

## CHAPTER 10

# Functional Relationships Between Arbitrary Stimuli and Arbitrary Responses: “Operant Conditioning”

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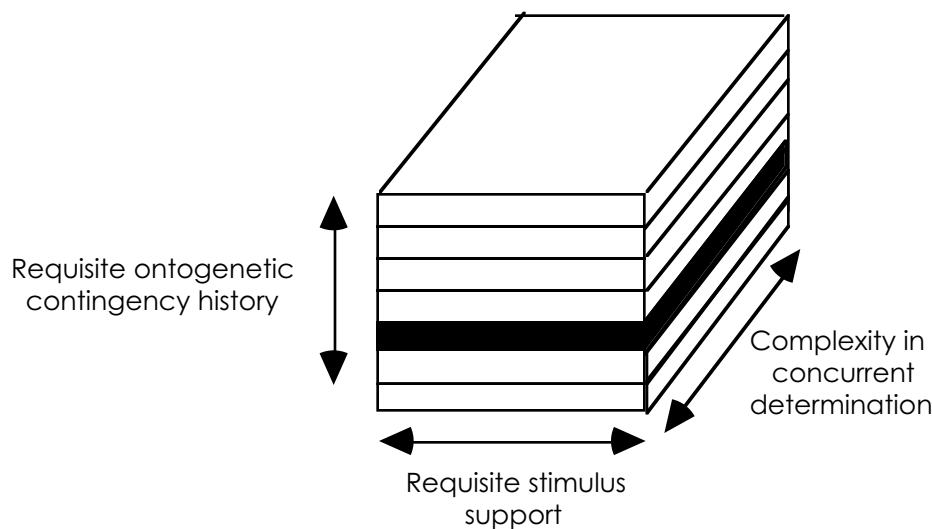
## CHAPTER 10

# Functional Relationships Between Arbitrary Stimuli and Arbitrary Responses: “Operant Conditioning”

### I. Introduction

#### A. Functional Relationships Between Arbitrary Stimuli and Arbitrary Responses

The bottom layer of this structure represents behaviors which are totally reflexive or instinctual and do not show associative short-term adaptation. They are noted for context and were discussed in Chapter 5. The second layer represents reflex conditioning. These adaptations required ontogenetic contingencies for the arbitrary stimuli to come to control the fixed responses. They were discussed in Chapter 7. The third layer represents a second type of associative short-term adaptation, this being the control of arbitrary behaviors by arbitrary stimuli.



An arbitrary stimulus controls an arbitrary response.

$$S \rightarrow R$$

## **II. Prototypical Situation Resulting in Functional Relationships Between Arbitrary Stimuli and Arbitrary Responses**

If a cat is confined in a box which requires a series of arbitrary behaviors before the escape door opens, then the cat will acquire those behaviors and will perform them more rapidly and with a shorter latency with each successive incarceration. The task of a student of behavior is to understand how and why the cat comes to be adaptive. What led to the cat appearing “smart”? How can the experimenter come to know what “was really going on”?

## **III. Conceptual Precursor: Methodological Issues Review**

### **1. General Paradigm**

There have been two basic procedures used to investigate associative short-term adaptation. The two behavioral processes are the same, so for most purposes the terms are interchangeable. However, when used to refer to distinct procedures the terminology is as follows:

#### **a. Instrumental Conditioning**

These procedures were most popular in the 1940 through to the late 1950s. They typically involved spatial movement behaviors such as maze learning or problem box escape. They have been supplanted by operant procedures.

#### **b. Operant Conditioning**

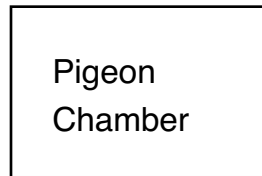
These procedures began in the late 1950s and are current today. They involve testing conditions such as key pecking or lever pressing where little spatial change occurs and the behavior of interest is the repetition of some simple act.

### **2. Subjects / Apparatus**

#### **a. Operant Apparatus for Pigeons**

The vast majority of research on short-term adaptation is conducted with pigeons in experimental chambers which provide stimuli, operanda, and reinforcers. Pigeons are small, easy to care for, inexpensive, and easy to handle. They are essentially pests to humans, like roaches and rats. They are visually dominant and have acute color vision. Because visual stimuli are the easiest to control and one of the least expensive ways for the experimenter to communicate to the subject. Additionally, pigeons have a behavior (pecking) which they can emit for long periods which is easy to transduce and, finally, they eat a food which is inexpensive and easy to dispense. That food provides a good reinforcer. For these many reasons pigeons are an ideal research subject.

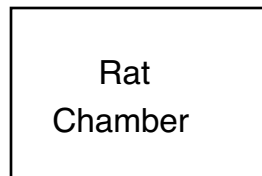
A typical apparatus is shown below.



### b. Operant Apparatus for Rats

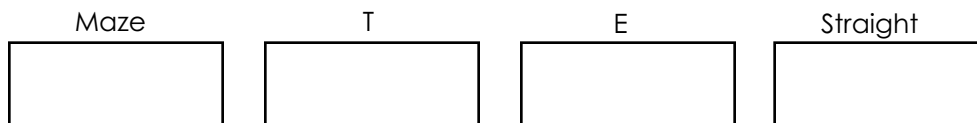
Rats are the second most popular subject for research on conditioning. They are tested in an apparatus similar to that for a pigeon. Rats are used for many of the same reasons as pigeons. Because rats are not very visual, most often tones, or lights which are either on or off, or left or right are used as stimuli.

The apparatus is shown below.



### c. Instrumental Apparatus for Rats

Early research designs had rats running through Hampton Court mazes then in T mazes, then E mazes, and finally in straight alleys or “runways.”



The motivation underlying the evolution in the apparatus was to simplify the task down to a single “behavioral atom” so that the factors affecting it could be studied without confound. It was quite like purifying a chemical so that its true properties could be measured, or reducing a nonfunctional computer program down to just a few lines of code in order to find the bug. In the case of the rat maze, the task was to understand the most basic determinants of associative learning by removing complexity.

### **3. Running Procedure**

#### **a. Discrete Trials**

Forced start and stop time exemplified by taking a rat out of its home cage and letting it run down the alley then removing it to its home cage for 24 hours before the next trial. This was common in instrumental conditioning procedures.

#### **b. Free Operant**

Exemplified by a pigeon responding on a VI schedule which is implemented on equipment mounted in its home cage. The bird would have access to the schedule 24 hours a day, without interruption. Variants of this procedure are most typical of operant conditioning.

Operant conditioning procedures expose animals to a procedure which provides numerous opportunities for food throughout an experimental session which lasts about 1 hour, and is administered daily.

### **4. Dependent Measures**

Dependent measures are varied. Most typically, we will be interested in the acquisition of behavior as the result of exposure to a task (left frame), or the specification of the final equilibrium (or asymptotic performance) resulting from sufficient exposure.

One of the most seminal points made by Skinner was that an operant was to be defined functionally not as a muscular act. The operant was envisioned from the start as a response class rather than a motor output. If a rat is conditioned to press the lever with its right paw and then that paw is taped down, the rat will probably use its left paw or its nose. From the functional perspective, the behavior has not changed, when the red light goes on the rat presses the lever. Skinner also defined the stimulus functionally. The stimulus is all those stimuli in the class which control the same operant. Occasionally, an ill informed philosopher or sophist points out that S-R psychology cannot be valid because when people have their trained arm tied down they can dial a phone number with their other arm. Again, this misses the functional definition of an operant.

#### **a. Running Time**

Elapsed time from starting point to finishing point. Numbers get smaller with experience. Used almost exclusively in instrumental situations with alleys.

#### **b. Running Speed**

The distance covered per unit of time. Numbers get larger with experience. Again, used almost exclusively with alley research.

**c. Latency**

Time from stimulus onset to response. This measure is in widespread use in both instrumental and operant procedures.

**d. Choice**

Which of two or more alternative responses occur. This measure is also in widespread use in both instrumental and operant procedures.

**e. Resistance to Change****i. Extinction**

x

x

**ii. Momentum**

x

x

**f. Rate**

Typical operant methodology generates a repetitive discrete short duration behavior such as a key peck or a lever press as its behavioral atom. The behavior is novel. Therefore, the initial effect of following it with a reinforcer can be easily seen. Secondly, a key peck is a behavior whose rate can change over a wide range. The increasing rate of the behavior with increasing experience is also an increasing probability of that behavior per unit time. Rate is, therefore, taken as a measure of response strength. Response rate increases asymptotically to a level determined by the reinforcer. Weaker reinforcers maintain behavior at lower rates, while large reinforcers maintain behavior at a higher rate.

It's reasonable to ponder in what way does pecking faster indicate stronger knowledge. The key to answering this question is that it doesn't matter. It is the change in behavior that we are trying to understand "what is the associative process and how does it work"?

**i. Graphical Display Technology for Understanding Changes  
in Rate: The Cumulative Record**

The cumulative record of the behavior of an organism is time on the x and cumulative total responses on the y. This produces a line whose angle represents rate, instantaneous changes in rate are easily seen because they deviate from smooth functions. The cumulative recorder was a device to plot the changes in rate across time. Traditionally, the paper was about 6 inches wide so the pen was reset

about every 500 responses. The step pen could be piped to represent one event (usually reinforcement) while the event pen could only pip and was at the bottom and was used to indicate responses to another key or stimulus procedures. The cumulative recorder is rarely used anymore.

### **g. IRT Distribution**

A different metric, which provides different insights, is available to measure behavior. Rather than cumulating responses across time, the inverse could be done. The time between each response could be measured and analyzed. Short IRTs indicate high rate. Long IRTs indicate low rate. IRTs are especially important if the action of reinforcers is thought to act by way of reinforcing responses closely following prior responses as in "molecular" theories of reinforcement.

### **i. Graphical Display Technology for Understanding Changes in IRTs: Dot Plots**

Slide Set

x  
x

### **h. Other**

x  
x

### **Instrumental Foundations**

goal directed	- backward talk
must experimentally manipulate	- must experimentally manipulate
	- must respond first

x  
x

### **Early Investigations**

Thorndike - habit / law of effect

x  
x

### **General Background**

1. there are instinctual S#-R#
2. there are learned habits (i.e., S-R)  
typing, smoking, etc.

x  
x

**Experiment**

1. learning was slow - therefore cannot be ideas and must be S-R
2. learning if and only if it has an effect
  - a. must be hungry
  - b. must give food
3. it is not that we choose pleasure but rather that those responses followed by pleasure are learned or recur. Spencer via Hobbes and Locke

Thorndike was

empirical not rational

behavior not mental internals

make the SR (behavior) connection fundamental rather than neurological models

x

x

**Modern Approaches to the Study of Instrumental**

x

x

**Discrete Trial Methods**

atom - free rate

abstract

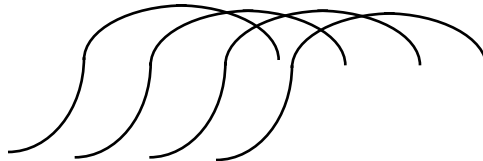
**Free Operant Method**

x

x

**Acquisition**

shaping



x

x

**Response Rate as a Measure of Operant Behavior**

Moment to moment

x

x

**Cumulative Recorder**

tool

x

x

**Behavior Baseline Technique**

baseline

single subject designs

x

x

**Instrumental Conditioning Procedure**

+stim -stim

rate increase rate decrease

positive contingency negative contingency

negative reinforcement escape avoidance	negative punishment omission

x

x

**Positive Reinforcement**

x

x

**Punishment**

x

x

**Negative Reinforcement**

x

x

**Omission Training**

x

x

**Final Note on Terminology**

x  
x

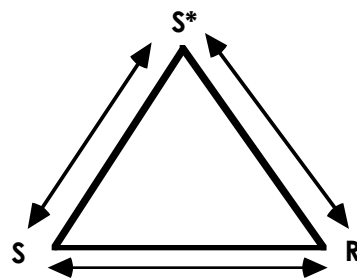
**Fundamental Elements of Instrumental Conditioning**

x  
x

**Instrumental Response**

possibly shape and maintain variable

x  
x

**Response Constraints on Instrumental Conditioning**

belongingness

some R with some S\*

instinctual drift

x  
x

**Behavior Systems Approach to Constraints on Instrumental Conditioning**

prelearned across evolution

testable via observation

testable via classical conditioning

x  
x

**Instrumental Reinforcer**

x  
x

**Quantity and Quality of the Reinforcer**

increase reinforcement

increase rate

x  
x

**Shifts in Quality or Quantity**

x

x

**Response Reinforcer Relation**

Temporal contiguity

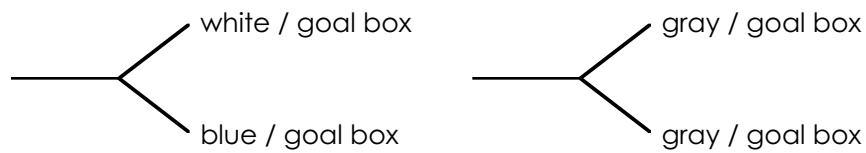
Response reinforcer Contingency

x

x

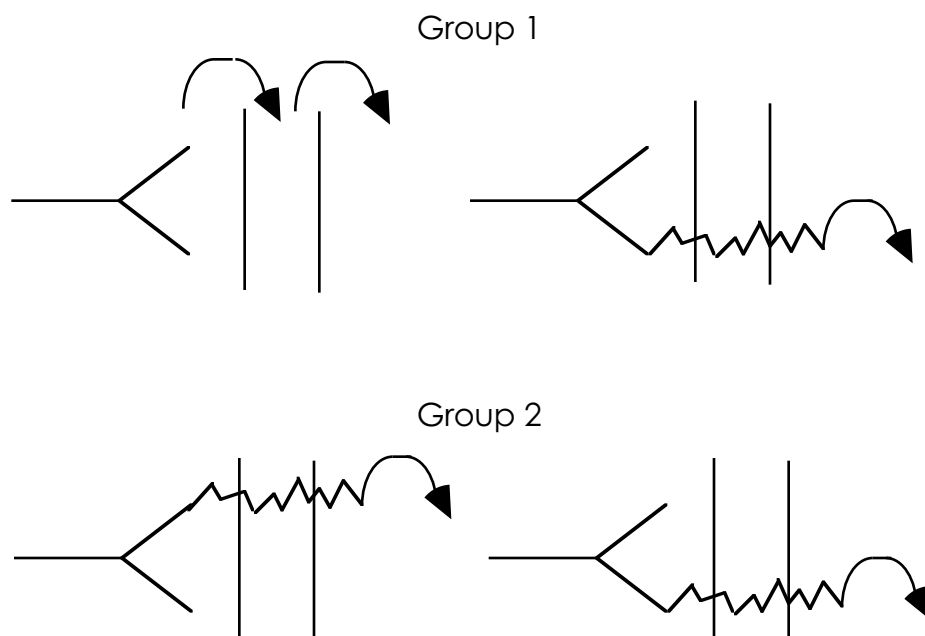
**Effects of temporal contiguity**

delay of reinforcement contiguity, and cond S\*



other things happen which get reinforced

Lieberman, McIntosh, &amp; Thomas (1979)



Handled immediately after response learned response with delay not handed  
immediately after response not learn it

### Response Reinforcer Contingency

If and only if response --> food  
but has to be some limit

x

x

### Skinner's Superstition Experiment

given every 15 seconds

thrust head in upper corner

head down with tossing response

x

x

### Reinterpretation of Superstition

Staddon & Simmelhag

terminal responses

interim responses

behavior system foraging system

what behavior governed by system activated

x

x

### Direct Detection of Response Outcome Contingency

80-90% accurate in detecting causality

I'm not impressed

if change when pecking --> peck left

if change when no pecking --> peck right

x

x

### Effects of the Control of Reinforcers

"learned helplessness effect"

Expose		Condition
E	escapable shock	escape avoid
Y	yoked inescapable shock	escape avoid
R	restricted to apparatus	escape avoid
		E>Y
		E=R

learned helplessness hypothesis

animal learn shock independent of behavior  
animals learn behavior independent of outcome  
["CS" preexposure effect]

Alternative 1: learn to be inactive

Alternative 2: learn to pay less attention to actions  
if marker is added to behavior in conditioning phase, then deficit  
is abolished

Alternative 3: E group could learn more  
Escape training facilitates learning subsequent follow ups of  
response come to be conditioned by "relief" of shock free period  
which conditioning to background - yoke group have conditioned  
fear to situation

brief signal after shock abolished the Y group retardation

x

x