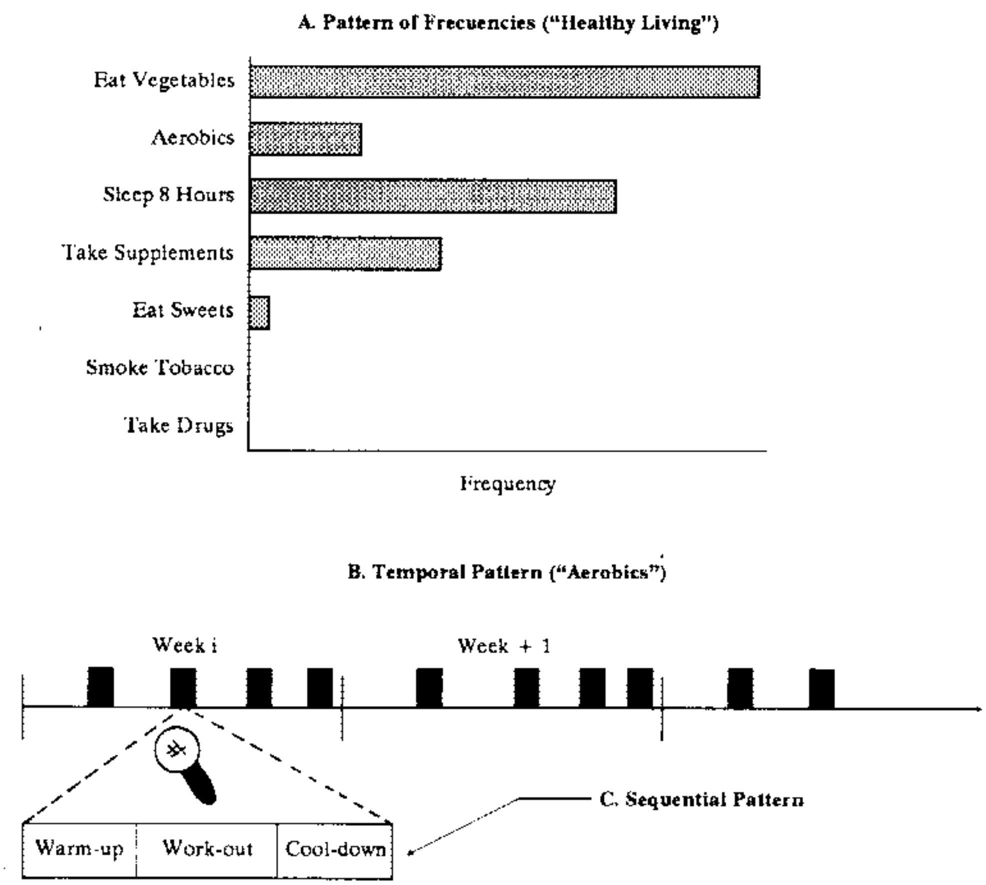
Rachlin took this line of reasoning a step further by pointing out that any activity is typically composed of several other activities. A bank teller's servicing of customers is composed of withdrawing money, depositing money, acquiescing to robberies, and so on. A robin's hunting consists of hopping, listening, tugging on worms, and so on.

No matter whether we speak generally or specifically, Rachlin argues, it is still true that activities are composed of other activities. If living a good life is an activity, it is composed of activities like maintaining health, taking care of responsibilities, and attending to spiritual needs. Likewise, the activity of taking care of responsibilities is composed of attending to one's family and working. Attending to one's family is composed of caring for one's children and relating to one's spouse. And so on.

Since each activity is composed of other activities, one may further say that each activity consists of a pattern of other activities. There is a whole pattern to the activity of attending to one's family; it should include both caring for one's children and relating to one's spouse. One individual's pattern might be to spend equal amounts of time caring for children and relating to his or her spouse. Another's might be to spend a little time with the children and much more with spouse.

Figure 2 illustrates some meanings of patterning in behavior. The top graph shows a hypothetical pattern of activities over a period of time. If the pattern of frequencies remains about the same from one time period to another, we say there is a stable pattern to the behavior. Let us say that Liz is trying to live a healthy life. The graph shows that she eats vegetables frequently, engages in aerobic exercise, often sleeps 8 hours a night, and takes vitamin and mineral supplements. She occasionally eats sweets, but rarely, and she never smokes or takes drugs. The middle part of Figure 2 examines another meaning of pattern, the temporal pattern of an activity (aerobics here). Since Liz works on Mondays, Wednesdays, and Fridays, she exercises on Tuesdays, Thursdays, Saturdays, and Sundays. Since she does this regularly, there is a stable temporal pattern to the activity of aerobics, week after week. The bottom part of Figure 2 illustrates still another type of pattern in behavior, a sequential pattern. If we take any one session of aerobics and examine it in more detail (with a magnifying glass, so to speak), we find it is composed of three separate activities, warm-up, work-out, and cool-down, always in that order. The stable order of the activities represents a stable sequential pattern.

Figura 2



Behavioral patterns. A: a hypothetical pattern, "Healthy Living," in which various activities occur at different frequencies. Each bar shows the frequency of an activity. B: a hypothetical temporal pattern for one activity, "Aerobics," in Part A. Time travels from left to right, as indicated by the arrow at the right. Each rectangle represents one session of aerobics. The frequency (four/week) and the spacing are stable week after week. C: One session of aerobics is magnified to reveal a more detailed pattern, this time sequential. The three component activities of aerobics, warm-up, work-out, and cool-down, always occur in that order.

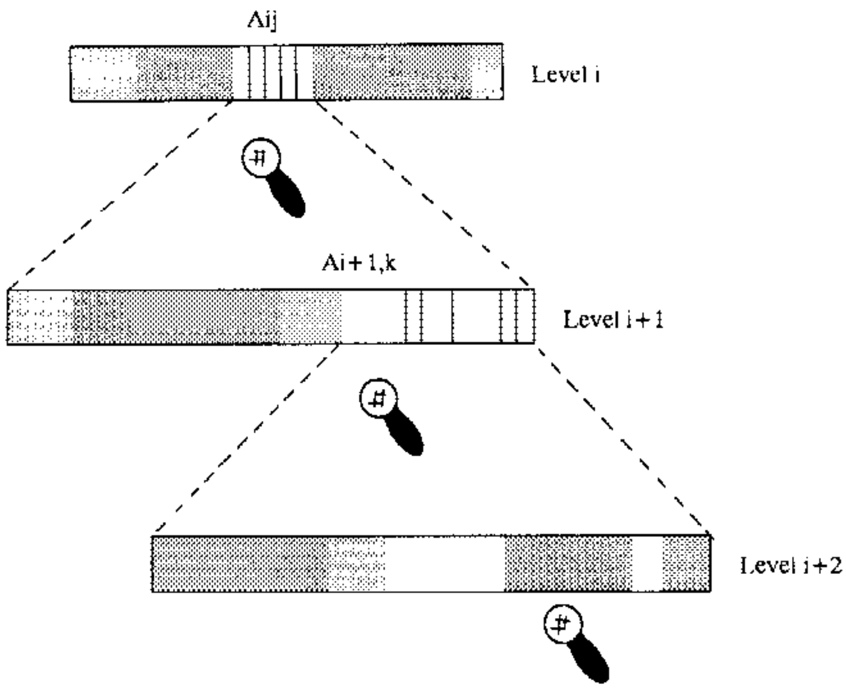
Figure 3 illustrates Rachlin's idea of activities always being composed of other activities, as suggested by the bottom portion of Figure 2. We may speak at different levels of generality; Figure 3 starts with an arbitrary Level i. Perhaps there is a most-general level; it would be just "living." According to Rachlin, one's most general pattern, taking in one's life as a whole, would be called by Aristotle one's soul. At Level i, we recognize several activities. Their frequencies and perhaps their temporal pattern or sequential pattern are shown by means of differently shaded rectangles. We can take any one of the activities ($A_{i,j}$) and examine it in more detail, as with aerobics in the bottom part of Figure 2; as in Figure 2, the icon of the magnifying glass symbolizes moving to a level of greater detail. At Level i1, activity $A_{i,j}$ is composed of several other activities, and if we pick any one of those activities ($A_{i+1,k}$) and look in more detail, we see it too is composed of several activities. And so on, into more and more detail. At each level there are several activities that fit together into a larger pattern. The level on which we discuss the mix of activities depends on our aims, whether to modify them for practical reasons or whether to study them for theoretical reasons.

Rachlin argues that, in a sense, the larger pattern explains the activities it includes. One could say, for example, that a person cares for his or her children because this is part of attending to one's family, and that one attends to one's family because this is part of taking care of responsibilities. This is what Aristotle called an explanation in terms of final causes.

Explanations in terms of final causes go alongside of explanations in terms of prior events— what Aristotle called explanation in terms of efficient causes. To fully explain a person's pattern of attending to family, for example, we study both the patterns into which that activity fits and also its origins in the person's history of reinforcement and genetic endowment. Different individuals behave differently because of different histories and different genetic inheritance. Different species behave differently for similar sorts of reasons, because of different evolutionary histories and different genetic endowments. This type of explanation is common both to evolutionary biology and operant psychology.

In molar behaviorism we find the ultimate departure from the mechanistic reflex model of the nineteenth century. Not only is behavior measured in molar terms, not only are consequences conceived in molar terms, but discrete events are transcended altogether by considering extended patterns of activity through time.

Figura 3



Rachlin's view that every activity is composed of other activities. At any level of analysis i, a pattern of several activities may be seen. The differently shaded rectangles represent different activities; their widths represent their frequencies. The pattern may be a pattern of frequencies (Figure 2A), a temporal pattern (Figure 2B), or a sequential pattern (Figure 2C). Any one activity Ai,j, may be magnified, or analyzed at a higher level of detail, Level i+1. It is divided into several activities at Level i+1, and again any one of those activities Ai+1,k may be magnified, or analyzed at a yet higher level of detail, Level i+2, where it is seen to be composed of several activities, and so on.

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