

## **SPECIFYING PSYCHOLOGY'S OBSERVABLE UNITS: TOWARD AN INTEGRATION OF KANTOR'S *BEHAVIOR SEGMENT*, SKINNER'S *OPERANT*, AND LEE'S *DEED***

Daniel K. Palmer  
*Monash University*

**ABSTRACT:** Psychologists sometimes discuss the need to refine clear designations of the observable units comprising their subject matter. This paper links such discussions to (a) Dewey and Bentley's (1949) account of specification as relatively accurate unit-designation, and (b) the logical base of scientific classifications and abstractions in observable particulars. The paper then reviews, clarifies, evaluates, and contrasts the psychological units proposed by Kantor (behavior segment), Skinner (operant), and Lee (deed). Overall, Lee's deed is found to be the sharpest, least ambiguous designation, and the only specification. Deeds, fields of contributors, and contingencies are then used to selectively integrate aspects of all three units. The resulting integration is consistent with field-based approaches to causal relations within and among units, where the noun *cause* is synonymous with *one of many contributors*. It is also applicable to the analysis of feedback loops, which are designated as circular networks of dependency among subclasses of deeds.

**Key words:** Psychology's observable units, Dewey & Bentley (1949), specification, Kantor's behavior segment, Skinner's operant, Lee's deed, feedback loops

The progress of a science is marked by a growing certainty as to subject-matter, and a clearer conception of the nature of that subject matter. (Walker, 1942, p. 569)

### **On Clarifying Psychology's Observable Units**

#### ***Existing Discussions***

Psychologists sometimes discuss the need to refine clear designations<sup>1</sup> of their observable particulars in the sense of the units,<sup>2</sup> items, or single cases into which

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<sup>1</sup> I herein use *designation* in the Oxford English Dictionary's (OED's) leading sense of "the action of marking or pointing out; indication of a particular. . .thing by gesture, words, or recognizable signs."

their subject matter is analyzed for the purposes of a scientific account (e.g., Barker, 1963; Kantor, 1938/1971; Kolb, Jacobs, & Petrie, 1987; Lee, 1995; Midgley & Morris, 1988; Miller, Galanter, & Pibram, 1960; Murray, 1951; Newton, Engquist, & Bois, 1977; Reed, Montgomery, Palmer, & Pittenger, 1995; Rogoff, 1992; Skinner, 1938; Staddon, 1967; Thompson & Zeiler, 1986; Zinchenko, 1985). Miller et al. (1960) expressed the matter as follows:

Most psychologists take it for granted that a scientific account of the behavior of organisms must begin with the definition of fixed, recognizable, elementary units of behavior—something a psychologist can use as a biologist uses cells, or an astronomer uses stars, or a physicist uses atoms, and so on. Given a simple unit, complicated phenomena are then describable as lawful compounds. That is the essence of the highly successful strategy called “scientific analysis.” (p. 21)

Such discussions typically acknowledge that scientific analysis *begins* with observable units (e.g., Dewey, 1930, p. 415; Kolb et al., 1987, p. 220; Lee, 1988, p. 28; Zinchenko, 1985, p. 97). That is, psychologists, like all scientists, *must* analyze their subject matter into manageable units (observable items) before they have anything to count, measure, manipulate, classify, or theorize about.<sup>3</sup> For this reason, such units should be designated clearly and communicably. As Skinner (1938) emphasized in his seminal discussion of behavioral units, “we always analyze. It is only good sense to make the act explicit—to analyze as overtly and as rigorously as possible” (p. 9).

Despite recognition of (a) the necessity of designating units and (b) the importance of making that designation explicit, the relevant discussions are dispersed throughout psychology’s various guilds, remain unintegrated, and seem to be on the decline. Miller et al. (1960) lamented, “for the most part, serious students of behavior have had to ignore the question of units entirely” (p. 23). Zinchenko (1985) observed that “in contemporary psychology. . .the problem of . . .units. . .is rarely brought up at all, and only then in historical context” (p. 99). Sidman (1986) discussed the historical context in which “the problem of behavioral units. . .was swept under the rug” (p. 213). Such meager attention has unquestionably contributed to psychology’s much-discussed lack of consensus about appropriate units of analysis (e.g., Kantor, 1963, p. 4; Lee, 1988, pp. 2-3; Rose, 1996, p. 104; Walker, 1942, p. 569).

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<sup>2</sup> In this paper the term *unit* is not to be confounded with the phrase *unit of measurement* (e.g., millimetres or Joules). I use *unit* in the specific sense of a thing (object or event) distinguishable from a background, or, in the OED’s phrasing, “a single individual or thing. . .; one of the separate parts . . .of which a complex whole. . .is composed or into which it may be analysed.”

<sup>3</sup> This is not to say that scientists need define their starting units *explicitly*, but that they cannot get started without them. In an enlightening discussion, Dewey (1930) explained: “What [the physicist or chemist] starts with are things [e.g., oil and water, iron and tin] having *qualities*, things qualitatively discriminated from one another and recurrently identifiable in virtue of their qualitative distinctions” (p. 415). Consider also Van Melsen’s (1961) “quantitative data are always obtained through measurements, and measurements always presuppose something qualitative. The object to be measured has to be distinguished from its surroundings. . .” (p. 54).

## PSYCHOLOGY'S OBSERVABLE UNITS

In the interests of reviving discussions about appropriate psychological units, I will shortly attempt a critical integration of three different suggestions regarding *a* (as opposed to *the*) suitable unit for psychological analysis. First, however, I will outline some emphases in the conceptual orientation from which the integration will proceed.

### *Specification*

In their *Knowing and the Known*, Dewey and Bentley (1949) developed a taxonomy for assessing the relative accuracy of unit-designations (which they called event- or existence-designations). Designating was equated with naming, where, among other things, “naming selects, discriminates, identifies, [and] locates. . .” (p. 147). Dewey (1944, cited in Ratner & Altman, 1964, p. 266) had previously explained that to name “is to identify-by-distinguishing; to elect or select; that is, to pick out something from other things and identify it by its difference from them” (p. 266). Dewey and Bentley (1949) distinguished three gradations of name,<sup>4</sup> ranging from evolutionarily primitive *cues* through everyday commonsense *characterizations* to the most accurate, efficient, or firm *specifications*.<sup>5</sup> An example of cue is a warning cry alerting one’s companions to an immediately present predator. An example of characterization, which makes up the bulk of everyday conversation, is *whale*, where whale is considered to be fish in that it lives in water like other fish.

It is only at the next level of *specification* that the relatively accurate names underlying modern science emerge. An example of specification is *whale* when whale is considered a mammal (and no longer a fish) as an outcome of controlled inquiry. Dewey and Bentley (1949) described specification as follows:

Specification is the type of naming that develops when inquiry gets down to close hard work, concentrates experimentally on its own subjectmatters [sic], and acquires the combination of firmness and flexibility in naming that consolidates the advances of the past and opens the way to the advances of the future. (p. 162)

As this statement implies, specifications were always grounded in communally accessible observations of spatio-temporal events. Further, given that names identify-by-distinguishing, specifications (as relatively firm names) do so with minimal ambiguity or vagueness. With respect to usage in contemporary psychology, for example, the specification *neuron* is less ambiguous than the vague characterization *intelligence*. Finally, specifications were never fixed or complete; “the regions of vagueness remain in specification, but they decrease” (p. 166).

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<sup>4</sup> Naming was located between behaviorally basic *signaling* and behaviorally advanced mathematical *symboling*; these latter two ranges are not discussed here.

<sup>5</sup> The OED (which Dewey informally referred to as his “bible”) defines *specify* as “to mention, speak of, or name (something) definitely or explicitly.”

In sum, Dewey and Bentley described simple *cues* and vernacular *characterizations* as relatively inaccurate or vague unit-designations. They reserved the name *specification* for the most accurate (and yet ever-improvable) designations of observable units available to a community of scientific observers. In this paper I use the names *designation*, *characterization*, and *specification* as Dewey and Bentley did. Accurately specified units are my goal, and accuracy of designation is the criterion against which I evaluate existing unit descriptions.

### ***Particulars, Classes, and Beyond***

A focus on specifying observable units does not deny the more abstract, logically subsequent, and typically mathematical phases characteristic of mature sciences. While grounded in unique particulars (which have ideally been specified), science soon proceeds to abstractions (e.g., classifications, laws, and mathematical symbolizations). The components of Quine's (1957) tentative scientific ontology, for example, were physical objects (i.e., spatio-temporal particulars), classes of physical objects, classes of classes, and so on up. Feibleman (1944) likewise suggested actual objects, abstractions from actual objects, abstractions from abstractions, and so on. As discussed by Bunge (1959/1979, p. 270), it is only within such abstract domains that scientific laws have their purview (in the sense of holding only for classes, such as the class of all physical objects). Whitehead (1911) combined the above points as follows:

To see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought. In the eye of science, the fall of an apple, the motion of a planet around a sun, and the clinging of the atmosphere to the earth are all seen as examples of the law of gravity. (p. 11)

In seeking increasingly abstract and broadly applicable accounts, however, it is a mistake for scientists, especially in fledgling sciences, to neglect the logically prior designation of particular, observable units. Murray (1951) acknowledged this in discussing psychology's inclination to "leap over all the tedious stages of observation, description, and classification through which chemistry and all the biological and medical sciences have passed, and find shortcuts to eminence via logical positivism and mathematical models" (p. 436, see also Thompson & Lubinski, 1986, p. 220). A focus on designating observable units, therefore, is merely an attempt to begin at the beginning.

### **The Psychological Units of Kantor, Skinner, and Lee**

With a focus on accuracy of unit-designation and with an eye toward critical integration, I now review (and where necessary, clarify), evaluate, and compare the psychological units proposed by J.R. Kantor, B.F. Skinner, and V.L. Lee.

### J.R. Kantor (1888-1984): The Behavior Segment

For Kantor, all psychological events consisted of “interactions between organisms and objects” (Kantor & Smith, 1975, p. 32). More specifically, Kantor (1938/1971) argued that “the psychologist is obliged to construct a descriptive unit simple and stable enough to enable him to understand what is essentially continuous and integrated. Such a descriptive tool he constructs in the form of a behavior segment” (p. 34). As Kantor went on to explain, “essentially the behavior segment is an abstraction designed to fixate a definite spatio-temporal event. This event can be analyzed into a series of factors operating in a specific framework which may be designated as a field or setting” (p. 34). In understanding the behavior segment, two of the just-mentioned factors, which Kantor named *response function* and *stimulus function*, are central. I will discuss what Kantor designated with these two names in detail before considering additional factors.

#### *Response Function and Stimulus Function*

Kantor (1959) wrote:

The behavior segment, that is the unit psychological event, centers around a response function (rf) and a stimulus function (sf); the first is identified with an action of the organism, the second with an action of the stimulus object. The acts of referring to a building as a *house*, *casa*, or *maison* represent different modes of response functions. The building's act of stimulating one or another of these actional patterns is the stimulus function. (pp. 15-16)

Note that for Kantor, response function (what the organism does—but see below) and stimulus function (what the stimulus object does) exist only together. In this respect, the relation between response function and stimulus function as equally critical, codefining aspects<sup>6</sup> of a single behavior segment is analogous to the relation between husband and wife as equally critical, codefining aspects of a single marriage. For Kantor, a response function without a stimulus function (or vice versa) makes as much sense as a husband without a wife (or vice versa). This differs from alternative conceptions, in which stimulus and response may exist separately, and a stimulus, for example, may precede and elicit or occasion a response. To distinguish his conception of response (as rf) and stimulus (as sf) from alternative conceptions (e.g.,  $R = f(S)$  or  $S \rightarrow R \rightarrow S$ ) Kantor used a bidirectional arrow ( $R \leftrightarrow S$ ).

The names *stimulus* and *response* are notoriously ambiguous (Gibson, 1960; Kantor, 1933/1971, pp. 82-86; Schoenfeld, 1976). It was in trying to decrease this ambiguity that Kantor came to emphasize the contrast between *stimulus and response functions* and the *stimulus objects and actions of organisms* in which they respectively inhered (Kantor, 1942/1971, p. 78). This change in emphasis partially

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<sup>6</sup> I use the noun *aspect* in Dewey and Bentley's (1949, p. 290) sense of a component of a full situation or system knowable only as a component of that system. As Bentley (1954, p. 315) notes, *aspect* is also a verb, where *to aspect* means *to observe in system*.

explains a lingering ambiguity in Kantor's discussions of the response function—an ambiguity that I will clear up before continuing. In his more detailed analyses Kantor spoke of an action of the organism as “harboring,” “carrying,” “constituting the vehicle of,” or “being the locus of” the response function, where the response function was said to “inhere” or “be localized” in the organism's action (e.g., 1938/1971; 1942/1971; 1959, pp. 93-94). In such discussions Kantor emphasized that response function and organism's action “must be differentiated” (1959, p. 93). Occasionally, however, Kantor wrote in ways that concealed this differentiation. In his prominent 1959 definition of the behavior segment, for example, he wrote that the response function “is *identified with* [italics added] an action of the organism” (p. 15).<sup>7</sup> It is important to appreciate that while Kantor sometimes equated the organism's acts and response functions, he more often emphasized their differentiation. I now examine Kantor's basis for the differentiation (along with the corresponding differentiation between stimulus object and stimulus function) to further clarify both the nature of response and stimulus functions and their relation to the rest of the behavior segment.

Kantor's motivation for the differentiation was the lack of any one-to-one relation between stimulus and response functions and the stimulus objects and the acts of the organism in which they inhered. Some actual examples offered by Kantor (e.g., 1938/1971, p. 47; 1942/1971, pp. 78-79; 1959, pp. 93-94) on this point were that (a) different objects, such as a hammer or a pair of pliers, may serve the same (stimulus) function of driving a small tack into a picture frame; (b) the same object, such as a sheet of paper, may serve different (stimulus) functions such as writing notes or wrapping a gift; (c) different actions, such as nodding the head or saying “yes,” may serve the same (response) function of indicating assent; and (d) the same action, such as throwing a stone, may serve the different (response) functions of moving the stone or doing something about a threatening dog.

These examples are important because they reiterate first that Kantor's stimulus and response functions are inseparable, “mutual and reciprocal” aspects of single behavior segments. In addition, they show that stimulus and response functions are single events viewed from different perspectives or what Kantor called “symmetrical poles.” Whether “driving in a tack” is called a stimulus function, a response function, or a unitary functional relation between the two, for example, depends on the aspects of the situation to be emphasized (or “aspected” in the previously mentioned sense of Bentley). Kantor focused above on “driving in a tack” as a stimulus function common to various objects. If, however, he focused on the fact that a tack can be driven in via a tapping or pushing action, he would be coming from the response perspective to the unitary function (i.e., driving in a tack) achievable via two alternative actions. For the purpose of this

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<sup>7</sup> Probably an additional contributor to these misleading presentations in Kantor's writing is the linguistically attractive tendency to describe the acts of organisms and the acts of stimulus objects as symmetrical complements within the behavior segment. Properly speaking, however, the lines of symmetry run organism-object, act of organism-stimulus object, and response function-stimulus function (where stimulus function *is* the act of the stimulus object; see Kantor, 1946/1971, p. 17).

specific emphasis, “driving in a tack” would now be called a response function. I will return to this important point in the coming discussion.

***Behavior Segment as Field***

Having clarified (and with the intention to shortly clarify further) the two central aspects of any behavior segment, I now consider additional factors. In addition to being “bipolar acts” (Kantor, 1924, p. 36) or “symmetrical and reciprocal functions” (Kantor, 1959, p. 93), behavior segments were viewed as “integrated systems of factors” (Kantor, 1921, p. 15) or “concrete field structures of confrontable elements” (Kantor, 1969, p. 382). As such statements suggest, Kantor emphasized that every behavior segment involved the coming together or assemblage of many different participants or contributors in what he called an interbehavioral field or setting. In more detail, a behavior segment, like any other event, “is regarded as a field of factors all of which are equally necessary, or more properly speaking, equal participants in the event” (Kantor, 1959, p. 90).

Factors participating in or contributing to<sup>8</sup> a behavior segment (e.g., changing gear while driving) included the action of an organism (various hand movements), a stimulus object (the gear stick), contact media (the tactile surfaces by which the stick is felt and the light by which it is seen), an interactional history<sup>9</sup> (a history of gear-changing experiences), and setting factors (e.g., the rev limit of the engine, an upcoming slope). When drawing attention to these additional factors, Kantor expanded  $R \leftrightarrow S$  to  $PE = c(k, rf, sf, hi, st, md)$ , where PE stands for *psychological event*, “*c* indicates the inclusion of all necessary factors, *k* the specificity of the factors for particular situations, *rf* the response functions, *sf* the stimulus functions, *hi* the behavioral history of the organism, *st* the setting factors, and *md* the media of stimulation contacts. . .” (Kantor, 1970, p. 106). This expanded formula should be read as a heuristic device rather than a mathematical formula. If interpreted as a mathematical formula it would be uncertain what to make of *k* and *c* because *k*, or the specificity of the other factors, is placed inside the parentheses as if it was itself a factor, which it is not. Likewise, *c* could misleadingly suggest that the “inclusion of all necessary factors” was itself an additional function of these factors, which it is not. Rather, the formula is merely a compacted version of the statement “any psychological event entails the necessary inclusion of the following specific factors: *rf*, *sf*, etc.”

On the relation between the different components of each behavior segment or interbehavioral field, Kantor wrote “it is an essential rule that the primary interbehaving factors—for example, stimulus objects and [the acts of] organisms—

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<sup>8</sup> While Kantor more often referred to factor *participation* than *contribution*, he used both terms, and I rely more on the latter due to its central usage by another of the theorists to be reviewed later in the paper (Lee), thus easing the upcoming integration. Additionally, while including the connotations of *participate*, the verb *contribute* carries the useful additional connotation of *active* participation. Compare “participate: to take or have a part or share of or in” with “contribute: to do a part in bringing (it) about; to have a part or share in” (OED).

<sup>9</sup> Which resolved to *reactional biography* on the side of organism’s action and *stimulus evolution* on the side of stimulus object.

must be interrelated to other factors, even though the latter are regarded as peripheral” (Kantor, 1959, p. 19). Further, the particular (response–stimulus) functions arising in any behavior segment “are conditioned by the interbehavioral setting, which constitutes the framework of any particular behavior segment” (1959, p. 94).

Figure 1 portrays the behavior segment in a diagrammatic fashion intended to assist in clarifying both its own internal relations and its relations to yet-to-be-reviewed units. Each C symbolizes one of the different factors contributing to any psychological event. Each arrow is a synonym for “contributes to.” I will shortly clarify the figure, which draws less on Kantor’s own figures than his writings and specific examples of behavior segments.

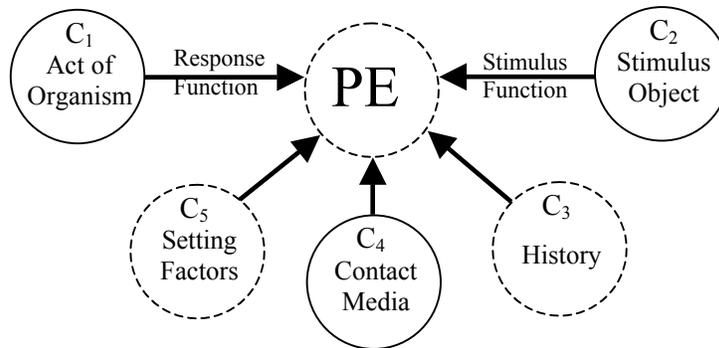


Figure 1. Kantor’s behavior segment unit, consisting of a psychological event (PE) and its many contributors ( $C_{1-5}$ ), which for Kantor included the act of an organism ( $C_1$ ), a stimulus object ( $C_2$ ), interbehavioral history ( $C_3$ ), contact media ( $C_4$ ), and setting factors ( $C_5$ ). Arrows are synonyms for *contributes to*, where the phrase “ $C_x$  contributes to PE” is synonymous with the phrase “PE is dependent on  $C_x$ ” or “PE would not have happened without  $C_x$ .” Note that *response function* designates the contribution of an organism’s act to PE, and *stimulus function* designates the contribution of the stimulus object to PE. Continuous circles indicate accuracy of designation and dashed circles indicate ambiguity or vagueness of designation.

### ***Is Behavior Segment a Specification?***

Having outlined Kantor’s proposed unit for psychological analysis, I now explore the accuracy with which he designates that unit (where the name *specification* applies only once highly accurate designation has been demonstrated). Recalling that to designate is to point out or indicate, the first question is whether one can unambiguously indicate instances of behavior segments by pointing them out. It will help to imagine oneself observing a psychological activity (e.g., a child writing a letter) while attempting to indicate a behavior segment to a co-observer naive to Kantor’s writings.

## PSYCHOLOGY'S OBSERVABLE UNITS

Observe initially that at least some factors contributing to behavior segments may be unambiguously designated. In Figure 1, such factors are indicated with continuous circles. We need not quibble over whether they are all accurately designated for present purposes, and I grant the skeptical reader some leeway with the dashed circles surrounding two of the factors leading into PE (the dashed circle surrounding PE being a separate matter to be dealt with shortly). In the example of co-observing a child writing a letter, certain acts of the organism (e.g., movements of the pen), the stimulus object (e.g., the notepad), and the media of contact (e.g., light from the window) are readily distinguished and consented upon. The same might be said of certain setting factors such as the time being between that associated with coming home from school and going to bed or the fact that the television is temporarily broken.

So far so good. Then our co-observer says “okay, you’ve indicated an act of the organism, the stimulus object, the contact media, and some setting factors—but what about the behavior segment you mentioned earlier?” To this, the interbehaviorist (a name inclusive of Kantor and other psychologists aligned with his system) replies “the behavior segment is simply the way in which all these things come together—their total interaction in the field.” Feeling that the groundwork is now laid to designate the stimulus–response function at the heart of the behavior segment, the interbehaviorist continues: “The stimulus function is how the notepad affects the child’s interaction with it (the notepad) and is defined by its relationship to the interbehavioral field, especially to the response function and not on the basis of the notepad alone. Conversely, the response function is how movements of the pen affect the child’s interaction with the notepad and is defined by its relationship to the interbehavioral field, especially to the stimulus function and not on the basis of the pen movements alone.”<sup>10</sup>

At this point the interbehaviorist receives a bewildered gaze from his originally keen-eyed co-observer. Something has gone wrong. Such definitions of behavior segments and stimulus–response functions are obscure. The obscurity (and consequent bewilderment) is unnecessary in that a more precise designation is already available, if typically implicit, in Kantor’s writing. Let me substantiate this claim.

While one may point out at least some of the (conceptually) separable contributors to a behavior segment, there does not appear, at first glance, to be anything to point out in addition to these contributors (apart from making relatively vague references to their “total interaction” or similar). To review, the behavior segment is a configuration of confrontable elements centering on a bidirectional relation between an act of an organism (in which inheres the response function) and a stimulus object (in which inheres the stimulus function). In turn, the resulting stimulus–response functional relation is defined with emphasis on the

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<sup>10</sup> These wordings adapted from Morris’ (1982) definition of stimulus function as “how a stimulus affects an organism’s interaction with it” where “stimulus functions are defined by their relationship to the interbehavioral field, especially to the response functions, and not on the basis of their stimulus forms alone” (p. 203). The reason I omit the helpful and arguably indispensable real-life example by which Morris clarified these definitions will become clear shortly.

two central participants (stimulus objects and the acts of organisms) and then their various peripheral (but no less integral) accompaniments, all of which together constitute a behavior segment or interbehavioral field. In attempting to point out a behavior segment on the basis of its formal definitions, one's finger is drawn from the whole field of contributors to the functional relation at their center, then from the functional relation back to the field of contributors.

Consider something Kantor wrote in critiquing the traditional deterministic notion of *cause*: "The flame of a match in no wise determines or creates an explosion but only completes the syncrasy [i.e., the configuration] of the individual factors necessary for a certain event to occur, including the presence and flammability of the exploding materials" (1984, p. 29). Here Kantor points out that one thing, an explosion, cannot occur without an appropriate assemblage of other things, such as a lit match and a cask of dry gunpowder. The latter are among the contributors to the former, just as stimulus objects and the acts of organisms are among the contributors to psychological events. In the case of the explosion, however, there is a specifiable something (namely the explosion) that can be conceptualized *without explicit recourse* to that something's contributors (though their presence is implied). One can point out, count, and classify explosions without pointing out, counting, or classifying the various contributors to explosions. This is not so clearly the case with behavior segments. In a behavior segment, the closest equivalent to *explosion* is *stimulus-response functional relation* or, more generally, *organism-object interaction*.<sup>11</sup> Yet Kantor, as outlined above, defines both of these with explicit reference only to their participants (and vice versa). Behavior segments are "integrated systems of factors" or "complex interactions." *Interaction* points to *actions* and *actions* points to *actors*.

The path to firmer designation lies in the following observation. Whenever Kantor offers a specific example of a behavior segment, organism-object interaction, or stimulus-response functional relation, it is in the form of an everyday verb like *referring*, *driving*, *writing*, *wrapping*, *indicating*, *saying*, *moving*, or *pressing*. The role of such verbs in Kantor's writing is not trivial. Like explosions, one can consider the events designated by the verbs of everyday action language in conceptual isolation from their contributors. One can count and classify instances of writing a word, sentence, or letter, for instance, without counting or classifying pen movements and notepads (which are co-present nonetheless).

This observation clarifies the designation of stimulus and response functions. Having designated a verb occurrence (Labeled PE in Figure 1),<sup>12</sup> the response

<sup>11</sup> Kantor listed criteria for distinguishing psychological behaviors, activities, reactions, or interactions from biological and physical interactions (e.g., 1924, p. 5; Kantor & Smith, 1975, pp. 4-11). Note, however, that such criteria, as attributes of some interactions, are secondary to the problem of specifying the criteria for distinguishing an interaction in the first place.

<sup>12</sup> On this interpretation, separate names should be secured for the verb-designated action-occurrence (PE in Figure 1) to which the other factors contribute and the sum total of all the factors inclusive of that to which they contribute (i.e., the entire figure). Where I have somewhat contentiously used *psychological event* for the former, *interbehavioral field* or *behavior segment* encompasses the latter appropriately and is consistent with Kantor's usage.

function is accurately designated as *the contribution an organism's act makes to that occurrence* and the stimulus function as *the contribution a stimulus object makes to that same occurrence*. The inseparability of the two follows from the fact that they designate the contribution of different factors to a single occurrence. To take away the stimulus object, for example, is to preclude the occurrence and thus to simultaneously preclude realization of both stimulus and response function. If no notepad, then no writing a letter. If no writing a letter, no notepad contributing to writing a letter (stimulus function) and no movements of pen contributing to writing a letter (response function). The increase in accuracy of designation speaks for itself.

While the above differs in emphasis from Kantor's explicit formulation, it is consistent with his examples of stimulus and response functions (see especially 1938/1971, p. 47; 1942/1971, pp. 78-79; 1959, pp. 93-94). That is, the foregoing interpretation is not so much reading something new into Kantor as giving more emphasis to something ever-present, if ordinarily implicit. In the following two paragraphs I review some relatively explicit statements of these points in Kantor's writing.

Consider a series of statements from a key paper entitled *The Nature of Psychology as a Natural Science* (first published 1938). First, Kantor viewed the terms *stimulus* and *response* as referring to symmetrical poles or functions of unitary events: ". . . both stimulus and response are mutual and reciprocal phases of a single event which occurs under specific conditions" (p. 47). Second, Kantor used the stimulus function construct to illustrate the contribution of an (stimulus) object to these unitary events, just as he used the response function construct to illustrate the contribution of an organism's act: "the isolation of the stimulus-function phenomenon. . . shows us the contribution of the stimulus object to a behavior event. . ." (p. 45).<sup>13</sup> Third, the unitary events in question may be characterized (without explicit reference to contributors) as instances of the actions indicated by everyday verbs. Accordingly, Kantor's "in a chair there inhere numerous stimulus functions corresponding to the response functions of sitting in it, standing on it to reach something, etc" (p. 47) may be paraphrased as "a chair may contribute to *sitting down* or *reaching for something* among many other psychological activities (e.g., throwing, hitting, lifting, etc)."

Consider next a statement from Kantor and Smith (1975) which combines two of the above points. In discussing the active role of stimulus objects in psychological events, Kantor and Smith asked the reader to "reflect on how much the outcropping rock *contributes*, through its various properties, to the *perceiving* and *judging* behavior of the geologist" (p. 33, all italics added). Here again is unambiguous support for a reading of Kantor such that his stimulus function (and, reciprocally, his response function) most accurately designates the *contribution* of a stimulus object (or reciprocally, an organism's act) to a psychological event. Also in this statement we find, again, that when Kantor designates a psychological

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<sup>13</sup> Cf. Lichtenstein's (1983) definition of *stimulus function* as "the specific role played by the stimulus object in the psychological event. . ." (p. 11).

event without explicit reference to its contributors he relies on verbs from everyday action language (in this case the verbs *perceive* and *judge*).

The foregoing suggests that bringing a verb-designated occurrence into the foreground increases the accuracy with which behavior segments may be designated. This increase in accuracy of designation, however, remains at the level of characterization, falling short of specification, because while the events corresponding to the verbs of everyday action language may be pointed out, such verbs have relatively vague application criteria and relatively fuzzy boundaries. While most English-speaking people can readily indicate an instance of “sitting on a chair,” for example, discrepancies arise if they are asked exactly when the sitting act starts and ends, and whether various borderline examples (e.g., kneeling on a chair) qualify. For these reasons Jacobs et al. (1988) repeatedly found their students unable to make consistent descriptions and classifications on the basis of what they called the “intuitive and informal classes of behavior” (p. 3) designated by everyday verbs. As I shall emphasize later in the paper (and as argued by Dewey, 1930), everyday action language constitutes an appropriate *starting point* for psychological analysis as opposed to an appropriate *result or conclusion*.

### **Summary**

Kantor’s behavior segment unit explicitly acknowledges the various factors contributing to any psychological event (many of these factors remaining neglected in contemporary psychology). Kantor accurately designates at least some of these contributors. Kantor’s designation of the core event to which the various factors contribute, however, is obscured with a formal over-reliance on relatively vague names like *organism–object interaction*.<sup>14</sup> This obscurity is ameliorated with a focus on Kantor’s specific examples of behavior segments. These examples revert to the commonsense verbs of everyday action language. Accuracy of designation is advanced if the ingredients of behavior segments are defined in terms of contributions to events designated by names like *write* or *perceive*. In particular, Kantor’s *stimulus function* designates the contribution of a stimulus object to such an event, and his *response function* designates the contribution of an organism’s act to that same event. Given that in arguably its clearest designation the behavior segment relies on the verbs of everyday action language, and given that such verbs fall short of specification, Kantor’s behavior segment likewise falls short.

### **B.F. Skinner (1904-1990): The Operant**

Skinner proposed the *operant* as an analytical unit for psychology. The operant is best understood in the historical context of its development, which I now sketch. Early in his career Skinner (e.g., 1935; 1938) examined the concept of the *reflex*, traditionally understood as a response elicited by a stimulus such as a knee-

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<sup>14</sup> Dewey and Bentley (1949, e.g., pp. 295-296) discuss the problematic ambiguity of the name *interaction* and particularly the prefix *inter* as used in philosophy, psychology, and logic (though see Kantor’s 1984, pp. 303-304 response).

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jerk elicited by a tap on the patellar tendon. Using such an example, Skinner (1935) reached a conclusion basic to his later work:

[I]f we are to continue to regard the flexion reflex as a single entity, both the stimulus and the response must be taken (tentatively, at least) as class terms, each of which embraces an indefinitely large number of particular stimuli or responses but is sufficiently well defined by the specification of one or two properties. (p. 42)

In other words, after distinguishing a number of instances of, say, “knee-jerk reflexes,” two classes of different instances (i.e., one class of responses and one class of stimuli) can be distinguished. These different instances differ in many ways (e.g., direction, amplitude, and latency, in the case of responses), but they have been classified on the basis of something they all have in common. To define a knee-jerk reflex one must clarify the basis for classification (i.e., one must specify some criterion or commonality that unites all otherwise unique instances). In Skinner’s words, “. . .we assign a name to it [a recurring aspect of behavior] which specifies (perhaps not explicitly) a defining property” (1935, p. 56) and “here again we merely specify what is to be counted as a response and refuse to accept instances not coming up to that specification” (1938, p. 37).

These quotations suggest that Skinner was attempting to specify basic analytical units from the outset (in the sense of *specification* discussed earlier in the paper). Early in his career he extended his approach to what is sometimes called nonelicited, purposive, or voluntary behavior:

The unit of a predictive science is. . .not a response but a class of responses. The word “operant” will be used to describe this class. The term emphasizes the fact that behavior *operates* upon the environment to generate consequences. The consequences define the properties with respect to which responses are called similar. . .an operant is defined by an effect which may be specified in physical terms. . . (1953, p. 65)

Thus, in the domain of voluntary behavior Skinner distinguished movements (e.g., instances of lever pressing), forming classes (e.g., “lever pressing”), and specifying a common effect (e.g., microswitch closure) by which the instances were designated instances of the same (operant) class. Most experimental work in Skinner’s tradition defines operants accordingly, in terms of proximal consequences like microswitch closure (as reported, for example, in the *Journal of the Experimental Analysis of Behavior*). In many theoretical discussions (including Skinner’s), however, operants are inconsistently defined in terms of distal consequences like food or coin delivery (e.g., Sidman, 1986).<sup>15</sup>

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<sup>15</sup> As noted in an insightful analysis by Schick (1971), because an operant is a class of responses sharing a common property, it is logically inconsistent to define operants in terms of properties not extending to all members. To define an operant (e.g., lever pressing) in terms of a property (e.g., microswitch closure) on which reinforcement (e.g., food delivery) is contingent, for example, is unsatisfactory. Skinner and his intellectual descendants often discuss what happens to response instances of lever pressing (or similar) operants during extinction, superstition, and transfer, in which

Skinner's operant is often described in terms of two-term contingencies between behavioral particulars, called responses, and environmental particulars, called consequences (e.g., Schoenfeld, 1976; Sidman, 1986). An occurrence of the consequence is said to be contingent on an occurrence of the response. Operant contingency diagrams (and theoretical discussions) usually include a third term in the form of a preceding, *discriminative* (noneliciting) stimulus (which in practice is never absent), but this term does not influence the present argument and will be omitted. The two-term contingency is illustrated in Figure 2 by the arrow leading from behavior (B) to consequence (Cons) in the center left of the figure, the other aspects of which will be clarified shortly.

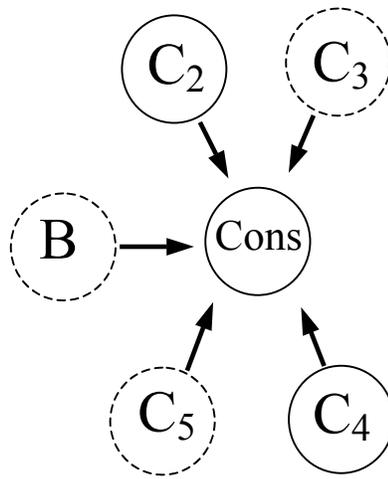


Figure 2. An illustration of a two-term contingency between a behavioral response (B) and its consequence (Cons). Also shown as  $C_{2-5}$  are additional contributors upon which the consequence is equally dependent. Arrows are synonyms for *contributes to*. Continuous circles indicate accurately designated contributors and dashed circles indicate ambiguously or vaguely designated contributors.

### ***Is Operant a Specification?***

As we have seen, an operant is a class of responses, not a spatially and temporally particular (i.e., observable) event. In other words, *this operant* is synonymous with *this class of responses*. A class is a logical entity that includes nonactual and future possibilities, so a class of responses is not an observable particular just as a class of trees is not an observable particular. One cannot point out a class of trees but only a particular tree or collection of trees (Lee, 1988, p. 31).

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cases reinforcement *is not* contingent on microswitch closure (see Catania, 1973, for an attempt to overcome such difficulties).

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Here we must avoid a potential confusion, for all observable particulars are both individuals *and* members of classes or species. In Van Melsen's (1961) words, "what we mean, then, by the species-individual structure of matter is the peculiar fact that every concrete material thing alongside its concrete individuality at the same time represents a certain species" (p. 95). That is, a name such as *book* identifies certain particulars as exemplars of a more general class or species. Just as the designated particular is incomprehensible without the class it is a member of, the class is incomprehensible without the particulars it serves to unite.

Now Skinner defines his operant unit as a class rather than an observable individual, which, as just shown, simultaneously connotes the class of which it is a member. As a result, Skinner's operant remains always at one level of abstraction from individual occurrences. Where *book* applies on the one hand to individual books and on the other to the class *books*, *operant* applies on the one hand to individual (operant) classes and on the other hand to *operants* as a class of (operant) classes.

Accepting that the operant itself is not a designation of any observable particular, but of classes of observable particulars, we can ask whether those particulars, namely responses, qualify as accurately designated units. To take an unambiguous example of a response, consider a lever press response. When one designates a lever press response, what observable particular is distinguished? There are at least two distinct possibilities. The first is a movement of an organism's body or body parts. The second is a consequence or effect of that movement, exemplified here by a microswitch closure. While emphasizing movements, Skinner (1938) mentioned both kinds of observable particulars:

By behavior, then, I mean simply the *movement* [italics added] of an organism or of its parts in a frame of reference provided by the organism itself or by various external objects or fields of force. It is convenient to speak of this as the action of the organism on the outside world, and it is often desirable to deal with an *effect* [italics added] rather than with the movement itself, as in the case of the production of sounds. (p. 6)

Both movements and effects of movements qualify as accurately nameable observable units; they can be independently distinguished, counted, and classified. However, there is much ambiguity in Skinner's writing, and in the operant literature at large, regarding whether the units underpinning response classes (i.e., responses) are movements, effects, or some combination. Surveying the operant literature one finds that responses have been defined as movements (e.g., Skinner, 1953, p. 64), effects (e.g., Stebbins & Lanson, 1962, p. 299), temporal gaps between effects (e.g., Ferraro & Grilly, 1970, p. 206; Margulies, 1961, p. 319; Notterman, 1959, p. 342), and combinations of activities (movements) and effects (e.g., Glenn & Madden, 1995, p. 241). Further, many theorists have discussed the problem of distinguishing movements from effects (Guthrie, 1940; Hamlyn, 1953; Jacobs et al., 1988; Kitchener, 1977; Ryle, 1971; Weiss, 1924; Zuriff, 1985, p. 44) and the way in which the term *response* blurs the distinction (Lee, 1988, p. 159, 1999a; Schoenfeld, 1976; Walker, 1942).

To summarize, an operant, as a class, is not a well-specified observable unit. Further, the observable unit on which operants are predicated, the response, *is*, in both formal definition and experimental application, ambiguous between two possible classes of specifiable referents—movements and effects of movements. The operant, therefore, is not designated with sufficient accuracy to qualify as specification.<sup>16</sup>

### ***How do Operants Relate to Behavior Segments?***

Figure 2 suggests a novel conceptualization of the relationship between the behavior segment and the operant (for extant comparisons see Hayes & Fredericks, 1999; Midgley & Morris, 1988; Morris, 1982; Parrot, 1983). Here Kantor's emphasis on the multiple factors contributing to psychological events is combined with Skinner's emphasis on the effects or consequences that define behavioral responses, leaving open the question of whether responses themselves are movements, effects, or some combination of the two. As in Figure 1, the arrows feeding into the consequence indicate contributors without which the consequence in question would not have occurred. As an example, a particular instance of a particular lever depression at a particular moment by a particular rat, in the sense of the closure of a microswitch (i.e., a change in the state of the switch from off to on), could not occur without the rat, the movement of the rat, the lever, a supporting floor, contact media, and so on. While Skinner was primarily concerned with one of these contributors, which he named *behavior* or *response*, Kantor emphasized them all.

### **V.L. Lee (1949-): The Deed**

Lee (e.g., 1995; 1999a; 2001a; 2001b) suggests that an appropriate unit for psychology is the *deed*, defined as “. . . events (i.e., changes in a state of something) to which the individual's physical efforts (and much else) contribute” (2001a, p. 49), or, in everyday language, “something finished, completed, done, or brought about by someone” (2001a, p. 49).<sup>17</sup> When Lee defines a deed as a change she uses the term *change* in the specific sense of the meeting of a stipulated criterion:

I use the word “change” to denote the moment of a difference in the state of a particular object (or surface or medium). For example, a button depression is the change observed at the *moment of a specified difference* [italics added] at a particular button (for example, 2550 milliseconds since session commencement). It is important to accept that I am talking literally and only

<sup>16</sup> Cf. Bentley's (1952) conclusion in a draft of a letter to Skinner regarding an early version of *Science and Human Behavior* (1953): “I am not able to say with any certainty what the word ‘behavior’ ‘names’ in your treatment” (Dated February 22, 1952).

<sup>17</sup> For similar proposals see White and Liberty's (1976) *critical effect*; Newton et al.'s (1977) *break-point*; Gilbert's (1978) *accomplishment*; Reed, Montgomery, Schwartz, Palmer, & Pittenger's (1992) *concrete functional result within a task*; Järvillehto's (2000) *result of behavior*; and what Kemp (2002) has independently named *deeds*.

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about the change you would see if you looked at the button at that exact moment in time. Such changes either occur or do not occur. (Lee, 2001b)

Starting with the events designated by the relatively vague verbs of everyday action language, Lee developed the deed unit in the course of refining clearer designations of these same events (here using *thing done* as a synonym for *deed*):

Washing the dishes is something a person gets done. We would probably agree that the person has done that thing if (a) there were dirty dishes, (b) now the dishes are clean, and (c) that change in the state of the dishes would not have occurred without the person. The dishes have been done when a particular change in the state of the kitchen has been brought about (no dirty dishes, all dishes clean). You might say the person is now *doing the dishes* when you see her having effects that contribute to getting the dishes done (e.g., getting the sink full of water, getting successive dishes out of the water and onto the dish rack). However, you would not say she has *done the dishes* until the criterion implied above is met. . . . The specified change *is* the thing that the person gets done (i.e., completed, achieved, accomplished). (1999a, pp. 68-69)

Reminiscent of Kantor's emphasis on the multiple contributors to behavior segments, Lee stresses that deeds always have many contributors, including an organism (e.g., a human) and a thing changed (e.g., a gear stick). For Lee (2001a), deeds "are at the same time of the organism *and* the environment: They are events that have the physical efforts of the participant's body and much else as their constituents" (pp. 64-65, see also 1996a, p. 159). Accordingly, Lee (personal communication, 21 November 2002) considers a deed a *completion* in two senses: first in the sense of meeting a criterion and second in the sense of completing the configuration of contributors necessary and sufficient for the occurrence of a particular deed.

To summarize, Lee's deed is a moment of a stipulated difference (i.e., a change) in the state of an object, surface, or medium contributed to by the physical efforts of at least one individual organism among many other contributors. Figure 3 diagrams a deed along with its many contributors. Arrows retain the earlier meaning of "contributes to."

### ***Is Deed a Specification?***

Because a deed is equivalent to the meeting of a well-stipulated criterion, it is a specification. Deeds, such as changes in the state of a lever from up to down, changes in the state of food from absent to present, or the completion of successive words when writing, can be designated (i.e., indicated, distinguished, pointed out) without ambiguity or vagueness. Relatively speaking, Lee's unit designation is accurate enough to qualify as specification.

### *How do Deeds Relate to Operants and Behavior Segments?*

A primary difference between the deed and the previously reviewed units stems from the respective starting points of their developers. Both Kantor and Skinner started and remained with the traditional (borrowed) terminology of *stimulus* and *response* and the corresponding dichotomies of organism and object (Kantor) or behavior and environment (Skinner). In a landmark article Kantor (1921) wrote “what are these fundamental [psychological] data? Obviously, responses to stimuli” (p. 253). Despite recognition that “the terms [*stimulus* and *response*] are not used with precision” (1933/1971, p. 82), he stuck with them, attempting to pin their usage down within the context of his behavior segment. Turning to Skinner, he reached his conception of the operant while (a) trying to make sense of his data, and (b) considering the reflex as a correlation between classes of stimuli and responses. Skinner’s subsequent discussions of the operant remained with the language of responses, stimuli, and behavior–environment relations.

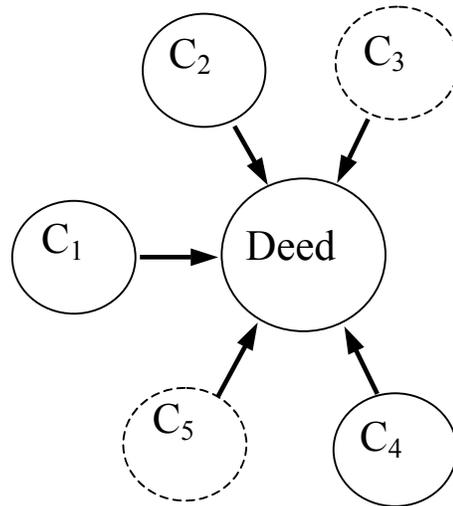


Figure 3. A diagram of Lee’s deed and various contributors (C<sub>1-5</sub>). Arrows are synonyms for *contributes to*.

In contrast, Lee began not only with an attempt to make better sense of operant data (more on which below) but with the events designated by everyday action language and common dictionary definitions of names like *behave*, *act*, and *do*.<sup>18</sup> Unlike Kantor and Skinner, Lee does not find the terms *stimulus* and *response* helpful in developing sharper designations of such events. Rather, she argues that they are ambiguous and misleading, that they “bring difficulties to psychology that cannot be answered by finding better ways to define them” and

<sup>18</sup> Consider, for example, the OED’s leading definition of *act*: “A thing done; a deed, a performance (of an intelligent being).”

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that “we must eliminate them from our technical vocabulary” (Lee, 1988, p. 159). To sum up, while behavior segment and operant rely on the names *stimulus* and *response*, a defining feature of the deed is their explicit rejection.

A related general contrast between the deed and the other two units concerns things people get done together, or what Järvillehto (2000) named *common results*. Consider a change in the location of a large rock to which three people contribute simultaneously. For Lee, this is as much a deed as deeds to which just one organism contribute:

If things done [i.e., deeds]. . .are the single cases [i.e., units] in psychology, then it does not matter whether a thing is done by one organism acting alone or by two or more organisms acting together. What matters is that the thing is done (i.e., that the particular change occurs). (Lee, 1994, p. 17)

Operants and behavior segments, by contrast, are both defined with respect to individual organisms, either in terms of responses emitted by individual organisms (operants) or stimulus–response functional relations to which the act of an individual organism and a stimulus object simultaneously contribute (behavior segments). Any link to common results is thereby indirect and must be interpreted in terms of combinations of separate operant responses or behavior segments. Direct applicability to mutually achieved outcomes is arguably an advantage of Lee's unit given their centrality in everyday life.

Turning to specific contrasts between the deed and the operant, the two differ in several significant ways. This is not surprising given that the deed unit was developed, in part, from Lee's criticisms of the operant (e.g., 1996b, 1999a) and her attempts to more adequately conceptualize the data (i.e., recorded particulars) collected in operant experiments (e.g., 1996a, 1999b, 2001a).

First, in accordance with the earlier discussion of the operant, “. . .a thing done [i.e., a deed] is a single case, particular instance, or a unit whereas a functional class (or an operant) is a class” (Lee, 1994, p. 33). That is, the time and place of a deed can be precisely stated (e.g., this door in this building changed in state from open to closed at 11:04:45 am today), which is not true of a class of responses defined by a common effect (i.e., an operant). As Roche and Barnes (1997) put it, “the operants that comprise behavior have no boundaries in the physical world” (p. 610). Additionally, even a response member of an operant class cannot be unambiguously bounded in space and time. If a response is defined as a bodily movement effecting a microswitch closure, for example, it is possible to say when the response ended (i.e., at the moment of closure) but not when it began.

A second point of difference relates to the above discussion of a lever depression in which a bodily movement was contrasted with an effect or consequence of that movement. Of these two phenomena Skinner was ambiguous, sometimes tending toward movements and sometimes toward effects. In contrast, Lee explicitly specifies what is ordinarily called the *effect*: “The changes brought about by one or more organisms comprise a subject matter that is distinguishable from the motions of the body segments and from the activities of other parts of an

organism's body" (Lee, 1992, p. 19). It was partially from acknowledging movement–effect ambiguity in the word *response* (also *behavior*) and the “need to find words that denote our subject matter more precisely” (1994, p. 11) that Lee explored alternative designations, including *act* (e.g., 1988), *thing done* (e.g., 1996a), and *deed* (e.g., 2001a).

As a third point of difference, Lee's use of the term *deed* is more inclusive than the term *consequence* or *effect* in Skinner's sense. Consider the respective interpretations that Lee and Skinner make of a cumulative record. A cumulative record is a visual representation of how at least two classes of events are distributed through time. In the majority of Skinner's research (e.g., Ferster & Skinner, 1957; Skinner, 1938) each increment in the slope corresponded directly to the closure of a microswitch, and each slash corresponded directly to the operation of a food dispenser. While Skinner argued that an increment followed by a slash represented a *lever pressing response* followed (and potentially reinforced) by an *environmental consequence*, Lee argues that both the represented events are more accurately specified as units of the same logical type—deeds. That is, Lee sees in the data files records of what Skinner would call effects, results, or consequences *and nothing else*. Lee's specification thereby unifies instances of what are traditionally seen as fundamentally different kinds of events (e.g., responses of the organism versus consequent environmental stimulation) under a common specification. For Skinner, some recorded events were of the organism (behavioral responses) and other recorded events were of the environment (antecedent and consequent stimuli). For Lee, all the recorded events are deeds, which are indivisibly of organism *and* environment in the sense of depending on contributions bodily *and* worldly. Indeed, Lee argues that “the units represented by psychological data are distorted by theories that partition psychological phenomena into two parts corresponding to organism and environment” (1994, p. 32). Where Skinner advocated the elucidation of functional relations between behavioral responses of the organism and their environmental consequences (and antecedents) Lee is concerned with the internal organization of the domain of deeds (meaning an interest in classifications of deeds and in relations or patterns among the resulting subclasses of deeds; Lee, 1992, p. 1341; 1994, p. 35). The difference in emphasis has major implications for experimental work (see Lee, 2001a, for a recent example).

Moving to the relation between the deed and the behavior segment, the first thing to note is that Lee's deed unit allows sharper designation of the verb-characterized occurrences on which the behavior segment relies. This is achieved by specifying the criteria to be met before some action is said to have occurred. The characterization “washing the dishes,” for example, is more accurately designated as a change in the state of the dishes from dirty to clean. If necessary, the designation may include nested deeds like a change in the state of an individual cup from dirty to clean or a change in the state of the hot tap from open to closed. In general, the resolution with which deeds are designated will depend on the requirements of the particular inquiry.

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Second, Lee resembles Kantor in explicitly acknowledging the many factors contributing to any instance of the deed unit. Take the earlier example of driving in a tack. From Lee's perspective, various objects (hammer, brick, etc.) and various movement patterns (pushing, tapping, etc.) are conceptualized as potential contributors to the same deed (a change in the state of the tack head from protruding from to flush with the relevant surface). That deed, in turn, may be taken in conceptual isolation from the many contributors that Kantor carefully categorized. Finally, where Lee is concerned with classifications of and relations among deeds, Kantor was more interested in systematizing the factors contributing to individual behavior events (i.e., their internal organization). For Kantor (1959), "events are scientifically described by analyzing [their] participating factors and finding out how they are related" (p. 90). To sum up, Kantor clarified the various factors contributing to events he characterized at the relatively inaccurate resolution of everyday action language. Adopting a compatible conceptualization of contributors, Lee more accurately designates (and, indeed, specifies) these same events.

### **A Preliminary Integration of All Three Units**

Having outlined and contrasted the psychological units of Kantor, Skinner, and Lee, I now explore any benefits accruing from their selective integration. I have argued that the behavior segment and the operant (or, for that matter, the response) are either not designations of *individual* units (the operant), are ambiguous (the response), or are relatively vague (the behavior segment). I have also argued that Lee's deed *is* a sharply specified individual unit.

Figure 4 suggests a preliminary integration of the behavior segment, the operant, and the deed. This figure retains Kantor's concept of a field of contributors and Skinner's contingency as a functional (if-then) relation between two subclasses of events. Lee's deeds, however, comprise the event subclasses so related. In accordance with the above discussion Figure 4 shows an instance of the deed subclass on the left (e.g., microswitch closure) as among the many contributors to an instance of the deed subclass on the right (e.g., a change in the state of food from unavailable to available).

The three central features of the proposed integration are as follows. First, Figure 4 centers on deeds in Lee's sense of moments of stipulated difference (i.e., changes) in the states of objects, surfaces, or mediums contributed to by the physical efforts of at least one individual organism. Recall that a deed is binary in that it exists at and only at the moment a stipulated threshold or criterion is reached. Further, subclasses of deeds are specifiable, such as "changes in the position of the computer mouse" and "changes in the position of the cursor on the computer screen," instances of which may then be related to each other.

Second, this exploratory integration incorporates Kantor's emphasis on the many contributors to psychological events, represented with the Cs leading into each deed subclass. It localizes psychological events in contributor fields including at least one organism and many other equally essential factors.

Third, the integration retains the (response–consequence) contingencies at the heart of Skinner’s account in terms of (if–then) relations of dependency among subclasses of deeds. It is such a dependency, for example, by which a change in the orientation of a car’s steering wheel contributes to a change in the angle of the front wheels (along with the various other contributors to that event). It is another such dependency by which that change in front wheel angle contributes to a change in the lateral displacement of the car on the road.

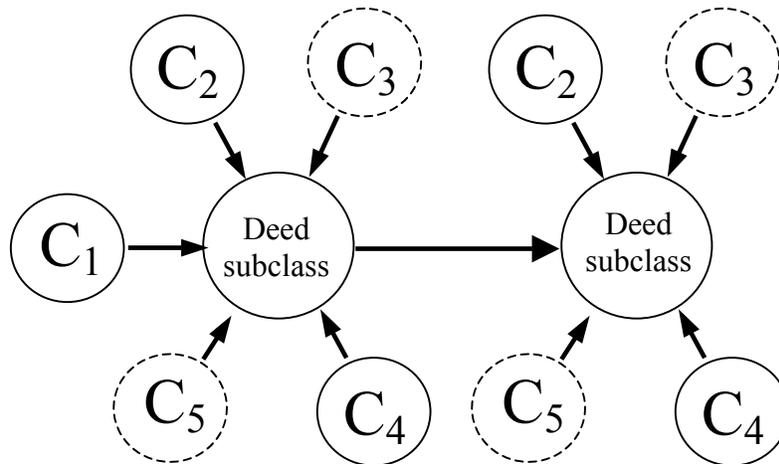


Figure 4. A dependency between two subclasses of deeds, where an instance of the right class (e.g., a change in the state of food from unavailable to available) depends on an instance of the left class (e.g., a change in the state of a microswitch from off to on) as one of its many contributors (i.e., as its  $C_1$ ). Arrows are synonyms for *contributes to*.

### **Causality**

The integration in Figure 4 supports a systemic yet experimentally manageable conception of causality. Where interbehaviorists have found Skinner’s operant compromised by its adoption of “environmental determinism” and “traditional causal philosophy” (Parrot, 1983, pp. 113-114), operant psychologists have expressed concern that Kantor’s behavior segment is too all-encompassing for any causal analysis. As Marr (1984) put it, “Kantor’s view may properly characterize the reality of the behavioral world, but it is difficult to see how an *experimental analysis* can be conducted in the midst of such chaos” (pp. 194-195, though see Smith (in press) for a review of behavior segment based experimental research). The present integration neither rejects causal analyses nor accepts simple one-way lineal causality, as detailed next.

A given deed depends on the assemblage of its various contributors in real time. To say that a deed depends on any one of its contributors is to say that particular deed would *not* have occurred *without* that particular contributing

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factor.<sup>19</sup> As Kantor wrote of the relation between a lit match and an explosion, the former merely completes the configuration of items on which occurrence of the latter relies. If there is to be any talk of *causes* in such a context, the term can only refer to what Weiss (1978) called “negative observations; a cause is a phenomenon *without* which an expected correlated change in nature would *not* take place” (p. 14; for similar comments and insights see also Ackoff & Emery, 1972, pp. 22-23; Kotarbinski, 1965, p. 15; Whitehead, 1920, pp. 143-144).

In addition to focusing on the configuration of factors contributing to individual behavior events, these contributors can be acknowledged but left as background to focus on dependencies between different behavior events, what are here named deeds. In discussing a complex set of dependencies between events qualifying as deeds, Oyama (2000) explained as follows:

These multiple dependencies ultimately make the metaphor of the linear chain inapt, though a scientist may excise part of the process to analyze it as if it were an isolated chain running off autonomously against the background of the rest of the system. To do so, however, all of that background must be held constant (treated as *given* as well as kept from varying). . . (p. 123)

This is precisely what happens in a traditional operant experiment. Typically, contributors such as deprivation (which Kantor would call a setting factor), lighting (Kantor's contact media), operanda (such as a lever, which for Kantor is a stimulus object), and so forth are held constant and thereby relegated to background, which allows a focus on relations among selected deed subclasses (e.g., among changes in the state of a backlit disk from green to red, changes in the state of a lever from up to down, and changes in the state of food from absent to present).

This treatment of causality, in which the word *cause* is either omitted or used cautiously as a synonym for *one of many contributors*, extends to the complex networks (i.e., patterns among deed subclasses) into which everyday human lives can be analyzed. As Lee (1994) put it, deeds “constitute a vast and changing domain that is spread through time and across space and manifests a remarkable density (i.e., events per unit time) and diversity” (p. 32).

Imagine an observational apparatus enabling a bird's-eye view of a spatially and temporally circumscribed region of such a domain or network. An example would be the deeds occurring in a classroom between time x and y, or the deeds directly contributed to by a certain person between time x and y. Further, imagine some level of resolution at which the observed deeds are interesting yet comprehensible in number (e.g., include words spoken but not phonemes articulated, steps taken while walking but not mid-step stages). Because any such visualization involves enormous quantities of deeds, imagine that the apparatus displays deeds as they occur (as colored dots on a screen, perhaps), gradually

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<sup>19</sup> Consider here Dewey's (in Dewey & Bentley, 1949) comment that “the words ‘not without’ are golden words. . .” (p. 286), concerning the observation that the fiddler and the fiddle are equally critical partners in (i.e., contributors to) the fiddling.

fading them out as time accrues, making space for the display of subsequently occurring deeds. Now train the apparatus on deeds contributed to by one particular person during the morning ritual of getting up and going to work. From our bird's-eye perspective we observe a fuzzy cloud of interrelated events proceeding from bedroom (e.g., alarm off, light switch on, body out of bed) to bathroom (e.g., hair combed, teeth brushed) to kitchen (e.g., toast cooked, newspaper read, breakfast eaten) to garage (e.g., trash out, engine started, reverse gear engaged) to road (e.g., horn sounded, pedestrian avoided) to elevator (e.g., button depressed, door opened) to office (e.g., computer switched on, e-mail retrieved) and so on.

To sum up, the present integration accords with a systemic, nonlinear conception of causality enabling complex dependencies among instances of deed subclasses to be mapped out in space–time.

### ***Loops***

In discussing psychology's basic units, many psychologists have emphasized feedback loops, variously designated as circles of organized coordination (Dewey, 1896), functional circuits (Ashby, 1960), test-operate-test-exit feedback algorithms (Miller et al., 1960), person-mediated environment-to-environment circuits (Barker, 1963), negative-feedback control loops (Powers, 1973),<sup>20</sup> circuits of differences making differences (Bateson, 1979), perception–action cycles (Swenson & Turvey, 1991), and balancing loops (Senge, 1994). The notion of feedback loops was also implicit in Skinner's discussions of operant contingencies in that the consequence of an instance of a response class has implications for future instances of that response class (cf. Baum, 1989). How might an emphasis on loops be combined with an emphasis on dependencies among subclasses of deeds? Figure 5 is one suggestion, portraying feedback loops generically as *circular patterns of dependency among subclasses of deeds*.<sup>21</sup>

Figure 5 shows how deed subclasses can be related in trains of dependencies that are circular. Here, an instance of one deed subclass contributes, via intervening instances, to a successive instance of itself (cf. Ashby, 1960, p. 50; Bateson, 1979, p. 104). As an example, a change in the orientation of the steering wheel when driving contributes to a change in the angle of the front wheels, which contributes to a change in the lateral displacement of the car, which may then contribute to a further change in the orientation of the wheel, and so on. While such sequences of deeds can be traced around in circles, it is misleading to attribute this sequential structure to the events themselves rather than the pattern in which they are being observed. In the above case of driving, instances of all three

<sup>20</sup> Powers' (1973) *control system* unit was included in an earlier version of this paper along with the behavior segment, operant, and deed. On the advice of an anonymous reviewer, however, the author has postponed his treatment of Powers' unit for a future paper.

<sup>21</sup> Importantly, Kemp & Eckerman (2001) also offered a diagrammatic analysis of iteration cycles among state transitions they designated *deeds*. Where Kemp and Eckerman's (e.g., p. 142) arrows indicated state transitions, the arrows in Figure 5 indicate *dependencies among* state transitions. Despite such differences in emphasis, the two accounts overlap considerably and the author is presently collaborating with Kemp toward their integration.

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deed subclasses are occurring (and thus contributing and being contributed to) simultaneously. As Shotter (1984) put it, “all the ‘parts’ of continuously functioning feedback loops, whether forming co-ordinations or not, are (1) in operation simultaneously, yet the feedback function depends upon (2) the co-ordination of a temporal succession amongst them” (p. 202).

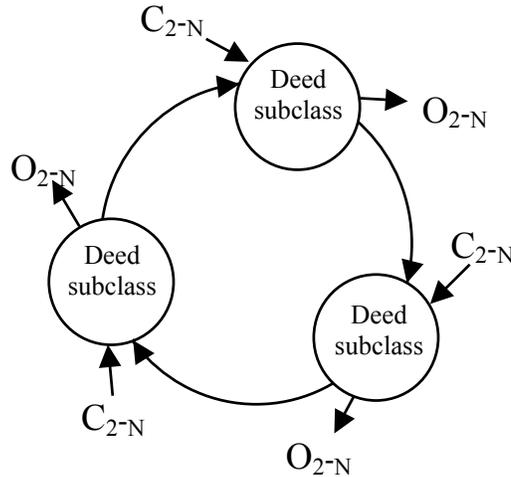


Figure 5. A circular network of dependencies among subclasses of deeds. Arrows are synonyms for *contributes to*. Each instance of each deed subclass has many contributors ( $C_{2-N}$ ) and contributes to many other events or outcomes ( $O_{2-N}$ ).

Three subsidiary comments. First, Figure 5 is a generic portrayal of feedback in that it applies equally to instances of positive (escalating or snowballing) and negative (homeostatic or regulatory) feedback. Which type, or which combination of types, emerges in a given situation is a function of how the individual modes of dependency (the curved arrows in Figure 5) combine in the total organization. Second, in addition to the many factors contributing to any given deed, Figure 5 incorporates (after Powers, Lee, and Dewey) what Dewey (1922/1957) called “the plural effects that flow from any act” (p. 212) or, in other words, the many nonfocal outcomes contributed to by any deed instance. Such outcomes are represented by the Os leading out from each deed subclass. An example is a bug unknowingly squashed when a step is completed while walking. Finally, note that for the purposes of examples like maintaining the lateral displacement of a car when driving, what Skinner called a *discriminative stimulus* may also be conceptualized as a deed (i.e., a change in lateral displacement).

Given that such feedback patternings are one of many possible configurations of interconnected deed subclasses, they remain consistent with the conception of causality discussed above (cf. Rosenblueth, Wiener, & Bigelow, 1943).

## Summary and Conclusion

I have applied Dewey and Bentley's (1949) account of naming to the problem of specifying psychology's observable units. In particular I have reviewed and preliminarily integrated Kantor's behavior segment, Skinner's operant, and Lee's deed. Unambiguously observable aspects of all three units were combined in the designation *dependencies* (Skinner, Lee) *among subclasses of deeds* (Lee), *which have multiple contributors* (Kantor, Lee) *and multiple outcomes* (Lee, Dewey, Powers). This designation accords with a systemic, nonlinear conception of causality, incorporating feedback circuits as circular patterns of dependency among deed subclasses.

I hope these conclusions will be read in the spirit with which they were reached. I have not advocated any one unit as *the* unit, nor any one terminology as *the* terminology. Rather, I have converged on one unit as *a* (potentially useful) unit and one terminology as *a* (potentially useful) terminology. In doing so I have aimed at what Dewey and Bentley described as "the combination of firmness and flexibility in naming that consolidates the advances of the past and opens the way to the advances of the future" (1949, p. 162).

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