

## CHAPTER 4

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## CHAPTER 4

# Historical Evolution of the Field of Conditioning and Learning

### I. Evolution of Primitive Explanations for Action

#### A. Primitive

Action Via God's Will				
Non-living	Living			
Rolling Rocks	Swaying trees	slithering worm	Jumping chimps	Talking humans

The very earliest notions of nature suggested that all things were either living or non-living and that the activities of all things were due to god's specific will.

#### B. Thales

Action Via Internal Will (Animism)				
Non-living	Living			
Rolling Rocks	Swaying trees	slithering worms	Jumping chimps	Talking humans

Thales (624-546 BC) broke from the primitive view. He argued that events occurred for their own reason not simply as the result of God's will. One instantiation of his perspective was that each thing had its own internal will. An alternative (and more correct) view would assert that each action was the result of the natural forces acting upon that thing.

#### C. Plato

Material World					Ideal World
Non-living	Living				
Rocks	Trees	Worms	Chimps	Human body	Human mind

Plato (427-347 BC) suggested that existence was separable into material things (a chair) and the ideal of that thing (a "Chair"). The ideal of each thing

was available in the human mind. This is the reification of dualism first started by Thales. It should be emphasized that it was Plato's opinion, rather than a fact of nature. This bears repeating. No known fact supports the view that there are two kinds of existence. Democritus, a contemporary of Plato, for example, was a monist. He considered it self-evident that there was only one kind of existence. The most likely explanation for Plato's notion of the "ideal" was in order to account for generalization or "classes" (e.g., how is it that I can go through a furniture store and label things as chairs or not chairs even though the various chairs are widely different. This is often labeled as I have an idea of "Chair" that transcends any particular chair.). In modern times, generalizations and classes are well-understood and do not require a magical cause.

#### D. Galileo

Action Via Natural World	Action Via Internal Will				
	Material World				Ideal World
Non-living	Living				
Rolling rocks	Swaying trees	Slithering worms	Jumping chimps	Talking humans	Thinking human

Galileo Galilee (1564-1642) realized that: (1) some things in nature could be understood, (2) the way to understand them was by observing them (do experiments), and (3) that non-living things in nature behaved according to natural causes acting upon them and those laws could be discovered and understood. This latter realization was prompted by the finding that the activities of nonliving things were completely describable, predictable, controllable, synthesizable and could be explained.

#### E. Descartes

Action Via Natural World					Action Via Internal Will
Material World					Ideal World
Non-living	Living				
Rolling rocks	Swaying trees	Slithering worms	Jumping chimps	Jerking humans	Talking human

René Descartes (1596-1650) tried to develop a systematic explanation for the behavior of living things which followed Galileo's explanation of causation in

nonliving things. He suggested that almost all things follow simple natural physical laws like rocks; their cause was in the environment, they themselves were “passive.” The behavior of all animals and much human behavior were simple stimulus-response reflexes. They were caused by changes in the environment. Environmental events were REFLECTED as behaviors (therefore, the word “reflex”); these behaviors were involuntary and “mindless.” An example is a child’s mechanical bank into which you roll a coin which rolls through a channel and causes the arm to doff the hat. The enormous explanatory power of this simple mechanical input/output or “reflex” conceptualization is best appreciated by considering the many behaviors that can be predicted given nothing more than the stimulus. Given light in the eye, the pupil contracts; given meat powder in the mouth, salivation occurs, etc. The poor explanatory power of the mind is easily appreciated by considering the many reflexes which will occur in an animal when there is no possibility of mental control because the head has been cut off. Clearly, a chicken is not thinking or wanting anything while it is running around the barnyard after meeting with the chopping block. Whatever nonempirical, metaphysical, unfalsifiable claims can be made about the mind, one thing is clear: everyone agrees it’s in the head. Remove the head and you remove the mind as a possible cause of the behavior. The fact is there are many behaviors which are nothing more than reflexes.

Additionally, Descartes extended Plato’s opinion about the nature of things in order to explain the cause of human voluntary behavior. Descartes’ extension of Plato’s belief was that the nonmaterial mind caused the difficult-to-predict human behavior labeled “voluntary” or “free will.” His view was that all of nature follows natural laws except voluntary human behavior which he thought to be not lawful. Human voluntary behavior was thought to be caused by the mind, a transcendent thing which did not follow natural laws. It’s important to note that there have never been any observations which have supported this view. In all likelihood, Descartes had this view so that the then current Judeo-Christian view of heaven and hell would make sense. If all human behavior followed natural laws, then those behaviors were not consequent by heaven or hell. On the other hand, if people had free will, they could thereby be held accountable for their acts and be justly tortured in hell by an “all loving god” (theologians label the conundrum of an all loving god torturing people “the problem of evil”). Besides, people who did not support the then current church doctrine were burned alive at the stake. Descartes’ view was that animals were not accountable for their misdeeds, and neither were humans accountable for their reflexes (e.g., their hand withdrawing from a pinprick). Humans were, however, not accountable for their voluntary behavior because it was caused by the mind and the mind had free will.

Descartes’ position brilliantly codified existing, well-accepted ideas (Galileo’s empirical findings and Plato’s opinion) into a view which was acceptable to his society (and spared him a painful death). Descartes’ dualistic view, with its roots in a justification of a narrow, mistaken theological doctrine, has grown in

popularity to the point where it is seen as “common sense” or “intuitively obvious” by people in the street. Behavior is commonly thought to be the result of free choice by humans with rational powers. The common view is that reflex behavior “makes sense” or can be scientifically studied and understood, while voluntary human behavior has no cause and cannot be subjected to scientific study. Descartes was the progenitor of both the scientific study of human behavior (reflexes) and the greatest impediment to the solution of human problems (the belief in the mind).

### F. Hobbes

Action Via Natural World					
Material World					Ideal World
Non-living	Living				
Rolling rocks	Swaying trees	Slithering worms	Jumping chimps	Jerking humans	Talking human

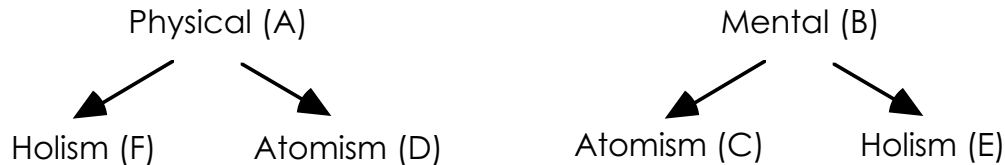
Thomas Hobbes more correctly put the history of thought together. He came to a more astute conclusion than Descartes. He argued that voluntary human behavior occurred as the result of the pursuit of pleasure and the avoidance of pain (such a system is labeled hedonism) and was as mechanistically simple as stimulus-response reflexes. The only difference was that the consequence controlled voluntary behavior, whereas the antecedent controlled reflexive behavior. He rejected Descartes’ erroneous notion that voluntary human behavior was intrinsically unpredictable and occurred for “no reason.” Hobbes rejected free will. Hobbes agreed with Descartes that voluntary human behavior had its origin in the mind, that animal behavior and human reflexes were innate and showed no learned adaptation, and that voluntary behavior was adaptive and could change as the result of experience. Note that hedonism implies a conscious internal entity that is working for a future good state while behavior analysis simply says that some consequences increase the rate of behavior and a mind, or awareness, or a future goal is irrelevant. The label good is appended to the event by behavior analysis only after the stimulus functions as a reinforcer.

## II. Evolution of the Early Explanations for Behavioral Adaptation

Following the watershed separation (not necessarily correct) in the classes of behavior (material versus mental) provided by Descartes and Hobbes, scholars followed one of two paths: Either the cause of behavior was a natural phenomenon (the physical paradigm) or it had its own reality (the mental



paradigm). Within each of these “schools,” scholars either broke things into component parts (atomism or structuralism) or took them as wholes (holism or molarism). We will follow each path in turn. (Note the outline sections in parentheses.) Keep in mind, however, that the reality of the artificial mind-body or mental-physical controversy and the evolution of the study of learning stemmed from Plato’s opinion and Descartes’ misunderstanding, rather than reality; this dichotomy is not based on the facts.



### A. Physical

The spirit of this behavioral research (i.e., experiments resulting in empirical data) was the study of a natural science. Scientists studied behavior, such as stomach secretion in response to food in the stomach or heart rate as a function of exercise. The difference in the spirit of the physical paradigm and the mental paradigm is captured in Catania’s descriptions of different human behaviors. While it might be said that “I” run or “I” jump or “I” breathe, it would never be said that “I” heartbeat. Building on that distinction, scientists in the “physical” category studied “heartbeats,” not “running” or “jumping.” Whatever is the difference in the former and latter usage (i.e., the verb class “to do” rather than the verb class “to be. “To do” verbs can have the subject “I”, whereas “to be” verbs do not), that is the difference between a monistic and a dualistic paradigm. (It is revealing to think about what it is that you think makes the difference. An informative, but not entirely pleasant thought experiment is to consider how you would describe your headless body walking down the street or scratching an irritation in some grade C horror film. Would you say, “I walked” or “it walked”? Would you say “I wanted to soothe the irritation” or would you say “it responded to the touch with a scratch”? The difference in the description with and without the head is exposed mentalism, pure and simple, established by over a thousand years of verbal usage.)

It is very important at this point to stop and realize that many behaviors, such as heartbeats **are, in fact**, obviously mindless. They occur in the total absence of a head. Even if the mind is accepted, it cannot be invoked in the headless case. The use of “I” in these cases is clearly silly. A plant will grow toward a lighted window; a frog’s leg separated from the body will move; an isolated heart will beat faster or slower; a chicken will run around; and a cat will scratch the place on its side that is irritated rather than a random spot. Each of these behaviors occurs absolutely without any mind whatsoever. The important

seminal realization is that some mechanism must control at least some behavior in the absence of a mind. The subsequent question “whether there is any mind, even with the head” -- is covered later in the chapter. (It is important at this point to review the problems with mentalism provided in Chapter X, Page Y.)

Physical behaviors were studied by scholars who came to be called scientists. The paradigmatic frame of reference for research in the area of behavior was that the stimulus energy was thought to be simply reflected back as muscular energy. Descartes had labeled it a reflex. They were the behaviors as mindless as a stone rolling down a hill, or a pushed statue of a person sliding along the floor or a toy bank doffing its hat. This list included a great many human behaviors such as pupillary contraction, knee jerks, stomach secretion, heart beats, etc. They were involuntary behaviors, and they were studied by physiologists.

1. Ultimately, these investigators could believe that only a single reality existed (monists) or that two realities existed (dualists). By definition, however, their research interests were directed exclusively to what was physically real.
2. Rocks, animals, and humans, as far as research was concerned were the same type of existence.
3. All things could be studied directly (other than human voluntary behavior for dualists).
4. Meaningful research focused exclusively on what could be sensed. Only it had acceptable reality (empirical materialists).
5. Questions were concerned with physical reality which was appropriately studied directly via empirical investigation.
6. All laws were natural laws.
7. All things had a cause (determinists).
8. All effects were preceded by their causes (mechanists).
9. Explanations were non-reductionistic (like reaction, gravity, mass, and electricity).
10. Behavioral research tended to be concerned with reflexive behavior.  
The culture accepted it as clearly having nothing to do with the mind. But a dualist could claim that reflexes were from the mind or a monist could claim that voluntary behavior had a physical cause.
11. The whole process was simply “trigger then response.”
12. e.g., Fire stimulates nerve, nerve releases animal spirits. The spirit flow into and fill muscle causing the muscle to contract.

## **B. Mental**

This very different paradigmatic approach was thought about and argued by philosophers. This paradigm was “not-necessarily-empirical” because it was dualistic (two types of existence: “empirical” as well as “soul/mind”). It implied special laws which could only be argued by philosophers; no definitive resolution

was possible. Experiments were not carried out and were not even the obvious thing to do to resolve controversy. To study reflexes (involuntary) was to miss the point, reflexes were not of the mind.

1. Voluntary behavior (only human) came from the mind.
2. Voluntary behavior was thought to be controlled by a non-physical entity which was not subject to physical law.
3. Voluntary behavior (controlled by mind) is totally and intrinsically unpredictable. It is absolutely impossible to predict because it is determined by free will.
4. Key words: mind, soul, thinking, consciousness, will. The early Greek culture had a strong belief that people had a spirit or psyche. Early Christian writings talked about life spirit. The Greek was subsequently variously mistranslated into the concepts labeled “psyche,” “mind,” and “soul” in English. This confusion was prominent in the writings of Aquinas and thereafter Descartes and the intelligencia of that time. Very often, the way “mind” is used by a speaker is identical with that same speaker’s usage of “soul” with the religious context removed.
5. Cannot study reflexes (not from mind).
6. Involuntary behavior was predictable, but not related to the mind. Its study was irrelevant to understand the mind.
7. Cannot study behaviors of others, including speech, because it was the physical stuff (not mind).
8. Must study one’s own mind (introspection). It was the only one open to an investigator. Mind could be studied by reflection upon itself.
  - a. Assume inputs reliable and transmission of information through body to the mind was orderly.
  - b. Assume mind reacts to them in repeatable way.
  - c. Assume that “you” are in the mind when “you” “think” about “things” (after all, technically it could be argued that you are in the reflex center or even a back room of a delusion not connected to the real causes of behavior (Freud’s view was a exactly this)
  - d. All people’s minds work the same, and the difference in their behavior comes from somewhere else

\* Note that this list of assumptions underlying the productive use of introspection was absolutely necessary for introspection to be valid, but the assumptions are not very likely to be true.

The spirit of this research was to study the presumably special aspects of humans, i.e., their minds. How does input affect the mind and, given that some experience is relevant, how much of an impact does it have?

What follows is a historical view of the study of the mind and of the body. The atomistic approaches (processes could be best understood by understanding their component parts) to the study of the mind and of the body are covered first

because they were the most dominant themes of scholarship. Each will be covered in turn. They are then followed by holistic approaches (processes could only be understood by considering those processes as wholes).

### **C. Mental Atomistic (Behavior as the Result of the Mind)**

Under the atomistic study of mental phenomena, there are two subdivisions: behavioral repertoire developed mostly by way of experience (ontogenetic); and secondly, behavior repertoire is developed mostly by way of phylogenetic experiences (innate). Each of these positions can be made more or less reasonable by a change in emphasis, for example “all knowledge innate versus much knowledge learned,” or “some knowledge innate versus all knowledge learned.”

#### **1. Phylogenetic Experience Most Important (Nativists) (Rationalism)**

Most knowledge is innate. Knowledge is inborn or acquired through heredity. It is not entirely clear whether the following thinkers thought that the knowledge we are born with simply "popped" in there or whether they would agree with the suggestion that the species picked it up across evolution (if they knew of the notion). In either case, they believed that it was not the result of ontogenic experience.

##### **a. Evolution of Thought**

###### **i. Plato (427-347 BC) [      ]**

Plato believed that we are born with perfect knowledge and can know that knowledge through introspection. In fact, experience corrupts our perfect knowledge. Knowledge gain is to be had by thinking about things rather than by doing empirical research. This latter opinion was the very principle which Galileo overthrew. What is surprising is how often rationalism surfaces in modern discourses.

###### **ii. Descartes (1596-1650) [      ]**

People are born with an innate understanding of the nature of God, infinity, and some geometrical axioms. Mind was intrinsically unpredictable. Strictly speaking, it is not entirely clear whether Descartes and Kant would be most comfortable categorized as atomists (because they talked about various specific ideas) or holistic. In the present framework, they are considered atomists.

###### **iii. Kant (1724-1804) [      ]**

Concepts of space and time are inborn. Innate ideas are very important, experience is not that important.

**iv. Reid (1710-1796) [     ]**

Faculty psychology

**v. Gall (1758-1828) [     ]**

Phrenology

**vi. Summary**

This line of reasoning led to the belief that a child's parents were everything. How the language someone spoke could be innate was an obvious problem with this sort of view.

## **2. Ontogenetic Experience Most Important (Empiricism) (Associationism)**

Most knowledge acquired through experience gained during the life of the individual.

**a. Evolution of Thought****i. Aristotle (384-322 BC) [     ]**

Knowledge by sensory experience and reasoning upon that information. Ideas experienced together tend to be remembered together through the principles of contiguity, similarity, and contrast.

**ii. Hobbes (1588-1679) [     ]**

Hobbes rejected the notion that voluntary behavior was due primarily to innate factors, in addition to rejecting the notion that it was unpredictable in principle. He argued that human voluntary behavior was as predictable as reflex behavior; and that it was not innate but rather was acquired via the pursuit of pleasure and the avoidance of pain (hedonism). Hobbes asserted that human behavior was not caused by reason. However, Hobbes did accept the view that voluntary behavior came from the mind.

He accepted Cartesian dualism and accepted that voluntary behavior was caused by the mind, but did not believe that it was free will. Organisms were thought to work to get pleasure and avoid pain (no morality). The mind causes body activity via hedonism, not via reason. Man as well as animals are machines. An organism's goal influences its activity through anticipation and that anticipation through experience. He was a resolute materialist: cause via physical motions, endeavor, or rg. He was an anti-rationalist, he was a hard core determinists, and was anti-teleological.

### iii. Locke (1632-1704) [     ]

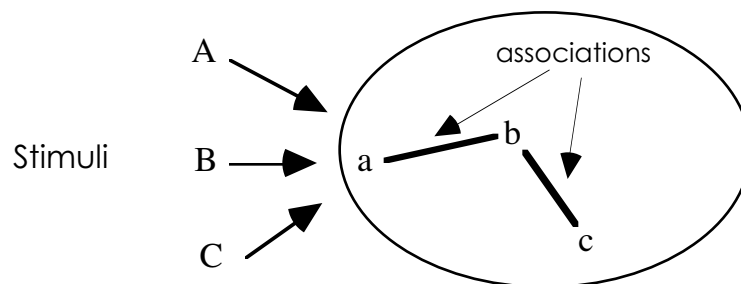
Contents of mind built up via experience and associations of small elements. Mind was passive. It was a tabula rasa or a blank slate. Locke was an associationist. He did not accept free will. There was a correspondence between experience (sensations) and memory (ideas). All ideas, no matter how complex, were the product of simple ideas which are the product of simple sensations.

### iv. Summary

This line of reasoning is developed more fully below under the section detailing how cognitions were seen as the combination of elements. In general, the philosophers who argued that much of our knowledge is gained through our ontogenetic interaction with the environment (they were labeled British Empiricists or British Associationists) believed that experience was very important and innate ideas were not all that important. We are born with blank slates and we become who we are as the result of experience. They agreed with the mind versus body distinction, and that introspection is the path to understand mind. As hard as it is to believe in modern times, the necessity of actually doing experiments to validate their speculative ideas did not occur to them.

### b. Implications of Emphasis on Ontogenetic Experience

A position which argued that the mind had nothing to start with and that everything came from sensations would then be obligated to argue that ideas were sensations grouped together. The problem with accepting that all things are via experience is the task of understanding how isolated sensations are connected together to form higher level groups like “chair.” The first questions would be, therefore, how do the sensations get into the mind and secondly, how do they get together or become grouped into the obviously complex ideas that are in the mind?



#### 1. What is a stimulus?

What is the nature of what gets into the mind?

How are we to map one to the other - the real world and the mental

world?

How does a stimulus get into the mind?

How strong does it have to be?

In what way is it changed when it becomes a mental element  
(i.e., the area of sensation/perception)?

2. Once things get into the mind, how are they assembled into larger units?

What types of connections?

How strong?

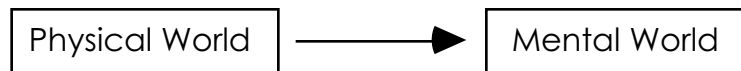
When are things connected?

For how long?

(i.e., the area of association or "learning")

### **i. Perception / Sensation**

To the people who believed the importance of ontogenic experience, it is important to study stimuli and how they get into the mind; if and how they are changed when they get there? How do sensory impulses pass from the physical world to the mental world?



### **(1) Distance / Space**

The association of sensory aspects of distance with behavioral aspects via contiguity. This is where our idea of three dimensionality comes from. The events in the natural world which caused “depth” were discovered in the Renaissance. After that, artists painted with “perspective.” This is an unusually good example of finding the “real” cause of a psychological phenomenon (i.e., the environmental causes rather than reductionistic spooks). The “stupid” animal was revealed by clever scientists (see Chapter 1).

#### **(a) Berkeley (1710) [1685-1753]**

The distance to an object causes our pupils to move together to converge. Muscle tension associated with the degree of convergence is associated with how far we have to walk before impacting the object.

## (2) Stimulus Detection

A natural question concerns the smallest stimulus which can be detected. Exactly what are the capacities of the sensory system?

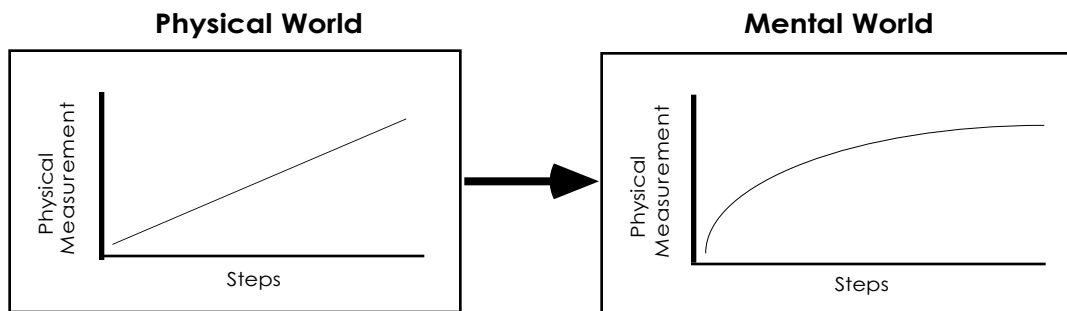
### (a) Weber (1795-1878) [ ]

There is an orderly relationship between overall physical intensity and the smallest possible detectable increment in intensity. An increase in overall intensity produces an increase in the just noticeable difference magnitude. That is, a JND is proportional to the stimulus intensity. Weber's law was strictly a functional relationship; in that sense, Weber was a behaviorist. He did not talk about how the mind caused behavior, but rather how changes in behavior were a function of changes in the environment. Weber's law is  $\Delta I / I = K$ .

For example, if we could just tell when 1 candle was added to 10; then we could just tell when 10 were added to 100, and 100 were added to 1000. We could not detect an increase if only 9 are added to 100, or 99 added to 1000. In this case, the JND for candle light would be  $1/10 = K$ ,  $K = 1/10$ , or  $K = 10\%$ .

### (b) Fechner (1801-1887) [1860]

Postulation of inner reality and its relationship to the natural world. If physical intensity steps are physically real, and if JND steps are subjectively real then we can map the relationship between physical reality (number of candles) and subjective reality (number of JNDs). (It is a log relationship.)



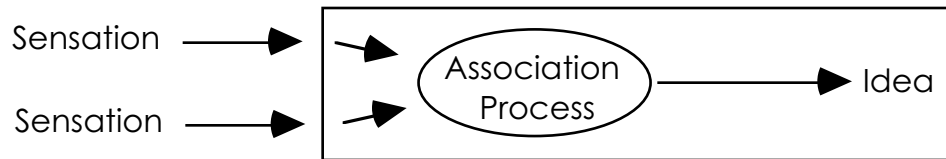
The amount of the mental sensation can then be calculated from the amount of the physical stimulus. This allowed sensation (an inner variable) to be known given an external variable (the stimulus). This is a bridge between the physical and mental world.

## ii. Atomism, and the Association of Events

The second important area of investigation to people who believed in the



ontogenic source of behavior, was how particular events combined to produce complex experiences from simple sensations. The solution was associationism. Things experienced together come to be associated.



## **(1) A “Perception” as a Combination of More Basic Elements**

### **(a) Property Specific Neural Transmission**

The doctrine of specific nerve energies is a result of one of the useful purposes of a theoretical position to guide empirical research. In this case, the paradigm asserted that a whole was made up of more basic component parts. This view was then used to make a hypothesis concerning how the nervous system worked. The result was the discovery that different neural paths are used for different aspects of a stimulus.

### **(i) Evolution of Thought**

x

x

### **((1)) Müller (1801-1858) [ ]**

Sensation is not so much the actual stimulus but rather which nerve is stimulated. Complex stimuli are broken up into various properties or aspects each carried by a specific nerve just as complex ideas are associations of elemental ideas. This only makes sense. Once an event passes the original sensory receptor (such as the eye), the stimulus (your grandmother) is no longer there. It is only electrochemical activity coding various properties of what you saw. There are no “stimulus objects” in the brain.

How many basic specific nerves are there for each sensory system?

What are the neural elements of sensation?

### **((2)) Helmholtz (1821-1894) [ ]**

Three primary colors enough for perception of all colors. Trichromatic theory of color vision. Drew heavily on associationism and argued that experience was some actual stimulus but mostly the result of associations from past experience (i.e., “perception” rather than “sensation”).

**((3)) Wever / Bray ( - )[] / ( - )[] ]**

Auditory sensation is coded.

x

x

**(2) “Cognition” as a Combination of More Basic Elements****(a) Evolution of Thought****(i) Aristotle (350 BC) [ ]**

The “mental glue” was provided by principles originally proposed by Aristotle (ca. 350 BC). For Aristotle these principles accounted for the fact that one thought leads to another and that thoughts are not random. We remember things together when:

1. they are similar
2. they contrast
3. they are contiguous

It was a relatively small step from one thought leading to another as Aristotle had proposed to one idea combining with another idea to produce a more complex idea as argued by Hobbes and Locke as detailed earlier.

It was thought to be important to find out about the primary constituent elements of combined forms. Complex ideas were seen as combinations of simpler ideas, and meaning was the result of the association of a word with an event through contiguity. Hear word and associate it with sense data e.g., hear apple pie and see and taste apple pie. Study then was focused on sensations or their combination. In particular, how principles of contiguity act in specific instances, to produce complex experiences, and, in fact, our entire mental life. All of it is from the association of simple sensations. The view was that the component parts of a cognition must be discovered just as the red, green, and blue components of color were discovered. The discovery of the indivisible parts of cognitions or the “analysis” of the mind was what introspection was all about.

**(ii) Hobbes**

Hobbes believed that behavior was caused by the mind and that the mind was based entirely on experience (see also previous section on Hobbes).

**(iii) Locke**

Locke also argued that the mind was due entirely to experience (see also previous section on Locke).

**(iv) Hartley (1705-1757) [ ]**

Contiguous experience produces contiguous ideas which produce associations.

**(v) Hume (1711-1776) [ ]**

Reality is only what we experience, it is not intrinsic. Our idea of causation is from the association of events together. He was an associationist.

**(vi) James Mill (1723-1836) [1829]**

His view was that ideas were formed as a result of mental mixtures. All sensations related to chair become the meaning of "chair." What we know of the world is through the senses. Elements of the world are sensations. Objects are combinations of these sensations.

**(vii) Brown (1778-1820) [1820]**

Laws of Association. Which elements would become associations are determined by:

1. duration of contiguity
2. intensity of sensation
3. frequency of pairing
4. recency
5. amount of competition
6. abilities of subject
7. emotional state of subject
8. physical state of subject
9. similarity of other associations

**(viii) John Stuart Mill (1806-1873) [ ]**

John Stuart Mill argued that ideas were developed as a result of mental chemistry. All sensations may combine to produce something new, not mixture like salt and pepper, but rather like oxygen and hydrogen to produce water with emergent property.

**(ix) Ebbinghaus (1850-1909) [ ]**

Ebbinghaus did the first formal experiment on learning. He was an early behaviorist. He characterized the functions that related inputs to outputs. He did not focus on internal causes, rather he documented how a behavior varied with types of experience. He studied the quantitative relations implied by the secondary laws of association of Brown especially frequency and recency. He experimentally tested these philosophical statements (it was a formal test of

association theory). He was not satisfied to know that more contiguity produced more learning but rather wanted to know exactly how much pairing produced how much association. It is amazing that it had been 1500 years before it occurred to someone to empirically test the beliefs of associationism. He was interested in the deterministic impact of frequency and recency of association. His intent was to study properties of the mind. He wanted exact quantification. The person was thought to associate an element with all other elements and the closer the more associated. Ebbinghaus tried to use material which was unbiased (nonsense syllables). Ebbinghaus followed in the tradition of Aristotle, Mill, Mill and Brown. He found that as the list increased, time per item increased (not simply that 20 items took longer than 10 items, but rather that an item took 1 minute when a list of ten and took 2 minutes when in a list of 20). He also found that association strength increased with practice even after the list was mastered - more practice then more savings.

#### (x) Spencer (1820-1903) [1855]

Spencer agreed with Hobbes that evolution has linked pleasure and pain with survival and that the species survived via hedonism. But he differed in that he argued that pleasure and pain guide behavior via what we **learn** not simply what we **seek**. Hedonism determines what becomes associated and associations determine **who** we are not just what we know. This is the difference between an animal moving toward food and a learned stimulus-response association being reinforced by food. An individual repeats things which bring pleasure because they learn do to it. It was a repertoire of behaviors which are drawn out by the environment. That learning moved the simple statue across the floor. The system was as simplistic as an S-R reflex like a ball bearing that rolls in, bounces against the brain, and then back out again. But neither was it a little man at a mentalistic switchboard. Spencer provided a mechanism for the environment to produce extremely complex behavior in novel situations in the absence of immediate reward. With Spencer's system, experiences in the past could affect what is done in the future. Knowledge is no more magical than what we do. He was a materialistic, hedonistic determinist.

Spencer provided a critical realization: that learning determines who we **are** and what we do. Whereas Hobbes' great realization was that what we do is governed by pleasure and pain not free will; Spencer's great realization was that pleasure and pain accomplish this by determining what we learn and that learning is what determines "who we are." The very homunculus was assembled from experience. It was not that the homunculus always was and simply chose things or associated things.

#### (xi) Summary

At this point in history among the mental atomists, everything (a person's

essence, their personality, their hopes, dreams and thoughts) was believed to be constructed from a restricted set of sensations via contiguity and experienced pleasure and pain. The impact of this perspective was enormous. A person was the totality of the program installed by the environment through the association of experienced stimuli. Learning is how a person came to be who they were, and learning is how a person would become who they wanted to be.

Research was either introspection or targeted on the details of association (e.g., Ebbinghaus). Introspection research was the study of the components making up thought, personality, and humanity rather than the machinery of association itself. Introspection was used to get at the mind. Typically, introspection and verbal report were used to break overall sensations up into components parts and analyze complex experiences into elements, from that, the general laws with which elements were associated could be discovered. The thing to do was to have trained observers analyze experience into constituent elements.

Association research was focused on uncovering the laws of association.

How many pairings?

Exactly what constitutes a pairing?

Which of several simultaneous elements get associated?

Are they all equally associated?

Are they permanently associated?

#### **D. Physical Atomistic (Environmental / Mechanistic Cause of Behavior)**

This second school of thought did not focus their efforts studying something that may or may not be true (i.e., the mind). Rather, they focused on what was absolutely known to be real. What inputs caused what outputs? If intellectuals of this period were the “three little pigs,” these scholars decided to build a house of brick rather than sticks or straw. It was much slower to construct their kind of knowledge but much surer.

Descartes had created this paradigmatic approach by asserting that much human behavior and all animal behavior was simply the reflections of events in the environment back to the muscles. He labeled the fluid that flowed around in the body carrying out this mechanical transfer of energy “animal spirits.” The questions that the subsequent researchers asked can be seen as verifying, refuting, or documenting the machinery that Descartes envisioned. Descartes had speculated that reflexive behavior was from the energy of the stimulus traveling up the nerve and reflecting back to the muscle along the same pathway. Animal spirits were the vehicle and they acted by swelling the muscle. Reflexes were thought to be innate and unchangeable. The paradigmatic research following Descartes revealed the actual factors affecting “mindless” things like withdrawal from fire and the heart beating. Further, this mechanistic explanatory framework was also used for things like breathing or jumping, rather than escaping to an immaterial cause for those relatively complex behaviors.

It is important to note that this research had a clear mechanistic spin. There

was a strong interest in the reductionistic path taken by the “energy in” in its travel through the body to become the “energy out.” The task could be likened to trying to trace the travels of a penny through a mechanical bank which doffs its hat when a coin is put in.

## **1. Evolution of Thought**

### **a. Swammerdam (1637-1680) [ ]**

Swammerdam demonstrated that neural conduction was not animal spirits flowing from the mind or the pineal gland. Isolated muscle would work when the nerve was mechanically stimulated. Each muscle therefore, must have had its own mind or muscles did not need a mind to function. A heart beats outside a body. Either organs do not need a mind or each organ has its own mind which lives after a person's death. The obvious parsimonious explanation was that the mind and the soul are unnecessary for behavior to occur.

### **b. Glisson (1597-1677) [ ]**

Glisson showed that a reflex was not the reflection of animal spirits causing muscle to swell. There was no volume change. This was tested by submerging the arm under water and noting the water level when the arm lifted a weight.

### **c. La Mettrie (1709-1751) [ ]**

Treatise on mechanisms. Man is a machine.

### **d. Hartley (1705-1757) [ ]**

He argued that vibrations along nerves were the cause of information transfer. In this way, the problem of information transfer without something moving to the brain and back was explained, even though it did not answer how muscles themselves work. His “vibration” theory of neural information transfer followed from the then current revolutions in physics.

### **e. Prochaska (1749-1820) [ ]**

He demonstrated that the cerebrum was irrelevant, but that the spine was necessary. Reflex works with no brain but will not work without a spinal cord. Voluntary behavior from brain; reflexes from spine.

### **f. Magendie (1783-1855) [ ] / Bell (1774-1842) [ ]**

They demonstrated the anatomical path of the reflex by severing the nerve path in different places. If the posterior (or dorsal) cords were cut, the animal

could move but could not feel. If the anterior (or ventral) cords were cut, the animal could feel but could not move. Dorsal was sensory / ventral was motor.

#### **g. Sechenov (1829-1905) [ ]**

Sechenov worked with spinal preparations and turned general research interest to behavior away from the study of ideas. Sechenov was a strong spokesman for rigorous, reliable research and theorizing, even at the expense of the pace. The acquisition of knowledge about behavior should start with the simple. He argued that there was a clear difference between hypothesis and fact. Sechenov conceptualized the notion of excitation and inhibition. He removed a portion of the brain and found reflexes faster or stronger. That indicated that the brain exerted inhibitory control.

Sechenov developed a conceptual framework within which several important characteristics of reflex behavior could be understood. He demonstrated that the energy in a stimulus is not simply reflected back to muscle (the child's mechanical toy bank). A problem with prior views of reflexes was that energy in did not equal energy out. Sechenov conceptualized stimuli as triggers rather than energy inputs to reflex (an electric toy bank activated by the coin). This explanation also handled an early problem that complex behaviors did not necessarily need an equally complex stimulus. A third problem had been that voluntary behavior has no eliciting stimulus. The behavior seemingly arises from within the person. To Sechenov, voluntary behaviors were obviously actually triggered by very subtle stimuli in the environment of which we are not even aware (such as a bit of dust causing a powerful sneeze). A reflex then became a complex machine-like input/output process which could be modified by unnoticed and simple signals from the environment.

Sechenov also pointed out that thought could be a by-product of external causes rather than thought being the cause of behavior

One problem remained with Sechenov's behaving machine: how could behavior be different to the same stimulus over time? (he had no way to deal with learning). How could behavior occur which was not programmed in by evolution? In Sechenov's system, animals must remain fixed. Clearly, humans were modifiable via experience.

#### **h. Bechterev (1913) [ ]**

One time he said "we should approach behavior as if we are from another world so that we can study it objectively. Only then will we understand it. Otherwise we see only ourselves in the minds of others." Bechterev argued that thinking was subvocal speech, concept formation was generalization, and stimulus substitution was basis of conditioning.

### **i. Sherrington (1857-1952) [ ]**

Sherrington showed how simple reflexes were integrated by the spinal cord into simple adaptive behaviors. Sherrington worked on spinal or decerebrate animals. They behave in only reflexive ways and cannot learn; they were perfect Sechenov machines. Reflexes show no “ontogenetically” acquired adaptiveness but show remarkable phylogenetic adaptiveness. They walk, run, scratch, and withdraw from a thorn, shake their head when wet, swallow milk and reject acid. But, after a delay, all returns to a “base” state. All is completely reversible. There is no evidence of learning. “Final common pathway”; laws of reflexes. This set the stage for Pavlov taking it one step further by discovering how the brain did precisely the same thing at a higher level so that all behavior could be understood.

### **j. Summary**

At this point in history, extremely complex behaviors were well understood within a coherent framework which did not invoke any dualistic, non-empirical explanation. Additionally, these behaviors were the natural result of the grouping of atomistic processes.

## **E. Mental Holistic**

Some people rejected analysis or atomism as a meaningful way to study mental phenomena. The holistic mentalists felt that phenomena may have emergent properties beyond their component parts. Gestaltists were mental molarists. They used introspection in search of the properties of the wholes. They also argued for the validity of phenomenological (naively perceivable) elements.

### **1. Evolution of Thought**

#### **a. Köhler (1887-1967) [ ]**

In addition to being a mental molarist, Köhler argued that behavior change was through insight. He argued for intelligent learning rather than blind fumbling. One-trial learning rather than incremental trial-and-error learning. Solutions occurred instantaneously. Köhler emphasized means rather than ends. Detour character of behavior important. Holistic not atomistic. Phenomenological (common language) not positivistic. Isomorphism very important - brain fields react same as experience.

#### **b. Koffka (1886-1941) [ ]**

Rather than to analyze mental phenomena into elements, the emphasis was to study properties of the entire mind as it interacted with the environment.



Judge simply, and naively look at contents of mind as a whole. Behavior can best be described in relation to its goals not in relation to muscular acts. Insight sudden without gradual trial and error. Anti-empiricist.

#### Law of Prägnanz

Psychological organization moves toward regularity, simplicity, stability

#### Law of Similarity

Law of Proximity - closed or recent is better

Law of Closure - closed is more stable

Law of Good Continuation - perceptual inertia

### F. Physical Holistic

Packages of stimuli (various senses, various consecutive stimuli) can control packages of behavior (going to the store, getting a PhD). The level of molarity we choose can affect the orderliness of our obtained functions.

## III. Evolution of Modern Explanations for Behavioral Adaptation

### A. Darwin (1809-1882) [1859]

Charles Darwin inspired a paradigmatic revolution in the *Weltanschauung* just as Descartes had done. After Darwin, nature and the behavior of life forms were no longer seen in the same way. This new paradigm was based on what in retrospect were simple and obvious observations.

It had been well accepted that life forms were similar, and that there seemed to be continuity from one to the other. The fact that evolution occurred was generally accepted for centuries before Darwin. Very many facts supported it. Darwin's contribution was to realize that evolution could occur by natural selection. If there were variety, selection, and non-regressive replication, then there would be exactly the continuity we observe across life forms. If natural variation and natural selection; then the wondrous variety and harmony of the many species would be accounted for.

Variation and selection provided a natural explanation. for the similarity and diversity in nature and the amazing adaptiveness in living things. For example, one pair of house flies in April could produce 191,010,000,000,000,000 flies by August. Only a few flies survive. In fact if the number of flies on earth is remaining relatively constant, then the best guess is that only two flies survive out of all the potential offspring of a pair of flies. This "cut" ratio is capable of selecting individuals very different than the parents. The surviving flies are the best out of billions for the encountered environment, because those which were best suited to the conditions would be most likely to survive. As a result, the best guess is that flies are pretty much capable of maintaining themselves at the approximate ideal for their environmental niche.

Just how small of an advantage is necessary to come to predominant can be seen by a thought experiment. Imagine two spaceships, one traveling at 10 mph and the other at 11 mph. After a billion years, one will be very much further ahead of the other. Imagine that by some magic, you could select the two most extreme dogs that ever lived in the last million years and breed them. Suppose you turned the obtained puppies loose on a planet without dogs and waited another million years, suppose you magically chose the two most extreme out of the entire million years again and bred them again, and you repeated the whole process several times. That would be only one summer for a pair of flies. Darwin realized the obvious: 1) variation; 2) differential reproductive success; and 3) the non-regressive replication of the best-suited, produces evolutionary change.

It is not that nature has intentionality or purpose but rather that some life forms are more adaptive than others. Adaptation occurs to experienced conditions not toward some future goal. There is an easily understood machinery which produces evolution. Teleological or magical explanations of the diversity and adaptiveness of life forms is unnecessary.

A boulder rolling down a hill is a good metaphor for evolution. At each instant the boulder moves among options available to it in the direction of least resistance, as modified by its momentum. It is falling but not toward a particular valley (or your house), but rather along the path of least resistance. Life forms evolve along the path of least resistance not toward some particular form.

Implications: 1) continuity in species, continuity between man and animal; 2) the consequence of the behavior with respect to evolution (long-term adaptability) is a critical element in the understanding of behavior; 3) because evolution proceeds in small steps then an atomistic analysis should be maximally productive; and 4) it is unlikely that the brain structures involved in speech were around when much of our brain and behavior evolved. As a result, the mind is not an essential element in the explanation of behavior.

After Darwin virtually all areas of psychology and biology became sciences rather than philosophies. There was no need to postulate special properties to humans. If the adaptability of animals does not require a mind as a cause and man and animals are continuous, then man's adaptability can be best understood and explained without recourse to a totally different kind of existence outside the natural world (mind).

## **B. Paths in the Post Darwin Evolution of the Explanation for Behavioral Adaptation**

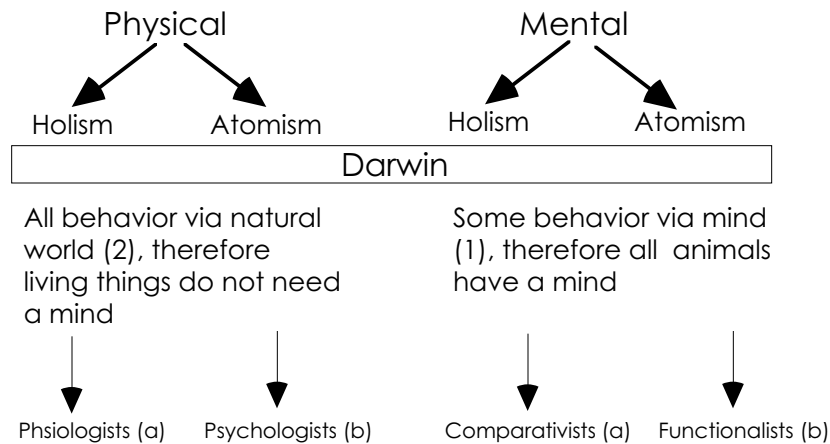
World views for researchers concerned with understanding the “mind” and “body” had to change in light of the commonality between man and other animals. One group persevered believing in the mind but some window dressing was added to make it seem less nonnatural and not the only causal factor underlying voluntary behavior in people. This lead them to the mind also becoming the causal factor in the behavior of lower animals. For the other group,

a natural explanation for human voluntary behavior, as well as lower animals, became available. The initial split in scholarly work in behavior was (followed by the outline section):

If animals did not need a mind, then  
man did not need a mind. (2)

If mind in man, then mind in  
all animals. (1)

Adding to the structure we presented earlier, we have



### 1. Search for a Mind in All Animals

After Darwin, researchers who had emerged from the tradition emphasizing the mind (recall II A and II B) came to focus on two issues. They were labeled comparativists and functionalists.

#### a. Comparativists

Evolution obviously shapes the body through variation and selection, evolution is just as likely to shape behavior (i.e., some behaviors provide relative reproductive success). Comparativists studied attributes of animal minds initially to evaluate Darwin and eventually in its own right. They studied how the mind was shaped by selective pressure to understand the trend which had as its end, man. The approach was to study at least two different species to study evolutionary forces which controlled the development of the mind. The researchers studied the capacities of animals. These researchers studied how different animals evolved different behaviors to adapt to different niches. Lions behave differently than antelopes and the reason is natural selection.

#### i. Romanes (1848-1894) [1882]

Romanes made the now obvious point that lower animals benefit from

ontogenetic experience. He pointed out that adaptive behavior could be as a result of exposure to the environment rather than simply instincts. He collected anecdotal evidence, with anecdotal explanations. He asserted that we could infer that animals have the conscious state we have, if they were doing the same act. Because animals acquired adaptive behavior as the result of ontogenetic experience, animals could be said to have minds or intelligence which was one way to view Darwin's realization that lower animals and man were continuous. Romanes focused on the study of behavior rather than biology. He carried out laboratory research, and searched for particular determinants of behavior.

Ontogenetic behavioral adaptation implied a mind and intelligence. Animals adapt, therefore, they have intelligence and mind. Therefore, we can study them to understand humans.

## **ii. Morgan (1852-1936) [1894]**

His famous dictum (actually, it was Occam's razor) stated that adaptiveness in animals does not necessarily imply insight or self-awareness on the part of the animal. It might just as well be the result of simple association. Behavior could be as mindless as a headless cat scratching an irritation on its side. His dictum was leveled at the Romanes' style of explanation, which postulated cognitive skills whenever an explanation for a complex behavior was necessary. Recall the dictum "smart animals prove the experimenter stupid; stupid animals prove the experimenter smart."

### **b. Functionalists**

The functionalists also argued that animal minds are continuous with human minds. Their view was that the study of the mind is easier if carried out on simpler systems such as lower animals. A clear experimental approach to coming to know how things worked. A bias toward environmentalism and associationism.

Originally, what the mind was for rather than the structure of the mind but later there was a shift to an interest in how the mind came to be what it was. The origin of ideas rather than what they were. Initial empirical investigations of animal behavior. The beginning of comparative animal psychology in the years between 1890 and 1900 searched for evidence of intelligent behavior in animals. Very soon, however the analysis of problem solving behavior in animals gave way to systematic experimental analysis of the *broader problem of how animals learn to adjust to their environment*. The interest became one of coming to understand the nature of adaptation to problems posed by nature and the nature of associative learning rather than the study of a particular species or continuity between man and animals to evaluate Darwin.

These researchers approached behavior from what came to be the psychological perspective. Rather than to study how different animals behaved

differently, functionalists were interested in the commonalities of adaptation to the environment across the species and how the machinery that caused it worked. This would reveal the fundamental determinants of adaptation itself.

### **i. James ( ) [1890]**

William James argued that consciousness is an evolutionary adaptation because it provides reproductive success. It provides flexible solutions when automatized behavior is not functional.

### **ii. Small ( ) [1899]**

Research program started with a comparison of mental qualities across species. In particular, the determination of the conscious state of a rat by watching the acquisition of adaptive behavior. Use a Hampton Court maze because it was natural. The subsequent shift in focus of functional research to the assessment of the atomistic components of associative learning drove the apparatus to evolve to a straight alley. The search was on for the "stupid" animal - the cause of behavior. The focus shifted from conscious experience to how the rat learned all turns, to how it learned a left turn, to how it learned to run straight, to how it learned to press a lever, to what controlled lever pressing.

### **iii. Thorndike (1874-1949) [ ]**

The context of "commonly held beliefs" at that time were: 1) Animals have innate S-R reflexes (i.e., scratch reflex); 2) If voluntary behavior is practiced enough it becomes a direct S-R connection (typing without "thinking about it"); and 3) direct S-R connections are called habits (the smoking habit or typing habit).

Thorndike's procedure: problem box.

Thorndike's question: 1) What is the nature of association? 2) What is associated when something is learned (e.g., one possible answer (Köhler's) could be the idea-of-string associated with idea-of-release-from-situation associated with idea-of-pulling-the-string, etc.). 3) What is the process and what makes it happen? Thorndike's question was Köhler's problem, but set up so the animal would be stupid rather than the experimenter.

Thorndike put the cats into the puzzle box and observed them getting out.

Thorndike's results: slow learning, no single instant where cat "got the idea," therefore, not association of ideas; it was not insight. It must be a direct connection of stimulus situation to response, like typing or "automatic" smoking after a meal.

The animal's motivational state and the consequences of the behavior were critical to the acquisition of the habit.

His paradigmatic contribution: all behavior was S-R, and S-R connection was

via consequence, much in the spirit of Hobbes and Spencer.

Thorndike did active research in a lab to understand behavior (much like Ebbinghaus). Thorndike talked about behavior when everyone around him was concerned with consciousness and ideas. He was like Ebbinghaus, in that he was focused on what actually happened and what in the natural world caused it. He used live animals to understand general laws of learning. He studied acquisition of new behavior rather than old behavior. He used a quantitative method rather than subjective. From previous acceptance of S-R connections in animals, Thorndike added learned S-R connections, and via Darwin, said all learning is S-R and does not depend on the mind for the adequacy of its explanation. Thorndike demonstrated himself smart. Thorndike was concerned with data rather than rationalism. Overt behavior (functional relations) was subject matter rather than an opinion about the reductionistic internal processes. In his view, motivation/reinforcer was key to understanding behavioral adaptation.

Thorndike started with chickens because Spalding had used them earlier, because environmental experiences started (emerge from egg) at an identifiable point and they were capable of functioning at that time. The use of chickens clearly illustrates a focus on basic processes, the understanding that animals were continuous with man, and that the animal species should be chosen based on its aptness.

## **2. Search for Nonmentalistic Explanations of Behavioral Adaptation Across All Species**

### **a. Physiologists**

#### **i. Loeb (1859-1924)[ ]**

His goal was to comprehend animal behavior in the same way that plants are understood. Researchers are smart when it comes to plant behavior because they look for its causes and don't make up excuses. Von Zatz, a plant biologist noted that plants respond to light even though plants have no neurons.

Major change in explanatory mechanism: from brain, and/or mind as a cause of behavior (internal cause) to light, or more generally the environment as a cause of behavior (external cause). Loeb conducted systematic research to discover causes of behavior, i.e., environmental events. Theory of tropisms (forced movements): animals changed their behavior as a function of the amount of light. Loeb was able to describe, predict, and control behavior. Experiments: caterpillar attracted to light (positive phototropic), horseshoe crab repulsed by light (negative phototropic), chemotropisms in butterflies.

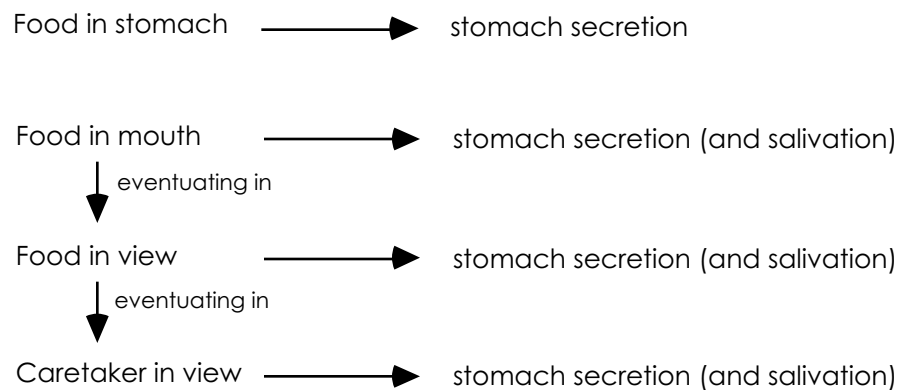
A limitation was that he conceptualized the mechanism as only in response to immediate external stimuli (i.e., S-R) and studied behavior that showed no adaptation as a function of increasing experience (i.e., no learning). (He is analogous to Sechenov in that regard, but Loeb studied the behavior of the whole animal.)

## ii. Pavlov (1849-1936) [1906]

Earlier, Sherrington had shown how the spinal cord had integrated spinal reflexes; Pavlov had wanted to extend this to the cortex integrating all higher behaviors. Extension of physiological analysis of bodily function. Pavlov was interested in showing how all behavior was a function of neuronal activity. Pavlov was more interested in how the nervous system worked than in the digestive system. Therefore, the natural shift to conditioning.

The task of explaining voluntary behavior required: 1) a way to account for high energy behavior in the absence of an equivalently strong stimulus. Recall that Sechenov had explained "voluntary behaviors" by invoking very slight changes in a stimulus functioning as a trigger and 2) the second problem that had to be accounted for was. How the same stimulus could produce different responses at different times in the animal's life (adaptation as a function of ontogenetic experience, i.e., learning).

Into this context, Pavlov's work arrived. Pavlov found these changes over increasing experience.



It was not plausible that the last reflex (caretaker-stomach secretion) was inborn. It must have been acquired or learned, thus answering Sechenov's stumbling block. Pavlov realized that each animal possesses: 1. a fixed innate set of relatively simple reflexes and, 2. that animals come to have a set of acquired reflexes. Pursuing his belief that all behavior must ultimately be caused by nervous activity, he argued that:

1. input produces cortical excitement
2. excitation spreads
3. excitement will be concentrated by an excitation on the cortex
4. after a few pairing, excitation is drawn to spot of UCS from the CS in enough quantity to produce the "UCR"
5. production of excitement in one center produces opposite process in surrounding area.

The gain resulting from this approach was significant. The acquired reflexes were acquired by experience with the natural world and were new adaptive

behaviors not instincts. Animals learn, thus proving that humans were not substantially different. There was continuity across species. The last of the problems separating man from animals was understood.

1. animal behavior was reflexive
2. reflexes did not need a mind
3. reflexes were physiological
4. reflexes could be learned
5. humans were continuous with animals
6. human behavior could be seen as the result of learning and without the need of a mind, rather it was purely physiological

Pavlov followed in the tradition of Sechenov and Sherrington. Some problems remained:

1. conditioning without a cortex
2. generalization not the same as cortical homunculus
3. some stimuli are not spatially represented
4. the effects of hormonal control was “ignored”

(An unfortunate impact of the success of his discovery that the nervous system accounted for much of the integration of behavior was that hormonal control of behavior was relatively ignored by biologists and psychologists for many years.)

## **b. Psychologists**

### **i. Watson (1878-1958) [1913]**

Watson was the philosopher spokesman for rigorous behavioral research as opposed to collecting anecdotal stories and ad hoc supposed explanations. He demanded that we should limit our discipline to what we can agree to (1924). “The study of the Mind is the province of philosophers; it is the realm of speculation and endless word games.” If one separates observation (data and facts) from hypothesis, then behaviorism becomes a matter of epistemological necessity. Even though no one today is a Watsonian behaviorist in every detail, all psychologists rise or fall on their connection to empirical reality. Therefore, everyone is a behaviorist today. Anything else is seen as the metaphysical word games of amateurs.

Watson was a student of Angell who had emphasized a search for how things came to be what they are. Watson followed in the tradition of Locke in that, in his view, virtually 100% of behavior was learned as the result of experience with the environment. Either frequency or recency of experience increases S-R connections. Where S-R implies that R is to be understood in terms of the environment, not that the response must have an immediately antecedent identifiable stimulus. Many people misunderstand this terminology. No one asserts that all behavior has an immediately prior stimulus which forces a very specific rigid response. The meaning of SR refers to an acceptance of correlative explanation and a rejection of reductionistic explanations. Watson was not a reinforcement theorist,



only contiguity was necessary. Solidified S-R as subject matter of psychology, and the mind as outside science and in fact, not believable. Habit was the basic unit.

Watson in rejecting the mind and demanding that behavior be the focus of psychology broke free from the trap of introspection and philosophical argumentation. After Watson, Psychology was either scientific or amateur's playing at psychology. He also opened all of nature to psychology rather than limiting the topic and practice to just a few specially trained introspecting researchers.

## **ii. Guthrie (1886-1959) [ ]**

Guthrie argued that a single trial produced complete conditioning to the existing subset of the stimulus population. Guthrie's theory broke ground in the sense that he added theoretical complexity in order to account for observed behavior. Obvious stimuli were actually to be seen as many theoretical stimuli. The higher the percentage connected, the higher the probability of the response. Generalization was the result of the percent of shared elements. Discrimination was to be seen as one response to one set of elements, a different response to a different set of elements. Reinforcement was seen as a change in the stimulus situation. Extinction was seen as attaching different response to the situation. Motivation: eating was the last thing done in hungry state, so hunger will result in eating; no motivation is necessary. One trial learning - there were constantly changing stimuli in environment. If all the stimuli were constant (same), then learning would occur with a single S-R. Behavior learned in form of S-R connections. Responses become conditioned to many stimulus elements. S-R S-R S-R S-R S-R. Contiguity theory - no reinforcement needed if S-R occur together then learning occurs. No reinforcement needed, no motivation needed. All that was necessary for learning was that the response occur and then the situation change.

## **iii. Tolman (1886-1959) [ ]**

Not molecular view as others above had been, but rather was molar (looked at whole first - from whole to component parts). Additionally, it was a cognitive view in that interval activities took on explanatory roles. S-O-R stimulus - organisms - response. The organism is the intervening variable. Place learning experiments in 1940s with rats. Rats learned to turn right for reinforcement, would turn right later even if no reinforcer there. "Cognitive maps:" Rats learned spatial layout of maze. Expectancy S-R-S\* - if particular sign, then particular behavior, then particular consequence.

## **iv. Hull (1884-1952) [ ]**

Animals have biological needs that they are driven to reduce. Homeostatic

survival mechanism - the S-R connection that decreased drive was acquired. This view is more complex, more sophisticated than the earlier theories of behavior. Animals learn to do whatever decreases the drive. Hullian view was popular in the 1950s. Drive reduction theory.  $E = D \times H$  (behavior = drive x habit (habit = S-R connection)). If either goes to zero then no behavior. Function looks right for multiplicative relationships.

This was a quantitative view that put learning on a stronger foothold. This view is deductive (deductive goes from global to data).

The simplicity of the core of Hull's concept can be illustrated with a robotic turtle. Imagine a turtle that can roll around on the floor of a room. As it runs low on electricity, it moves around (it gets hungry and becomes more active). When it bumps into an electrical outlet, it charges its batteries and remembers the stimuli it just saw and the behavior it just did. Need reduction results in an increment to habit which is a tendency to do the just emitted behavior in the presence of the just experienced stimulus. When the turtle gets low on electricity again, it moves around again. If it encounters the stimuli that preceded food, it repeats the same behavior it did just before getting food, because the turtle had learned to do that behavior. Higher-order conditioning adds the stimuli that preceded the conditioned stimuli. Repeated over and over, this process will extend a chain of behavior to stimuli out from the outlet in all the directions that the turtle has ever experienced. All these interlinked chains of stimuli and their responses will enable the turtle to go straight to the outlet whenever its batteries are low again. Specifically, if learning (habit) is the result of need reduction and if behavior is the what is learned (habit) multiplied by need (drive) (i.e.,  $B = H \times D$ ). Then an animal capable of benefiting from experience results. Additionally, if habit or drive is zero, then there is zero learned behavior output. Both habit and drive are necessary. This then accounts for motivation.

#### **v. Skinner (1904-1990) [ ]**

Skinner's enormous impact on psychology began in the 1960's. Skinner was empirical, pragmatic, and inductive. He observed, collected data, then formulated explanations. He went from data to global statements. He developed more sophisticated equipment for precise measurement.

An important aspect of his view "radical behaviorism" was that it rejected many of the logical positivist views popularized by Hull. Skinner rejected mentalism or the explanation of behavior via an internal nonobjective entity. But he accepted mental events. He simply said that they should be expected to function like any other behavior. He rejected philosophical realism, rather he followed philosophical pragmatism. It asserts that research does not discover the true real world rather it simply generates a set of predictions which allow us to function better. We are simply "making sense out of our experiences." He was a functional environmentalist rather than a mechanistic environmentalist. To Skinner, how the "energy in" traveled through the body was irrelevant. The only

thing that mattered was the systematic relationship between the environment and the behavior.

Schedules of reinforcement were ways to control the context of a reinforced response. Operant conditioning: response emitted, consequence follows that is contingent on response. Positive reinforcement - presentation of a positive reinforcer contingent on a response which results in increase strength of that response class. Negative reinforcement - removal of an aversive stimulus contingent on a response which results in increase strength of that response class.

Use pigeons in experimental chambers. What Skinner did was give general theory. What could be applied to pigeons could be applied to people in any number of situations. Behavior is learned and can be predicted and controlled.

#### vi. Rescorla ( ) / Wagner ( ) [1972]

Many current theories of classical conditioning are based on variations of the Rescorla-Wagner model or are responses to it. It is a general theory of reinforcement and nonreinforcement based in Pavlovian compound CS conditioning. The amount learned is equal to a proportion of the amount left to be learned. Depending on how effective the CS and US are, learning is faster or slower. If there are salient stimuli and strong reinforcer learning is faster. The mathematical formula for conditioning is  $\Delta V = ab(L-SV)$ , i.e., change in associative strength = percentage of (asymptote - total learned so far). Change in associative strength equals how salient the CS is times how effective the US is times (asymptote or the maximum learnable minus total learned so far).

This formula was developed to explain a phenomenon of blocking (Kamin, 1968) by the use of compound conditioning. Blocking had previously been explained by "attention." Subjects were said to pay more attention to one CS rather than another. The term attention is vague and is typically only invoked after the fact to rationalize the outcome. The Rescorla-Wagner formula is precise and can be applied not only to explain blocking but also other phenomena such as conditioned inhibition, overshadowing, and overexpectation. In a phrase, the Rescorla/Wagner model has had tremendous success in predicting results.

### C. Schematic of the Evolution of Modern Explanations for Behavioral Adaptation

