# From 1924 to 1996, and into the future: Operation Analytic Behaviorism[1]

*De 1924 a 1996, y hacia el futuro:
el conductismo analítico de operación*

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## Abstract

Operation-analytic behaviorism provides the framework for a taxonomy of behavior based on the investigative methods followed (the operations carried out) in research. Such a taxonomy enables those fuller descriptions that yield explanation and some degree of "prediction" and "control". Based on the functional definition of the environmental events that couple with events in the individual's activity, operation-analysis identifies experimental conditions that parallel and are congruent with behaviors as they occur outside the experimental context. The major classes of operations described include measurement operations, probe operations, paradigmatic operations, and categoric operations. The last include setting operations and other operations (e.g., subject selection) related to the already identified variables that define the interactive field within which any behavior occurs. Recategorization of psychological/behavioral findings within this taxonomy replaces the rubrics ("emotion," "cognition," "thinking," "memor") and shows the identity of processes that have been unnecessarily distinguished from one another. Operation-analysis forms require that both the design and report of an experiment give a full and clear account of each procedure followed (including many often overlooked), ena-

bling the replication of the experiment and the demostration of the relationship of each procedure to the problem studied and to its theoretical context.

Key words: empiricism, operationism, experimental method, paradigm, behavioral field

## Resumen

El conductismo analítico de operación proporciona el marco de referencia para una taxonomía de la conducta basada en los métodos investigativos seguidos en la investigación (las operaciones realizadas). Dicha taxonomía permite descripciones más completas que procuran explicación y algún grado de "predicción" y "control". Con base en la definición funcional de los eventos ambientales que se acoplan con eventos en la actividad individual, el análisis de operación identifica operaciones experimentales paralelas y congruentes con las conductas tal como ocurren fuera del contexto experimental. Las clases principales de operaciones descritas incluyen operaciones de medición, operaciones de sondeo, operaciones paradigmáticas y operaciones categóricas. Las últimas incluyen operaciones disposicionales y otras operaciones (por ejemplo, selección de la materia) relacionadas con las variables ya identificadas que definen el campo interactivo en el que ocurre cualquier conducta. La recategorización de hallazgos psicológicos/conductuales dentro de esta taxonomía remplaza las rúbricas ("emoción", "cognición", "pensamiento", "memoria") y muestra la identidad de procesos que se han distinguido entre sí innecesariamente. Las formas de análisis de operación requieren que el diseño y el informe de un experimento den una descripción completa y clara de cada procedimiento seguido (incluyendo a muchos soslayados), permitiendo la replicación del experimento y la demostración de la relación de cada procedimiento con el problema estudiado y su contexto teórico.

Palabras clave: empirismo, operacionalismo, método experimental, paradigma, campo conductual

Although the title of this paper is "From 1924 to 1996, and into the future", the behaviorism I shall present today finds one of its historical roots, not in 1924, but a good deal earlier —the day that a physiologist, working on the digestive processes, observed the sequence of events that was fouling up his data collecting. He abstracted from these uncontrived events the stimulus operation, pairing, varied its parameters, and found the processes controlled by that operation.

I hope that you will find what I have to say "old hat", repetitious, and not at all innovative. I hope that you'll conclude that you've encountered it all before, from many different people. I am going to present an *Operation-Analytic Behaviorism*, whose aim is neither prediction nor control, as some would insist is the purpose of scientific investigation, but rather the study, the description, the categorization, the ordering and hence the understanding of behavior, the reciprocal action, the ongoing dialogue between the individual organism and its environment. This Operation-Analytic Behaviorism is a system that necessarily incorporates not only a taxonomy, but also a methodology for carrying out investigations, for evaluating the data collected, and for categorization. It is a behaviorism that can order and include many of the findings of cognitive, physiological, and neuro-psychology. The ordering identifies both categories of behaving on which research has been lacking, and those in which there is a plethora.

The system[3] developed from the writing of a brief glossary stating empirical definitions of behavioral terms. The observation that ordering these definitions constituted a concise summary of findings of behavioral scientists had implications for both research and generalization based on data, and for "theory." I began work on the operations, the specific actions that we carry out in investigating behavior, for these were the basis of the empirical definitions. Over the past decades, research, analysis of research findings, and the systematic organization of these have been going forward hand in hand with the preparation of a much more inclusive glossary, and of a thesaurus that arranges the terms in that glossary in quasi-logical rather than alphabetic organization. The definitions in the glossary, when read in Thesaurus order, constitute a treatise on behaving.

## The data of this behavior science

The raw data we deal with are the activities of individual organisms as we observe and can record them as they go on about us. They are events in the everyday world, both in and out of the lab, occurring without or with experimental intervention. It is behavior in the world of tables and chairs, of runnings and

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3. This systematic viewpoint has been developing —evolving— in fits and starts, in steps forward and backward, over the course of many years of work, observing, both in and out of the lab, of shaping behaviors of rats, pigeons, and people, in the lab, and in classrooms, seminars, in reading, talking, writing. The viewpoint has, appropriately, been shaped by the contributions of many others, both antecedent to and concurrent with its development, as you will recognize.

jumpings, of meters, keys, bars, and recorders. It deals with such behaviors as dreaming, fearing, competing, refusing, procrastinating, and even "killing-time," and such objects as inkblots, Q-sorts, complete sentences, rainbows, and insulting graffiti. It is a world of objects and events, both contrived and uncontrived, the molar world.

## Definition of terms

The vocabulary used in reporting our observations 'scientifically' to others must be restricted to wordsterms and phrases that can be defined *ostensively*, that is, by pointing at a single object or brief event, or by demonstrating a sequence of events. Such ostensive definitions ensure that the sharing of observations, scientific communication with others, will be, insofar as possible, independent of the idiosyncrasies of any one spoken or written language. When language is used, there must first be agreement between observers on the referents of the terms used as the basis for later communicating by language.

Such ostensive definition, with its assurance of agreement, implicitly demands that the events, the simples, that enter into our reports of data be recurrently identifiable, and hence enumerable. Agreement in count of instances of their referents ensure that two or more observers are alike in classifying a set of simples. Enumeration, then, is basic to any science. The point-at-ables, the demonstrables, are the enumerable by the very definition of ostensive defining. Our language will hence refer to *classes* or *sets* of simples, that is, of objects, events, or of "properties". Members of such sets, instances of them, are single observations.

The data language, then, refers to sets of events. Many of these sets will necessarily be fuzzy sets: We must expect to encounter simples that may or may not be members of the set we are dealing with. Such marginal cases sometimes prove instructive in refining our reports.

The identification of sets enables the categorization together of two or more sets into a larger set. Once we take this step, we must recognize that we are at one remove from the raw data. In combining sets, we must state the rules or principles followed in choosing such and such a combination. Our colleagues may then demand that the categories that we have constructed are useful in describing economically the events observed and in ordering them within a taxonomy. The test of these formally stated categories —these formal *concepts*— is do they work?

## The formal concepts

The 'first-order' constructions of this system are (1) the behavioral event, (2) stimulus (ess)[4], (3) response (arr), (4) locomotion[5] (ell), and (5) stimulus/response (ess/arr) or locomotion (ess/ell) interactions.

The *behavioral event* is the single observation of an *individual* (organism) acting in an environment as it is observed and recorded by the *investigator*, at a locus in *time* and *space*, terms defined in the physical sciences. The individual is defined literally by the surface of his skin; his environment is all else that is observable by the investigator. The investigator, note, is part of, a participant in the event. The primary subject matter of this science of behavior, however, is the *interaction*, the reciprocal functional relationship *of an ess*, part of the environment, and an *arr* or *ell*, part of the individual's activities. These are what we measure, what we seek to describe, categorize, and ultimately "understand." "Understanding" here means having no further questions —an end-point unlikely to be reached. The environment of an ess-arr or ess-ell relationship is all else but the ess and arr themselves.

The term *interaction*, with reference to esses, arrs, and ells, is delimited by the following definitions and observations:

1. To assert that a recurrently identifiable part of the activity of the individual is a response, one must identify a recurrently identifiable part of its environment, one that systematically either precedes or is concurrent with it, or that is consequent upon it. Until such has been demonstrated, it is a *putative* response which an observer may then attempt to bring into such systematic relationship with a part of the environment by carrying out one or another paradigmatic operation.

In like manner, the term *"stimulus"* cannot be used in application to an object or event until one or more *responses* or *locomotions* are shown to be systematically related to it.

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4.  The words "ess", "arr", and "ell" will be used interchangeably with stimulus, response, and locomotion. Perhaps they will one day replace them: The words we now use have connotations for other psychologists that preclude their ability to read the behavioral literature correctly or, indeed, to read it at all. Operation analysis has required the introduction of new terms, including coined ones. Some words as currently used (e.g., "positive" and "negative") lead to oxymorons. In Operation-Analytic Behaviorism, these terms will be used solely for the statement of direction of change in measure.
5.  Locomotions differ from responses in that they appear in systematic relationships with reinforcers and aversors without previous occurrence. Both velocity and gait are a function of the physical properties of the intervening space; there is a single vector of locomotion in space to stimuli that function as reinforcers. Many more than one vector may be observed from the locus of an aversor. As we shall see, ells and arrs are incommensurate, unless the ell is restricted in distance, as in a maze.

[If it is argued that such definitions are "circular," the aptness of the meta-
phor is questioned: The metaphor should be that of the spiral, rather than of the
circle.]

2. This reciprocal relationship of ess to arr and ell is experimentally demon-
strated by the findings made in stimulus operations when they are carried out
under circumstances when any environmental event that may be dependent on
the arr or ell is precluded

(a) if the experimenter, through a period of time, repeatedly presents
spaced instances of ess differing in measure and then determines the ess value
that produces a constant measure of a single arr or ell as a function of the time
elapsing since the first instance of ess was presented, the process controlled is
termed "adaptation" or

(b) if the experimenter repeatedly presents instances of ess of the same
measure and measures arr or ell as a function of the time elapsing between the
first of the spaced series, then the process is termed "habituation," or "extinc-
tion."

(a) and (b) are obverse and reverse of the same coin.

In sum, when the interaction of an arr or ell with an ess in stimulus opera-
tions is experimentally investigated, the investigator may choose to vary either
the ess or the arr or ell; parallel studies may be found in the literature on
foraging behaviors.

3. When one observes the progressive change of an object or event as a
stimulus, progressive change in the response to it is *also* observed. Similarly, if
one observes the progressive change in the topography of a response that
changes the environment, one may or should investigate a parallel change in the
ess antecedent to it. Stimulus and response evolve together.[6]

4. In studying behavior, investigators customarily ignore any behavior of the
environment that is a consequence of —dependent on— the response of the
subject other than the consequent they have planned, even though the environ-
ment's response is a stimulus for some response of the subject. Such behavior of
the environment is often not even observed.

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6.    If an experimenter sticks a piece of paper above the bar in a Skinner box and then stops the operation
regular reinforcement, thus treating the paper as an essdelta, the rat first sniffs at it. After a few
unreinforced bar presses, he will attack it, tearing it apart. The experimenter must then return to regular
reinforcement, until he puts another piece of paper in place. Through a series of rat-paper interactions,
the attack behaviors will progressively change to a prompt and efficient removal of the paper. The
function of the paper, the stimulus, changes as the topography of the response, removes the paper,
changes. Anyone carrying out this easy and amusing experiment will surely be interested in differences
found dependent on whether the paper is a post-it, or a post-it clipped to the wall of the cage.

This seems especially true in the study of reflexes. In these, the responses of the environment that maintain them *outside* the laboratory, and have led to their occurrence in almost all members of a species, are precluded in experimental research. Sherrington's dogs had no fleas, nor did they step on red-hot surfaces.

In the sciences, every effort is made to minimize the degree to which the identity of the *observer* or *investigator* (*experimenter*) affects the event observed. "Objectivity" is a goal, the diminution to zero of such effects. This is not an instance of the Heisenberg principle, nor is the observer effect solely a matter of fraud —the planned alteration of the data observed to what is reported. The observer, the individual who collects the data, may be inept, may be careless, or badly trained; he may be disposed to make errors favorable or unfavorable to the planner of research, depending on their social relationship.

The computerization of data collection and analysis replaces one kind of observer-effect with others. Programming, if anything, amplifies these effects, not solely by obscuring their possibility, but by building them into the software.

The *behavioral event*, then, is the interaction of arr, response, or ell, locomotion, with ess, stimulus, as they are observed, where each are simples, that is, recurrently identifiable objects or events which can be counted.

This enumerability enables a demonstration of the reciprocal functional relationship of R or L, as f(S), and of S, as f(R or L). Their enumerability identifies esses, arrs, and ells as classes of events. Enumeration, counting, is hence the measure basic to a science of behavior. The loci in time and space of observer, individual, ess, arr, and ell identify and describe a behavioral event. For this, physical measures of space and time are accepted.

A *stimulus* (ess) is a part of the environment of the individual that is functionally related to a part of the activities of that individual; a *response* (arr) or *locomotion* (ell) is a part of the activities of the individual that is functionally related to part of the environment. The functional relationship of ess to arr or ell, and of arr or ell to ess is shown by a systematic relationship between measures of each. That is, the methods of measurement define ess, arr, and ell, and the measure of the interrelationship is defined in terms of measures of dependent probability. In practice, empirical measures of dependent probability are seldom available and under uncontrived circumstances cannot be estimated, so that the indifferent term "contingency" is generally used.

## Measures operationally defining ESS, ARR, and ELL

The implications of these statements are that those measures of behavior which apply to any ess or arr will be independent of the specific topography of the object, event, or activity under study. Ells, however, will depend on the topography of a terrain. Their measures, hence, have the physical dimensions of N, number; S, space; and T, time. These physical dimensions, N, S, and T, appear in all but one measure of behavior they are not peculiar to or restricted to the particular stimulus or response topographies and are comparable to the mass, space, and time of the MKS system. Locomotions are clearly incommensurate with responses. We know also that they are all, according to Stevens' analysis, ratio scales. Tables 1 and 2 demonstrate that this is indeed the case.

Given these principles, we may then take the next step and look more closely at stimuli and responses as they are applied in describing behaving.

## Classes of ESS

Esses, stimuli, fall into two general classes, depending on their duration in time. The first class is *transients*, those brief events (ca 100ms) that are over, done with, and gone before a response to them is observed. The *second* class is *stators*, which are objects and events that continue for a considerable amount of time while responses related to them occur. They include manipulanda and are referred to by some as essdees and essdeltas. Note that both prompt onsets and offsets of *stators* and *transients*.

Transients enable certain measurements to be made, such as latency of response; characteristically, only one response is given in interactions with transients. Transients are encountered in the classes of behaviors that Skinner has termed *respondents*, a subclass of which many have called reflexes. *Stators*, persisting stimuli, enable a series of responses to be given throughout the period when they are present; these responses may alter the stator from moment to moment. The manipulanda we install in experimental apparatus, the golf-balls we swing at, are stators. They include the book as we read it, the chair we sit in, the hum of the refrigerator we hear, and the floors we walk on. Regularly recurrent transients also function as stators; we can hear each tick of a clock; we respond when the ticking stops.

In recognizing that stimuli are classes of events, we must recognize, too, that the members, the instances of these classes as they are identified in their

## MEASURES OF ESSES
### (and of enviromental events that have
### not yet been identified as esses)

Measures of stimuli include information on the time and place at which they occur, and on their duration. Some measures, however, are independent of the particulars of their incidence in space and time.

All measures assume physical specification of the object(s) or event(s) presented adequate to produce replicas of them.

| OCCURRENCE | SINGLE INSTANCES | MULTIPLE INSTANCES |
|---|---|---|
| occurrence in time (when?) | $t_1$ <br> $t_2$ <br> T | N <br> N/T <br> iTi <br> iSi |
| measures of occurrence in space (where?) | $l_1$ <br> $l_2$ <br> D <br> θ | No measures have been developed other than increases in N of loci and statistics based on these. (But, a caveat) |
| measure (what?) | M <br> dM <br> I | Mmin <br> Mmax <br> dM <br><br> Here, stimulus measures become identical with parameters of stimulus operations. |

Key to Table, MEASURES OF ESSES

| | | | |
|---|---|---|---|
| $t_1$ | time of onset of S | N | number of presentations |
| $t_2$ | time of offset of S | N/T | rate of presentation |
| T | duration $(t_2\text{-}t_1)$ of S | | lapse of time between |
| | | iTi | interstimulus period |
| | | | $t_1$ of $S_n$ and $S_{n+1}$ |
| | | iSi | interstimulus interval |
| | | | lapse of time between |
| $l_1$ | locus of object or individual 1 | | offset of $S_n$ and onset |
| $l_2$ | locus of object or individual 2 | | of $S_{n-1}$ |
| D | distance $(l_2\text{-}l_1)$ | | |
| θ | angular measure of the line | | |
| | $l_2\text{-}l_1$ with respect to a | | |
| | specified set of coordinates | | |
| | whose orgin is at $l_1$ or $l_2$ | | |
| M | magnitude | Mmin | M of lowest S of series |
| | change M at $t_1$ – M at $t_2$ | Mmax | M of highest S of series |
| dM | $Mt_2\text{-}Mt_1$ | dMt | step interval; $M_{n+1}\text{-}M_1$ |
| I | Intensity | | |

These are basic measures. Further measures have been developed and used that incorporate these measures.

When repeated measures have been made, descriptive statistics may be calculated and reported. (e.g. M, S.D., etc.)

relationship to a response, may differ greatly from one another in their topographical characteristics.

*Transients* and *stators* are defined by their duration. A second major system of classification of stimuli distinguishes among those that occur consequent to (and, in experiments, dependent upon) a response or locomotion —they are most often stimuli produced by the response of the environment. These fall into three major classes, reinforcer, aversor, and neutral, dependent on the processes they control. When used in a dependence operation, each has two subclasses: onset and offset. Onset reinforcers and aversors may be either stators or transients. The most frequently used experimentally are food, a stator controlling eating until it is consumed, and electric shock, usually a transient. Offset reinforcers and punishers are invariably stators whose termination-offset is dependent upon an arr or an ell. The removal of food or a manipulandum are operations that preclude further responding until these stators are again presented.

Much research has been carried out using operations that may determine whether various objects and events may become members of a single stimulus, as when the sound of a bell in the Pavlovian experiment gains "control" over salivating, or when a pigeon, reinforced only for pecking at pictures including a human, shows that its concept is broad by also pecking at pictures of human artifacts.

*Concept*

In ordinary language, the term we use most often for such heterogeneous classes of events which control the same behaviors or, more narrowly, the same single response is *concept*. (When that single response is a *word* in human behavior, that word is the name of the concept.) Concepts are no more and no less than esses whose instances are diverse.

Note that among concepts there is one class which enters into the behavior of logicians, and of scientists qua scientists. These are the concepts of science, where the limiting qualifications for membership in a class are rigorously specified. In literature, philosophy, and religion, books have been written in vain attempts to specify formal concepts that function for other than members of self-identifying community. Formal concepts, including the *stimulus* and *response* of this system, may not become behavioral concepts until a process of education (differential reinforcement with respect to instances of the events formally specified) has been carried out.

## Classes of ARR and ELL

Four broad classes of the individual's activities are distinguished from one another by the measurements that can be taken of them. First are *respondents*,[7] which are over and done with in a matter of seconds: These interact with transients.

Second are *continuants*, such as postures, which may begin and be maintained through a extended period of time. Third are *operants*, brief responses that recur during the presence of a stator, (which may be a manipulandum). *Fourth*, most significantly different from the others, is *locomotion*, movements of the individual from place to place. Locomotions are incommensurate with other responses in that they always require measures of the physical dimension of space. Among locomotions, many subclasses have been (and must be) differentiated from one another. These are *gaits*, as running, walking, jumping, swimming, flying, and so on. Behaviorists have been uninterested in the investigation of locomotions; experimentally, they restrict them to such a degree that an instance of locomotion can be treated as an instance of a response. Of gaits, we can state little more than that they are dependent on the species of the individual, the distance traversed, and the terrain, as well as on esses. Behaviorists —psychologists— have investigated locomotion and gaits almost not at all, except perhaps, sports psychologists. Odd, since the gaits of us humans include driving automobiles.

A *probable* class of response are the *computates*. These are measures, scores derived by mathematical or statistical computation of counts of response to sets of questions believed or demonstrated to be related to some "characteristic" (trait) of the individual answering the questions.

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7.  How does one learn to identify those recurrent events that are identified as responses? Many behavior analysts never do, but accept as their primary, even sole subject matter the intensively-studied closures of relays by bar-pressing rats and key-pressing pigeons. Yogi Berra stated the best method when he said, "You can observe a lot by watching," which is not the tautology it may seem. Looking, with 'ostensive' tutelage by a trained observer, for example, an ethologist working in the field, is one method of learning to identify those recognizable recurrent events termed responses: The behaviors they look at are those of individuals with a limited repertory of responses and gaits. A second method is watching a demonstration of shaping by an experienced behaviorist, and by then watching closely the activities of a subject and observing which of these activities recur following your prompt delivering of a reinforcer. Do responses make up *all* the activities of the individual? *Not* in an Operation-Analytic Behaviorism: Functional relationships must be shown. Until then, recurrently identifiable parts of activity are *putative responses*. Can one specify a response before observing it? As I recall, it was Harry Harlow who asked if one could condition a pinky-wiggle 4 mm in amplitude, occurring at coordinates a, b, and c in space and occurring between times $t_1$ and $t_2$.

**MEASURES OF ARR or ELL**

| CLASS OF RESPONSE | SINGLE INSTANCE MEASURES | MULTIPLE STIM CONTROL: UNDETERMINED | INSTANCE STIM CONTROL: TRANSIENTS | MEASURES STIM CONTROL: STATORS |
|---|---|---|---|---|
| OPERANTS | $T_R$<br>P<br>M<br>Z | $N_R$    $N_b$<br>$N_R/T_0$   $T_0$<br>$N_1/T_0$<br>IRT<br>$IRT^1$<br>f(N,T)<br>Z | $L_1$<br>$L_2$ | N    $N_b$<br>N/T   $T_b$<br>$N_1/T_0$<br>IRT<br>$IRT^1$<br>f(N,T)<br>Z |
| RESPONDENTS | T<br>P<br>M<br>Z | | N<br>$N/N_s$<br>$N/N_0$<br>$L_1$<br>$L_2$<br>f(N,T) | |
| LOCOMOTIONS | D<br>T<br>V<br>θ<br>Z | Measurement Methodology dependent on particulars of apparatus. <u>Research needed</u> | $L_1$ | Measurement Methodology will evolve with research on env. control of stops, starts, etc. |

Key to Table, MEASURES OF ARR or ELL

N   number
$N_R$   no. of occurrences of response
$N_s$   no. of occurrences of stimuli
$N_0$   no. of occurrences, other responses
$N_{TR}$ incidence = no. of units of
     observation period in which
     one or more responses occurred
$N_b$   burst-length

T   duration of time
$T_s$   duration of stimulus
$T_R$   duration of response
$T_0$   duration of observation period
$T_{TR}$ summed duration of responses
$T_b$   burst-duration
$T_T$   total duration

P   precision, relative to
     a chosen standard
M   magnitude

f(N,T) some function of response no.
     and total duration: product of
     response topography, e.g.,
     body weight, N pellets hoarded

l   locus in space (coordinates)
$l_1$   locus of transient or stator
$l_2$   locus of individual
D   distance = $L_2 - L_1$
$D^1$  distance in running wheel:
     N rev. x circ. wheel
V   velocity  D/T
θ   angular direction of locus
     with respect to a fixed l

t   point in time
$L_1$  latency (t, onset of R -
     t, onset of S)
$L_2$  afterdischarge (t, offset of
     R - t, offset of S)
IRT  interresponse time, same R
     (t, onset R - t, offset of
     preceding R)
$IRT^1$ interresponse time, diff. R
     (t, onset $R_0$ - t, offset R)

Z   specific topographic measures
     e.g. A: amplitude, such as
       1. drops of saliva
       2. angle of excursion
       3. physical work
       4. amount of food eaten

Further Measures, e.g. various "discrimination indices," "% correct," are derived from these.
When repeated measures have been made, descriptive statistics may be calculated and reported
(e.g., M, S.D.)

The exceptional measure noted before is *magnitude*. This is an assigned number, the response of the observer to the events observed. In such measures the participation of the observer in the behavioral events is unmistakable. The observer/recorder (which may be an apparatus, whose record of observation is later read by an investigator) or investigator is always part of, a participant in, every behavioral event. The identity of the observer is one of the many variables that the literature repeatedly shows is critical for the data obtained. The essarr or essell of the subject functions as stimulus for the observer's recording; the record is hence dependent on all the variables that have functioned in the observer's behavioral history and hence in his behavior repertory.

## Setting factors; the "field"

Since scientific research on behaving began, a wide variety of antecedent and concurrent events have been found to affect any behavioral event observed. Defined in various ways, they have been termed in the experimental lingo 'independent variables' when they are experimentally manipulated as the subject of an investigation, and are described as being "held constant" when they are not. "Constant" here is a term that is an act of faith. The absence of changes in physical measure does not ensure that the function in behaving of an object or event will not change. More, the "constant" variables themselves are interrelated; they are not independent of one another and may interact, either synergistically or antagonistically. Within the purview of this analysis, these are "setting factors," defining the field of variables that affects any behavioral event being investigated.

Some of these setting factors are manipulated in *setting operations*, which are functionally related to families, categories, sets of essarrs, to be presented later. Others are manipulated by one or another *categoric* operation, for example, selection and training of subjects.

## Paradigmatic operations

In ordinary living, outside the laboratory, we observe babies sucking on their bottles until they are empty, when they may cry. We hear the mother say "Damn!" when the baby spits the mashed carrot in her face after she has spooned it into his mouth. We hear people argue, we watch the spilled milk

spread over the table-top, and hear the crash as the glass that has been elbowed off the table hits the floor and shatters. We read the ad and go to the movie. These are our subject matter —these successions of events, of antecedent, concurrent and consequent events, of esses, arrs, and ells.
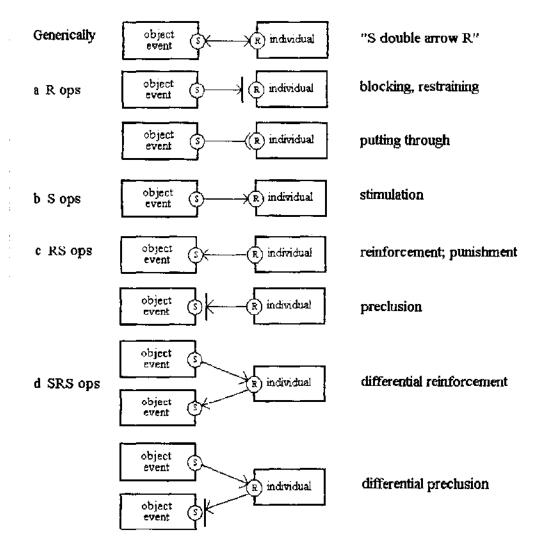
## Stimulus operations

Pavlov, after noticing that his dogs salivated when they heard the footsteps of the Diener coming towards their stock, thus making impossible the measurement of salivation to the specific foods he planned to give them, might have then required the Dieners to wear rubber-soled shoes and step silently. He certainly observed a series of events that included footstep-food, with salivation to each. From the full sequence, he "abstracted" the sequence S1 then S2, and thereby provided the first instance of selecting parts of a sequence of events that occur naturally and taking them into the laboratory. He controlled the sequence of occurrence of two stimuli, measured salivation and demonstrated the process 'classical conditioning.' He provided one paradigmatic operation for Operation-Analytic Behaviorism. He manipulated stimuli, he measured response. His was an instance of the first class of *paradigmatic operations* —the *Stimulus Operations*. The others are *Response Operations* and *Dependence Operations*, of which *Discriminal Operation* is a subclass. Figure 1 shows them.

In Pavlov's *stimulus operation*, pairing, with measure of responses, he found a process, a progressive change in measures of response, measured by a probe operation. His probe was presentation of the first stimulus alone consequent to a series of pairings of this with a second stimulus, food for salivation. In stimulus generalization, he defined the boundaries of the stimulus, the class of events. Further research with the pairing operation yielded further processes —so many, indeed, that Hull attempted to explain *all* behavior in terms of them.

Variations of this stimulus operation systematically yield a variety of processes. Pairing, however, is only one of the multitude of stimulus operations, which include all research in which the investigator presents stimuli independent of any antecedent, concurrent, or consequent response related to them other than the one he has selected to measure. Most often, he does not observe them.

In psychophysics, stimulus operations yield a variety of measures of response to physical (i.e., MKT measurable) events; psychophysics, it will be noted, is a science differentiable on this basis from behavior science, though

## Paradigmatic Operations
carried out vis-à-vis an individual

| | | |
|---|---|---|
| Generically | object event (S)←——→(R) individual | "S double arrow R" |
| a R ops | object event (S)——→| (R) individual | blocking, restraining |
| | object event (S)←—((R) individual | putting through |
| b S ops | object event (S)——→(R) individual | stimulation |
| c RS ops | object event (S)←—(R) individual | reinforcement; punishment |
| | object event (S)|←—(R) individual | preclusion |
| d SRS ops | object event (S) / object event (S) →(R) individual | differential reinforcement |
| | object event (S) / object event (S)|←(R) individual | differential preclusion |

This version omits the coding of the actions of the experimenter
in carrying out the operation.

there is an area of intersection. Most research on stimulus generalization that has been carried out fall within the realm of psychophysics.

When one reviews other research in which the investigator limits himself to presenting stimuli, and recording/measuring responses to them, one finds that a mind-boggling array of stimulus operations, and of *measures* and processes consequent on each have been investigated.

Table 3 tells it all. Those familiar with the literature will discover that the process yielded by a single stimulus operation may bear many different names, and be corsetted into, even considered basic to many different, often contradictory theories. When, one asks, is an error of anticipation a conditioned response, and when is a conditioned response an error of anticipation? And why?

## Dependence operations

A second investigator, interested in the eating behavior of rats, found that the delivery of food to a rat when it nudged open a door was far more interesting than the food ingesting. This second great contributor was Skinner, and the simple operation that emerged from his change of interest in investigation was a paradigmatic class of operations, here termed *Dependence Operations*. In these, obscured by Thorndike's phrase 'trial-and-error,' the experimenter arranges an environment such that when the individual gives/shows/emits an instance of a response, the environment necessarily responds to that instance and to other instances of the response in an orderly way, in a programmed way, determined by the experimenter. These responses, whose measure is controlled by the dependent presentation of stimuli following previous instances of them, are termed *operant responses*, or simply *operants*.

In the stimulus operations, a stimulus that precedes or is concurrent with the response controls the response. In the dependence operations, a stimulus that is *consequent* upon the response controls it. The operant, indeed, is the stimulus for a response of the environment, which in turn serves as the stimulus for further responses of the individual. Table 4 presents an analysis of the simplest dependence operations; Table 5 presents some of the terms that have been applied to response-contingent events, or in experimental reward, response-dependent ones.

Table III**
Processes controlled by stimulus operations

The reader is invited to identify or spell out the stimulus operation that yielded it. The list is by no means exhaustive; its terms are presented in no particular order.

| | |
|---|---|
| responding | prepotency |
| orienting temporal | competition |
| temporal summation | blending |
| spatial summation | algebraic summation |
| habituation | classical conditioning |
| extinction | concept acquisition |
| imprinting | choosing |
| facilitation | conflict |
| response compatibility | distracting |
| light adaptation | dark adaptation |
| Pavlovian conditioning | respondent conditioning |
| "errors" of anticipation | mimicry |
| attacking | social facilitation |
| threatening | imitating |
| disinhibition | fatigue |
| approaching | adaptation |
| withdrawing | following |
| concept identification | external inhibition |
| paired associate learning | |

This list includes many terms for processes for which the stimulus operations are identical (of which all but one are thus superfluous); redundancies abound. The word coinages stem from ideology, theories, undergraduate training, bias,... you name it. None relates to the operations that yield the phenomenon labelled. In some of these cases, choice of a term proves to depend on the observer/experimenter's neglect to observe any of the subject's activities except a single response.

** Note that with repeated presentation of the stimulus of a "reflex" response habituation occurs if the usual environmental consequence of (response to) the response is precluded. "Habituation" and "extinction" of an operant are most probably a single process, the distinction based on whether the behavior of the unmanipulated environment or the experimental environment present the consequent stimulus.

## Basic Dependence Operations (RS Ops)
### and the Processes controlled

| Class of Response-dependent Stimulus | | Dependent Stimulus Operation | Stimuli not necessarily previously occurring | | Stimuli necessarily presented dependently | Stimuli necessarily presented independently |
|---|---|---|---|---|---|---|
| | | | present (onset) | terminate; reduce (offset) | preclude, omit, withhold | preclude, omit, withhold |
| **Reinforcers** | transient | operation | 1 onset reinforcement ("operant cond") | 2 | 3 extinguish, habituate | 4 |
| | | *process* | *("operant cond")* | *— — —* | *extinction, habituati* | *not investigated* |
| | stator | operation | 5 onset reinforcement ("operant cond") | 6 offset punishment* | 7 extinguish, habituate | 8 |
| | | *process* | *("operant cond")* | *reduction in Rmeas* | *extinction, habituati* | *not investigated* |
| **Aversors** | transient | operation | 9 onset punishment | 10 | 11 extinguish | 12 avoidance training |
| | | *process* | *suppression* | *— — —* | *extinction* | *avoidance conditio* |
| | stator | operation | 13 onset punishment | 14 offset reinforcement | 15 extinction | 16 avoidance training |
| | | *process* | *suppression* | *escape cond.* | *extinction* | *avoidance* |
| **Neutral** (not identified as either) | transient | operation | 17 | 18 | 19 | 20 |
| | | *process* | *not investigated* | *not investigated* | *not investigated* | *not investigated* |
| | stator | operation | 21 | 22 | 23 | 24 |
| | | *process* | *not investigated**\ | *not investigated* | *not investigated* | *not investigated* |

* c.f. "loss," "cost"

** If the reader, you, will scratch your head each time you see a person with whom you are conversing give an instance of a single respons which you have identified, e.g., an eyeblink, a recurrent "uh," or "you understand," your "neutral" head scratch will most probably be responded to, and show itself to be an aversor... "Stop doing that!"

Table 5
The ESSES in the Dependence Operations.

There are several synonyms, and a variety of quasi-synonymous words and phrases for both reinforcer and aversor, each with its own swarm of connotations, and each used in differing social, linguistic, and theoretical contexts, for which reason, they are to be avoided. Here are some of them:

Skinner proceeded to combine the dependence operation with the stimulus operation, making the execution of the dependence operation depend ("contingent") upon the occurrence of the stimulus operation, *presentation*. This combination is the basic paradigm for all of the behaviors in the three step contin-

| REINFORCER | AVERSOR |
| --- | --- |
| positive reinforcing stimulus | negative reinforcing stimulus |
| reinforcing stimulus | aversive stimulus |
| positive reinforcer | negative reinforcer |
| satisfier | punisher |
| reward | penalty |
| gain | loss |
| goal | |
| pleasure | pain |
| pleasantness | unpleasantness |
| cathected object | |
| drive-reducer | drive-stimulus |
| | repellor |
| attractant | avoidant |
| hit | miss |
| right | wrong |
| end | incorrect |
| correct | |
| payoff | deduction |
| paycheck | negative outcome |
| positive outcome | |
| purpose | failure |
| success | dissatisfaction |
| satisfaction | |

gency, SRS. This major subclass of the dependence operations, the *discriminal* or *discrimination operations* has been widely used in the interpretation of *all* but so-called "rule-governed behavior" in behavior analysis. Such interpretation has too often appeared as a surrogate for research, when research is not difficult to carry out.

There is no need to summarize here the findings of behavior analysts who work within the Skinnerian framework.


## Response operations

The golf-pro is teaching a beginner. He shows the beginner how he grips the driver. The beginner tries to copy the grip. The pro says, "No! Not that way. This way", and moves the fingers of the learner's hands, one by one, into their 'correct' positions vis à vis one another and the club. "There —get the feel of it, and then try it again".

The attendants close in on the manic; they seize him, hold him down, and force his arms into the arms of a camisole. They tie the straps. The manic can no longer harm himself or others. He cannot move.

These are instances of the *Response Operations*, operations carried out in many contexts, whether in or out of the experimental laboratory, and about which little can be stated except how to carry them out.

The *response operations* carry out actions upon the individual or on his environment that use a physical force or mass of some magnitude to produce an action, or to preclude some action (including arrs and ells) from occurring.

The processes controlled by the response operations have seldom, if ever, been investigated; little systematic data are available on operations frequently carried out, either "naturally," in behavioral practice, or in the laboratory.

These operations are heterogenous; we cannot now systematically sort them out, for simple lack of data. We can, however, list some of the procedures carried out by experimenters with respect to an action or activity of the individual, independent of any stimuli which may be present or effective.

The experimenter may take action on a response:

1. He may *withhold a manipulandum* required for response: The experimenter may remove the bar from the Skinner box, the parent may remove the toy from the play-pen, the father may refuse to give the keys of the car to the teenager.

2. He may *block* a response, make it impossible for the individual to respond as before: The experimenter may lock the bar of the Skinner box so that it cannot move, the parent may lock the door to the liquor cabinet, the battery of the remote may be dead.

3. He may take action on the body of the individual: He may *restrain* him (e.g. tie the individual down, use a camisole or handcuffs, or otherwise prevent movement of any particular sort).

4. He may *force* an action similar to some chosen response, carrying out a response or a series of them on the individual such that the individual necessarily goes through the series of movements that simulate or parallel the experimenter's response. When little physical force is required, this has been called *putting-through*, by no means an inefficient way to produce a response. In training animals to perform spectacular feats for show, putting-through has proven effective, as golf and tennis coaches *also* know. Behaviorists have avoided the use of putting-through; it seems forbidden.

An exception appears in research requiring locomotion. Psychologists have found many ways to put their subjects through particular gaits: They build mazes requiring particular turns or climbs; they may, after initial training of their subject on a straightaway, remove a section, putting their subject through a jump, or insert a tank of water as a section, 'forcing' their subjects to swim. "Forcing" is applied to *putting-through* when the experimenter must do considerable work to put the animal through a behavior.

In our analysis of experiments, each of these paradigmatic operations may occur alone or in a series. Each controls processes, processes such as operant conditioning, respondent conditioning, habituation, extinction, and the like. It is characteristic of behavioral research that the paradigmatic operations are kept simple —although their particulars are varied to sometimes bizarre extremes, as in research using "schedules of reinforcement." In contrast, when the experimental researches of 'cognitive psychologists' are analyzed following these paradigms, they most often show a complexity of paradigmatic operations, thereby often rendering the results ambiguous in that they confound processes, meaningless outside of their theoretical context. It is needless to note that in such research the choice of the parametric values of the operations sometimes is made after exploratory work, and that the hypothesis of the investigator is not disconfirmed.

## Probe operations; remote probes

A further class of experimental operations are those carried out to demonstrate a process controlled by a paradigmatic operation. Like the paradigmatic operation, they parallel behavioral events that occur outside the formal experimental context.

In experimental research, the probe operation is often identical with the operations of measurements as they track the individual's performance. Sometimes, as in the conditioning process governed by the pairing of stimuli, the probe operation is the presentation of the first of the paired esses alone.

In experimental research, then, the probe operation that the experimenter carries out depends on both the categoric operations and the measurement operation possible. These are *immediate* probes which find their parallel in the Couch Potato's queries, "What channel is that?", or "Didn't the phone just ring?", and "What are you reading?"

The time at which the probe operation is carried out —when the question, as it were, is asked— is of major importance indeed.

*Delayed probes* define the full set of behaviors that are termed knowing, recognizing, remembering —remembering either 'what' or 'that' when communicative behaviors are the subject matter, and remembering 'to' or 'how' when communicating to others is irrelevant.

The behaviors given to *delayed* or *remote* probes have been a major part of the interests of "cognitive" psychologists; behaviorists have done little systematic work on remembering. Fettered by preconceptions, both linguistic and theoretical, which lead them to construct all manner of mental or neural loci/processes intervening both between an ess and its arr, and between paradigmatic operations and the time of probes of their processes, as well as between the probe, cognitivists have played an entertaining game that, on analysis, has had few important results. Their most compelling results have come when their experimental operations have been performed outside the laboratory or have occurred without experimental intervention.

It is encouraging that, in recent years, "direct theories of memory" are emerging. Operation analysis facilitates such research.

## Setting operations

Both *paradigmatic* and *probe operations*, whether they are observed occurring in 'real life,' that is, without experimental intervention, or in the laboratory, occur in a context, a particular set of circumstances. Their outcome is a function of that context, or, in the terminology of this system, it is a function of *setting factors*, all those variables of which the behaviors of both the observer/investigator and the subject are a function.

Such contexts are descriptively and experimentally investigated by the *Setting Operations*. The root we use, *set*, is here, very appropriately, a three-way pun: It has the connotation of a particular environment, as in a theatrical set; of a state of 'readiness' for a particular action, as in "ready, get set, go;" and of a mathematical set, a class of instances, members of a set.

Setting operations are procedures carried out vis à vis the individual which differentially alter the states of those essarr interactions that are available in his behavior repertoire. They hence enable the prediction of the likelihood of specified measures of the behavioral functions of objects, events, and actions, and hence an acceptable degree of control of the outcome of the paradigmatic operations. They determine to what degree objects and events will function as what class of stimuli, and thus which of the responses they interact with will be shown by the subject. That is, they control *behavior-sets*, a broad class of essarr interactions.[8]

Researches on behavior-sets and setting operations have been done in theoretical and experimental contexts that have obscured the common characteristics of behavior-sets. Misled by the diversity of setting operations and the ease with which they may be classified without regard for the behaviors they control, experimenters have developed concepts and designed experiments that have hence produced both contradictory and obscure results. Some tell us that "emotions" are disruptive, others say that they are "adaptive," and so on. The languages of "feeling" and of "attention," of "motive," "needs," "altered states of consciousness," "apprehensiveness," all obscure the data that show behavior-sets to be alike in membership and function.

---

8. Many recent discussions, papers, and books deal with setting factors, and their subset, setting operations, under the generic term "context." Thus we have "contextualism." Ryle, in writing about "dispositions" and "frames of mind," is referring to those interrelated sets of interactions that Operation-Analytic Behaviorism terms "behavior sets."

The fractionation of research by the historically based rubrics of 'perception,' 'emotion,' and 'motivation is manifest; it has had unfortunate consequences.

On the one hand, such categorization has precluded the study and recategorization of setting operations in terms of the behavior sets they control, and on the other, it has produced a plethora of theories of unobservable entities, "mental" or "neural," presumed to "explain" the particulars of some behavior-sets.

A rather different unfortunate consequence has been the restriction of the bulk of *behavioral* research on animals to work on only one such set, using only one class of setting operation. This is a set that has some unique properties. This setting operation is the deprivation of access to food from the individual. Conditioning processes are confounded with nutritional ones. The reinforcers used are the manipulanda that the subject himself removes from the environment by ingesting, eating, it. Nevertheless, generalizations derived from hunger and food are extended to, interpreted onto, all behaviors.

Setting operations are indeed diverse. They include

1. entry into a specific environment: of a person, say an upscale restaurant, or an experimental cubicle in a laboratory —or a funeral parlor; of a rat, into an open field; of a dog or a child, into a strange house.

2. the sudden attack of a dog, the shout "fire!" in a crowded theatre, the entry of a clergyman into an ongoing conversation, the onset of a 7.0 earthquake, a Playboy centerfold; the scent of a bitch in heat to a dog.

3. the statement of a set of instructions to a subject.

4. the immediate *removal* of a specific item from an environment, as in the absence of a television from its accustomed place —or the taking of food from an animal while it is feeding.

5. the protracted removal of substances necessary for survival —as in the "food deprivation" of hunger.

6. the occurrence, whether by plan or not, of a response operation.

7. the introduction of a drug into the individual, the fourth Martini, or the acid-loaded sugar-cube, crack.

And so on, and on.

All these are operations are events whose experimental or behavioral consequences have been studied under the many rubrics, each of which have been associated with its own vocabulary, methodology, and theory.

Setting operations, then, determine which objects and events in the environment of the individual at a given time will function as stimuli, which objects and

events which had been functioning as esses antecedent to the setting operation will no longer be effective, and hence, which responses interacting with the former will be observed and which interacting with the latter will be "disrupted" or disappear. Every setting operation determines a set of answers to the same question: What will the individual notice, what will he do about it, and what will be the consequences of what he does about it? What stimuli will be effective as reinforcing events? What stimuli will prove to be aversors? Setting operations, then, control *sets* of essarrs.

McDougall called these families of interactions "instincts," putting together "perception," "emotion," or "feeling" and "conation" (operants?) in his otherwise faulty theory. Others have called them "drives," an equally unfortunate term. They bear more than remote relationship to the James Lange theory of "emotion." Each of these labels for states of the individual, when certain behaviors will be observed and certain other behaviors will not, carry its own connotations, which a behavioral concept should not have. Our term is behavior-set —a state, a dispositional concept. Such states, for the time being, will necessarily continue to bear such names as 'fear,' 'sexual excitation,' 'anger,' 'hunger,' 'apprehension,' 'intoxication,' and even 'interest' or 'commitment,' as appropriate to the specifics of the setting operation.

## Communicative behaviors in behavior-sets

Of singular importance in these behavior-sets are those responses of the individual following a setting operation which have consequences for the behavior of *other* individuals of the same or other species, that is, those responses which are readily identified as stimuli for other individuals. Some of these, Darwin called "expressions of emotion." Every pet has its behaviors that inform its owner that it's hungry. Every postman can tell when he's likely to be bitten.

These communicative behaviors function as stimuli for a second (or more) individual, enabling him (them) to behave appropriately to the ensuing behaviors of the first individual. Indeed, such responses of the first individual often function as setting operations for the behavior of the second individual. At the common sense level, if two people are conversing and one individual says something to which the second individual "takes offense" and shows this in his behavior, then the second individual's behavior thereafter may show members of a behavior-set different than those which had been observable antecedent to the offensive remark. ("Smile when you say that!")

### Summary, basic concepts of Operation-Analytic Behaviorism

Operation-Analytic Behaviorism confines its vocabulary to terms ostensively defined, and to terms at no more than one remove from the ostensively defined. With experience in their use, these terms become ostensively defineable, e.g., one can point at a process in a cumulative record. Its statements and descriptions can be applied directly to events in the "real world."

In stimulus response interactions, the responsiveness of the environment must always be taken into account, whether it has been experimentally programmed or not. The environment is active, responsive. It is not inert, not a static warehouse of shelved goods. Responses produce environmental changes that are the response of both objects and events to the response of the subject. The latter serves as stimulus to the environment. Responding may and does change the function of parts of the environment, the events and objects in the environment that enter into the behavior of the individual; the events entering a stimulus class as members may become either more or less diverse. This is obvious when the environmental object or event is another individual with whom an individual is conversing. It also requires some individuals to reconsider their use of terms when the environment's response is the crash and shattering of a glass one has elbowed off the table, rather than the click of the relay closure produced by a rat or pigeon, the record of which "defines" the response in a Skinner box.

1. Paradigmatic operations parallel observable sequences that have not been produced by experimental manipulation, but occur without intervention. These experimental operations control processes, progressive changes in measures of behavior. The basic *paradigmatic operations* are robust in that they are easily performed, easily carried out in demonstrations, and that they show the occurrences of processes with minimal effort. When they are performed outside the laboratory, and when only one of the simple paradigmatic operations is carried out at a time, they prove relatively immune to the effects of the field of setting factors (other than instruction, for humans). One suspects that the processes controlled by the basic paradigmatic operations are primitive in that they show early the development of the behavior repertories both of a species and of an individual.

2. The operations of measurement, that is, the assignment of numbers to the behaviors observed, to use the vernacular, make the system work. Measurement, if only enumerative, identifies esses, arrs, and ells. It enters, explicitly or implicitly, into the definitions of the terms in this language of behavior. They

are critical for the description of the behaviors we observe in 'real life.' They are crucial for experimental research. So, to the formal experiment.

## Operation analysis of research: The Categoric Operations

Analysis of experimental research in terms of the operations carried out is imperative. As a basis of such analysis, we have developed Operation Analysis forms. These sheets permit the analysis of any report or research in terms of each of the actions carried out by an experimenter in the detailed planning and conducting of research, and in collecting, analyzing, and reporting the results obtained. Their format and content have been progressively modified with experience in their use.

The categoric operations that the new, most fully developed OpAnal Sheets require to be reported are presented in Table 6. Full information on these is required for the repetition of the experiment (and hence for the confirmation of its results). Figure 2 is a four-page, obsolete form.

These sheets permit the detailed analysis of experimental procedures and their results in terms of the *Categoric Operations*, which a published paper reports as having been carried out by the investigator(s). They reflect the choices made by the investigator in dealing with those Setting Factors that have been known to affect the behaviors of individuals of the various species that have been studied. The term *categoric* reflects the classification of such factors as they have been dealt with in the past.

Experience with the use of OpAnal sheets in examining research reports shows that published papers seldom report on all the categoric operations on which information is needed: Research can seldom be repeated, solely for lack of the information required. Omissions are inexcusable, whether they are due to an investigator's failure or disinclination to deal with a variable, to a failure to report it if it was considered in planning, or to its deletion by an overdiligent editor.

A full set of instructions as the Analysis of Categoric Operations will soon be available on the Internet.

UNIVERSITY OF TENNESSEE
September, 1972

BL/JS/RB/TH/WSV

| 1 - REFERENCES | | |
|---|---|---|
| 1.1 Title | | 1.2 Traditional References |
| KEYWORDS - | | |

| 2 - SUBJECT SELECTION | | |
|---|---|---|
| 2.1 Age | 2.3 Number | 2.5 Recruitment/Acquisition |
| 2.2 Species | 2.4 Sex | |
| 2.6 Grouping | 2.7 Group Assignment | 2.8 Behavioral Testing |

| 3 - OPERATIONS BEFORE THE EXPERIMENT BEGINS | 4 - MAINTENANCE UNDER EXPERIMENTAL CONDITIONS |
|---|---|
| 3.1 Bio-cyclical events | 4.1 Time (exact) |
| | 4.2 Bio-cyclical events |
| 3.2 Feeding | 4.3 Feeding and Maintenance |
| 3.3 Ambience | 4.4 Experimental Space |
| 3.4 Subject's History | |
| 3.5 Specific Experiment Related History | 4.5 Apparatus |
| 3.6 Pretraining/instructions | |

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5 - PHYSICAL STATUS, INTERVENTION, AND EXAMINATION

| 5.1 Physical Description | 5.3 Experimental Surgery | 5.4 Biochemical (: macological) In |
|---|---|---|
| | | 5.5 Examinations |
| 5.2 Nutritional Considerations | | |

6 - EXPERIMENTER CONTRIBUTION

| 6.1 Pilot Experimentation | 6.3 Experimental Design |
|---|---|
| 6.. Identification of Non Subjects Involved | |

7 - STIMULI, RESPONSES, AND DEPENDENT EVENTS

| 7.1 Stimuli | 7.2 Responses | 7.3 Dependent Events |
|---|---|---|

8 - PROCEDURES

| 8.1 Pretreatment Baseline Measures | 8.2 Treatments |
|---|---|

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_ MEASUREMENT AND ANALYSIS

| 1 T·chniques used to 9.2 Measurement | 9.3 Data Selection |
| --- | --- |
| ain Data | |

| .4 Data Analysis Techniques | 9.5 Graphic Displays |
| --- | --- |

~ SPECIFIC VALUES OF ALL VARIABLES

| 1 Independent Variables | 10.2 Experimenter Determined Probabilities of Occurrence |
| --- | --- |

| 3 Sequencing Rules | 10.4 Procedure Parameters of Trials or Operant Cycles |
| --- | --- |

OUTCOMES

Intra Subject or Group Treatment

Co·, ɔrative

1.3 Terminological

1.4 Side Effects

2 - PURPOSE

2.1 Introduction

2.2 Discussion

2.3 Summary

3 - EVALUATIVE COMMENTS

3.1 Critique of the Experiment | 3.2 Reviewer's Choice

### Summary: Operation-Analytic Behaviorism

Operation analysis is here defined as a systematic method for the gathering of data, for the evaluation of data that have been collected, and for the ordering, categorizing, and taxonomizing of results of research on the interactions of the environment and with the individual organism. Most simply put, its subject matter is the ongoing interchange, the conversation of the individual and his environment, most obvious in one special case of such reciprocal action —the conversation of one individual with another.

This may be communicated to you visually by the three diagrams of Figure 3. These will be recognized immediately by some as a variant of the diagrams with which J. R. Kantor so successfully communicated.

### Operation Analytic and 'Kantorian' Behaviorism

I started today by describing briefly how this systematization has developed along parallel tracks. These have not been precisely aligned in time; progress on one has facilitated further progress on the others. This is a work necessarily still in progress, and will continue to evolve.

As the system has developed, it has become progressively clear to me, as it doubtless is to some of you, that what emerges is experimental flesh for the systematic teachings and writings of J.R. Kantor. Work through many years has progressively thrust the system closer and closer to the principles that Robert Kantor relentlessly pursued from the publication in 1924 of his landmark *Principles of Psychology* until his death. Operation-Analytic Behaviorism is closest of kin to Kantor's *Interbehaviorism*, or more properly, to my reading (or misreading) of his writings.

The individual, embedded in his environment, is the locus of the many and varied interactions of ess and arr that relate him, or her, or it to the environment. These links, these identifiable interactions, are the subject matter of this behaviorism. Operation analysis provides a structure, a framework within which we may sort them out, arrange them, taxonomize them, independent of the identity of the particulars of the individual and the specificities of events.

Some years ago, I attempted to identify the distinctive characteristics of Kantor's psychology.

The first is *naturalism*, a study and investigation of behavior in ordinary, usual contexts, seeking their description in terms of those objects and events
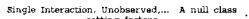
that occur and the environments in which behavior is observed. Second is *scientific pluralism*, the general proposition that each discipline, each science that deals with "the real world" (William James' "pure experience" or as Kantor would put it, "the event plenum") necessarily develops and must use its own distinctive and characteristic language and methodology for investigation. Thus, Kantor anticipated the later works of Wittgenstein, as in "Philosophical Investigations," by many years. Third, the subject matter of psychology in Kantor's terms is the interaction of stimuli, environmental objects and events, and responses, identifiable parts of the individual's behavior —that is, the progressive modifications of esses and arrs with continuing interactions. These evolve within the history of a species, of a community, and of an individual. Fourth, there is a rejection of the concept of causation encountered most often and most clearly in 19th century physics, but that remains all too obvious today, particularly in the view of a science as dealing with prediction and control of its subject matter. Prediction can be only probabilistic; control can be demonstrated only in restricted contexts. (In these terms, we can understand preoccupation with pigeons in Skinner boxes.)
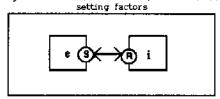
There are also characteristics of Operation-Analytic Behaviorism.
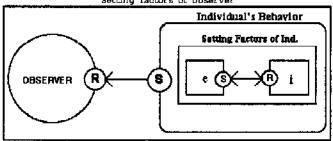
## Naturalism

The naturalistic approach that this behaviorism stresses is analogous to the naturalism espoused by Aristotle, whom Kantor identified as the first interbehaviorist. In the simplest terms, let us borrow a term, data-language, from the logical positivists. Naturalism demands that a science of behavior must begin with, rely upon, and always be able to return to the description of behaving in the *data language*. Our raw data must be reported in terms of the objects we sit on, the objects that we write on and then throw in the waste basket, and with the actions of writing and throwing themselves, in relation to the manipulanda —the objects needed if a response is to occur. Our data must include the events that occur, the flashes of lightning, the slammings of doors and the turnings on of a light. Such are the terms of the data. The activities of the individual organism, the activities of any individual of whatever species, are what the observer reports the individual as doing, as are the when and where he does 'it.' It follows that this naturalistic approach will necessarily demand ostensive definition, defining the names of objects and events by literally pointing at them or by demonstrating them, avoiding insofar as possible recourse to language. Naturalism implies point-at-ability. We must begin with the kind of communi-

Interaction*
Unobserved, Observed, and Experimentally observed

Single Interaction, Unobserved,... A null class
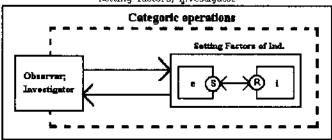setting factors



Simple Observation of the Behavior of an Individual
Setting factors of observer



What the observer will see, and be able to report, will depend not only on his/her behavior repertory, but also on setting factors.

Categoric Operations
carried out in the systematic ("exptal") investigation
to an individual

Setting factors, investigator



The setting factors controlling the behavior of an investigator of given behavior repertory include the theory or hypothesis he/she is testing.

cating we fall back into in developing language when we encounter a community that shares no spoken language with us.

In ostensive definition, to ensure that different observers identify that they can then talk and write about a single class of the objects, events, or actions, we must rely on accounts of them by different observers. The enumeration of a class of objects, events, or actions is the unique method of ensuring that two or more individuals communicating with one another on what each has observed agree on their spoken or written report of what they observe. Enumeration, whether explicit or not, is fundamental.

Most behavioral events, that is, interactions of the individual with the environment, are protracted in time; there is an exchange of activities of both the environment and the individual. Communication in respect with these is most effectively presented by demonstration, that is to say, by going through the set of events when another individual is observing so that the second individual can repeat the same sequence of interbehaviors insofar as this is possible for any one individual to replicate the behaviors of another.

*Scientific pluralism* is no more than the proposition that every science develops its own systematic procedures for the gathering and ordering of observations and hence evolves a language whose vocabulary includes terms ostensively defined within that observational methodology. In practice such languages may show a limited commonability of terms. Nevertheless, some terms of one may differ radically from those in another. A foreshadowing of scientific pluralism was perhaps given by Wilhelm Wundt, who defined physics as the science of experience studied as independent of the observer, and psychology as the science of experience studied as dependent on the observer.[9]

Kantor extended such a distinction: He differentiated physics, the science based on the MKS system and the concept of energy, from biology, the science of organisms in causative relationships, change in the organism dependent on environmental change, which Kantor summarized as S-R. Separate from these, he placed psychology, the science whose subject matter is defined by the reciprocal interaction of S to R, S—R. Kantor's pluralism anticipated Wittgenstein's later writings on the "language games" of the sciences. In the course of development of the systematic view now presented, languages related to ours can be

9. Ironically, many physical scientists recognize that their subject matter is the product of the instruments they build and the theories they write. Some then proceed to attempt to explain "consciousness." Many psychologists, on the other hand, seem engaged in attempting to explain 'experience'. in terms of "consciousness." Operation-Analytic Behaviorism is a term for this system. "Phenomenal," "phenomenalistic," and "phenomenological" were tried and rejected: too many connatations.

identified; they are those of three sciences that bridge. One of these is psychophysics; the other two are physiological psychology (which includes neuropsychology) and ergonomics, which relates the individuals' activities to physical work.

*Interaction as Subject Matter*

This psychology, this Operation-Analytic Behaviorism deals with the behavior of the individual and of the environment as end terms of an interaction at a time and place. Psychophysics deals with the relationship of such behaviors to the physical media that enable (and limit) such interactions, relating behavior from its point of occurrence to, if I may oversimplify greatly, the skin. In like manner, physiological psychology relates behavior to events that are occurring inside the skin, although here, there may be a more significant boundary than the skin isolating the interbehavioral event.

That the interaction of S and R is the subject matter of Operation-Analytic Behaviorism has been made explicit in this paper. Equally explicit is the role of interacting variables as affecting such interactions; this is implicit in the concept of field.

*"Cause"*

In his naturalistic view of the world, Aristotle identified four classes of "cause": material, formal, efficient, and final. A convenient way to look at things, this may be compared to Tinbergen's view. He defined ethology as the study of behavior from four points of view: first, that of "causation," approximately equivalent with Aristotle's efficient cause; second is *ontology*, the development of behavior as observed in the individual; third, the *evolution* of the behavior, its antecedents in species from which the species of which an individual is a member has evolved; fourth is *function*, defined as *survival value*, that is, the consequence for living and reproducing of the behavior, perhaps equivalent to Aristotle's final cause. Rather than 'causes', these are categories for descriptions of behaving; they bear more than passing resemblance to Aristotle's classification of cause.

A language of causality is often used when a behavior cannot be identified until it has been completed, completion defining the *"end."* In the Skinner box, a response is not counted until the relay closes: The "end" identifies the antecedent. On this rests a reading of the phrase "prediction and control." *Barker*, as

I recall, gave a more extended example, in an observational descriptive study of boys going through the woods while also carrying out many, many different behaviors. The *episode* could not be identified until the full sequence of activities was completed: The boys were "going fishing", which they could do only when they reached the pond. Cause: a word to be avoided. Both of these may be considered as instances of 'final cause,' or 'purpose.'

But prediction and control apply, with a degree of precision, only under very restrictive circumstances, for example, the Skinner box or the armed forces. Unfortunately, this phrase has effectively limited the behaviors that behaviorists have been willing to investigate.

When, however, we note that *enumeration* is basic to this conceptual system, probabilistic predictions may be madeas Skinner has stated many times in some contexts.

Operation-Analytic Behaviorism is thus congruent in characteristics with Kantor's interbehaviorism, just as it is with behavior analysis as it is done, rather than as it is described.

Operation-Analytic Behaviorism, with its roots in Pavlovian, Watsonian, Hullian, Skinnerian, and philosophical behaviorisms, grew from the attempt to reconcile the behaviorism of ethology with these antecedents. It developed along five tracks, the first of which is a glossary, a primitive thesaurus, and then a glossary and thesaurus of some 5000 terms, explicitly empirically defined as possible. This has been a project of some thirty years duration, of fits and starts, and is still going. A second track has been an experimental one, some of it in the lab, but more importantly in the classroom or anywhere that simple operations could be carried out and demonstrated, with both confirmation and disconfirmation of earlier findings guiding method. In this work, the applicability of operation analysis to human behavior —especially to verbal (communicative) behaviorhas been shown. A third track, the systematic analysis of experimental research as reported, has been pursued, always with emphasis on descriptions and report in data language, rather than on "theory"on constructions, if you prefer. A fourth has been observation —of people, of dogs, cats, of targets of convenience. The fifth has been the (usually) critical reading on the research of other sciences as they have been translated into language intelligeable to the layman.

Progress in one track has interrupted progress in others, to the benefits of each other track when it returned to priority.

All these tracks have interacted with one another and progressively converged towards the systematic, the Baconian, taxonomic system that I take to be all but identical with the views first expressed by Kantor in 1924.

Kantor's writings were not the foundations of this structure —the foundation I have just summarized. They *did* prove to be descriptive of the structure itself. They seem to show where we are now —and more importantly, to indicate how and where to pursue investigating.


## New directions

What directions should an Operation-Analytic Behaviorism take, as its vocabulary and analytic methods continue to develop and become refined?

First, there is the review and critical evaluation of published research so that it will be possible to assimilate much of the findings of "cognitive" and other research, possible only when their experimental methodology and results have been reported completely enough so that both evaluation and repetition can be carried out.

Second, in all cases, all uses of descriptive statistics must be scrutinized closely. When the behavior of a number of individuals is studied, such statistics must be calculated over the number of css-arr interactions, not over scores based on a number of the interactions of each individual. Averaging over a population of individuals shows "learning" as a process that is a relatively slow progressive change in behavior. Averaging over instances of a behavioral event following a paradigmatic operation more often shows saltatory changes in measure. The "learning process" of the literature is an artefact of the statistical operations applied to data. There is no such process; the term "learning" is a conflation of processes.

Third, operation analysis provides the methodology required for clean, simple, straightforward research on behaviors which, at first sight, seem remarkably complex, and have hence remained unstudied. Such research can be carried out and its findings then applied by behaviorists who work to ameliorate the behavior of troubled people.

Fourth, the systematic categorization of findings should tell us where to look next; it will show areas that are empty, or all but empty of data. Table 4, presented earlier, shows several such areas explicitly.

Fifth, operation-analytic research will yield "generalizations" under restricted conditions and will proceed by guess and by doing what comes next, not

by theory. By 'restricted,' we mean limited to the populations and environments from which the generalizations are drawn. Current practices in psychology, using inferential statistics, typically identify the human species as an infinitely large population of sophomores at, say, the University of North Nowhere through the spring semester, 1989.

Sixth, theory construction is an entertaining game.[10] Like professional athletes, players of this game are paid salaries for playing it (sometimes even badly); some attract a large and noisy group of spectators, some of them supporters, and some supporters of the other team.

Who won the Super Bowl in '66? Was the Hull-Tolman game a tie? Who refereed it? Remember Babe Ruth? Spence? What about them Jets?

If one were to ask in which broad area of behaving I hope and expect that the Operation-Analytic Behaviorism of the coming years will take as a primary subject matter, I would answer communicative behaviors, those shown by individuals in interacting, one with another. The speaking and "comprehending"/"hearing," the writing and reading of people are readily accessible to research. They are certainly not 'new' as subject of study; the volume of experimental work on language, and even more of theory, speaks for itself. Little of this, however, seems to recognize that "language" is a class of the behaviors of individuals, and not either a free-standing structure of rules with which we must comply or the fabrication of invisible entities.

Words, and some phrases, are unique in that they function simultaneously as both stimulus and response. They are responses to both antecedent objects and events, and to the words and statements that describe them, that is, each word is a response to stimuli concepts. Some words are the names of stimuli/concepts, a label we give them. At the same time, the identical occurrence of the identical word is stimulus for behaviors that follow them, at various probabilities. Each word controls a number of further interactions, some verbal and

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10   In designing experiments, in their choice of paradigmatic operations with specific values of esses, arrs, and ells, in determining the specifics of categoric operations, the theory-bound experimenters so often found working in the "cognitive" context behave like the contestants in Rube Goldberg contests. They start with their guess, an "hypothesis," which they work to "confirm" (that is, to fail to *disconfirm*). They have a boxful of gadgets ("intervening variables," "hypothetical constructs," "processes," and so on, often presented in some sort of flow-chart) which they can use to produce the outcomethe statement that is the same as their "hypothesis" and hence confirms it. Thanks to both previously published research and their own "exploratory research," they are able to find the specifics of a chosen categoric operation and string them together in a Goldberg apparatus that will produce the outcome they want. It is fun to watch engineering students compete in constructing a complex series of gadgets that will, say, strike a match or ring a doorbell. The operational analytic behaviorist finds the same amusement in analyzing the research of most cognitive psychologists.

some not; these may be termed its concept-set. The simplest and most restrictive example of such a set is this subset: the word associates given to it.

Humans speak and hear. They also read and write. These four behaviors must be investigated separately. Here are some specifics:

1. Operation analysis points out new directions for research on "applied" problems. One example falls in the area termed "reading disabilities" —the dyslexias. In verbal behavior, the spoken word is a transient stimulus for the hearer or watcher (in ASL) and a respondent for the speaker or signer. The *written* word is a stator for the reader, as well as a respondent of the writer that produces it. Could a hearing child, in listening to diktayshun, lern tu rite fonetiklee, then pronownss wot hee haz riten, and frum thiss, move through phonetically-spelled words to properly spelled English? An experiment might first be done in a community whose language is spelled phonetically. Should a child be taught to read and write at the same time? What does the literature on reading disabilities of children with some command of ASL suggest? This is surely worth a try.

2. And what are "thinking" and "problem solving?" These, too, operation analysis makes subject to behavioral research. Operation analytic research on "problem-solving" in concept identification shows that *confirmation*, the presentation to the individual of stimuli that control a notant (a descriptive statement) that has already been stated or written by him, is *at least* as effective a reinforcer as a "right," a "point," a coin, or an M&M. Rather than being recognized as such, behavior analysts refuse to study —even to observe— such confirmations, thereby ignoring the way they themselves (and little children) learn to operate a computer. An ambiguous doctrine of "rule-governed behaviors," which are described as independent of the contingencies of reinforcement, is uncritically accepted, enabling cognitivists to find a broad audience that finds them plausible, and that recognizes behaviorists as agreeing in principle with Newt Gingrich, who insists that students should be paid cash for learning.

3. In all our communicative behaviors, what are the environmental events that control a word, a gesture? Almost no instances of behavioral research can be found on the environmental control of humans' speaking or writing of words. Yes, Skinner did a little in the late thirties, but then moved into interpreting verbal behavior. Many have studied the lexical meaning of words, and of their etymology. And yes, the philosophical behaviorists Wittgenstein and Ryle have made a bold initiative. And yes, when Koch led a group of psychologists to examine the problem of defining, their solution was the same as our starting point: *pointing* —a *gesture* with respect to an object or event.

Within the terminology and procedures of operation analysis, what is the "meaning" of words defined by other words? Of "consciousness," which papers in BBS aim to find "taking place" in the brain?

In recent years, the development of a science of metaphysics has been not only advocated, but even initiated by both behavior analysts and philosophers —at least one logician— and many others who have not become enamored with brain tissue or who do not remain addicted to nitpicking examination of the relationship of words that have no referent, no stimulus other than words, to other such words. In most philosophies, ostensive definitions and confirming measurements remain adamantly unavailable or absent. Operation-analytic methodology, with its stress on the functional relationships of objects, events, and activities to one another, should prove a necessary complement to psychophysics and sensory psychophysiology in this initiative for a new science.

4. In the classroom, as well as in the lab, research on language that can be done includes statistical analyses of the occurrence of words in speech and writing. Such work, clarifying the determining antecedents and determined consequences of the occurrences of one word, is now readily done, given the development of electronic methodology.

5. Behaviorists need to further investigate the ordering of words in speech and writing, that is, syntax, in its relationship with the ordering in space and time of the environmental events to which they are related. The environment is very active and responsive. Much of the syntax of the environment has been described by physical scientists. Such study should relate the syntax of speaking and writing to the syntax of events, rather than to the workings of inherited mental dispositions such as a "language instinct." We know something of the syntax of movement; we've all tried to pat our heads with one hand and simultaneously rub our stomachs in circles with the other. We may now discover how the syntax or grammar of human languages is a function of the workings, the orderliness, the syntax, of the environment. Theories on how new sentences are to be written or spoken should be replaced by data drawn from an analysis of the ordering of the behavioral events they are related to.

The dust cover of a recent book, "The Language Instinct," informs us that this book shows "How the Mind Constructs Language." What operation analysis of language can show is "How Language Constructs the Mind."

6. But human language, replete with words and showing syntax, is only one class of our communicative behaviors. As Skinner, in his book "Verbal Behavior" and elsewhere, has made clear, "verbal behavior" is a misnomer for the broad class of human communicative behaviors. These include painting, sing-

ing, and drawing diagrams such as Kantor's lucid, even eloquent examples. Which behaviorists study these?

7. Finally, we need to enquire into communicative behaviors between individuals of different species. Surely the dog 'understands' some of his master's speech in complying with commands. Surely, too, these behaviors enable us to state that dogs are alert, "aware," and even "conscious." We, in turn, identify the different behaviors (some of them "intention movements") that 'tell us when' the dog is hungry or "needs to go out" and so on.

Let me summarize. What I have tried to present is a systematic viewpoint for the investigation of behavior that has developed progressively, and will continue to do so. It is one that may open doors to broader generalizations, to 'explanation' and 'understanding,' but not to a theory of behavior.

We will, I am sure, lay the mind to rest and exorcize the unnatural and the supernatural, however elegantly hypothesized and renamed. The hand-written note found the next morning on the night table by Kantor's deathbed read, "no spirits, wraiths, hobgoblins, spooks, noumena, superstitions, transcendentals, hupuks, invisible lords, supreme creators, angels, demons". Well put!

## References

1. As available in your library, or through interlibrary loan, read critically among the books catalogued under the following names:

Hull, Clarke

James, William (especially, *Essays on Radical Empiricism*)

Kantor, J.R.

Merleau-Ponty, M.

Ryle, Gilbert

Skinner, B.F.

Stevens, S.S.

Tinbergen, N.

Wittgenstein, L. (after 1945)

2. Browse among the journals listed under "psychology," "ethology," etc. But find and read the papers (selected by title) in the Psychological Review by Johnson, H.M.