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CHAPTER 3

CONSTRUCTS, VARIABLES, AND DEFINITIONS

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Scientists operate on two levels: theory–hypothesis–construct and observation. More accurately, they shuttle back and forth between these levels. A psychological scientist may say, "Early deprivation produces learning deficiency." This statement is a hypothesis consisting of two concepts, "early deprivation" and "learning deficiency," joined by a relation word, *produces*. It is on the theory–hypothesis–construct level. Whenever scientists utter relational statements and use concepts, or constructs as we shall call them, they are operating at this level.

Scientists must also operate at the level of observation. They must gather data to test hypotheses. To do this, they must somehow get from the construct level to the observation level. They cannot simply make observations of "early deprivation" and "learning deficiency." They must define these constructs so that observations are possible. The problem studied in this chapter is how to examine and clarify the nature of scientific concepts or constructs. This chapter will also examine and clarify the way in which behavioral scientists get from the construct level to the observation level, how they shuttle from one to the other.

Concepts and Constructs

The terms "concept" and "construct" have similar meanings, yet there is an important distinction. A *concept* expresses an abstraction formed by generalization from particulars. "Weight" is a concept. It expresses numerous observations of things that are "more or less" and "heavy or light." "Mass," "energy," and "force" are concepts used by physical scientists. They are, of course, much more abstract than concepts such as "weight," "height," and "length."

A concept of more interest to readers of this book is "achievement." It is an abstraction formed from the observation of certain behaviors of children. These behaviors are associated with the mastery or "learning" of school tasks—reading words, doing arithmetic problems, drawing pictures, and so on. The various observed behaviors are put together and expressed in a word. "Achievement," "intelligence," "aggressiveness," "conformity," and "honesty" are all concepts used to express varieties of human behavior.

A *construct* is a concept. It has the added meaning, however, of having been deliberately and consciously invented or adopted for a special scientific purpose. "Intelligence" is a concept, an abstraction from the observation of presumably intelligent and nonintelligent behaviors. But as a scientific construct, "intelligence" means both more and less than it may mean as a concept. It means that scientists consciously and systematically use it in two ways: (1) it enters into theoretical schemes and is related in various ways to other constructs (we may say, for example, that school achievement is in part a function of intelligence and motivation) and (2) "intelligence" is so defined and specified that it can be observed and measured (we can make observations of the intelligence of children by administering an intelligence test, or by asking teachers to tell us the relative degrees of intelligence of their pupils).

Variables

Scientists somewhat loosely call the constructs or properties they study "variables." Some examples of important variables in sociology, psychology, political science, and education are: gender, income, education, social class, organizational productivity, occupational mobility, level of aspiration, verbal aptitude, anxiety, religious affiliation, political preference, political development (of nations), task orientation, racial and ethnic prejudices, conformity, recall memory, recognition memory, and achievement. It can be said that a variable is a property that takes on different values. Putting it redundantly, a variable is something that varies. While this way of speaking gives us an intuitive notion of what variables are, we need a more general and yet more precise definition.

A *variable* is a symbol to which numerals or values are assigned. For instance, x is a variable: it is a *symbol* to which we assign numerical values. The variable x may take on any justifiable set of values, for example, scores on an intelligence test or an attitude scale. In the case of intelligence we assign to x a set of numerical values yielded by the procedure designated in a specified test of intelligence. This set of values ranges from low to high, from, say, 50 to 150.

A variable, x, however, may have only two values. If gender is the construct under study, then x can be assigned 1 and 0, where 1 represents one of the genders and 0 the other. It is still a variable. Other examples of two-valued variables are in–out, correct–incorrect, old–young, citizen–noncitizen, middle class–working class, teacher–nonteacher, Republican–Democrat, and so on. Such variables are called *dichotomies*, dichotomous, or binary variables.

Some of the variables used in behavioral research are true dichotomies; that is, they are characterized by the presence or absence of a property: male–female, home–homeless, employed–unemployed. Some variables are *polytomies*. A good example is religious preference: Protestant, Catholic, Muslim, Jew, Buddhist, Other. Such dichotomies and polytomies have been called "qualitative variables." The nature of this designation will be discussed later. Most variables, however, are theoretically capable of taking on continuous values. It has been common practice in behavioral research to convert continuous variables to dichotomies or polytomies. For example, intelligence, a continuous variable, has been broken down into high and low intelligence, or into high, medium, and low intelligence. Variables such as anxiety, introversion, and authoritarianism have been treated similarly. While it is not possible to convert a truly dichotomous variable such as gender to a continuous variable, it is always possible to convert a continuous variable to a dichotomy or a polytomy. As we will see later, such conversion can serve a useful conceptual purpose, but is poor practice in the analysis of data because it discards information.

Constitutive and Operational Definitions of Constructs and Variables

The distinction made earlier between "concept" and "construct" leads naturally to another important distinction between kinds of definitions of constructs and variables. Words or constructs can be defined in two general ways. First, we can define a word by using other words, which is what a dictionary does. We can define *intelligence* by saying it is "operating intellect," "mental acuity," or "the ability to think abstractly." Such definitions use other concepts or conceptual expressions in lieu of the expression or word being defined. Second, we can define a word by assigning expressed or implied actions or behaviors. Defining *intelligence* this way requires that we specify which behaviors of children are "intelligent" and what behaviors are "not intelligent." We may say that a seven-year-old child who successfully reads a story is "intelligent." If the child cannot read the story, we may say the child is "not intelligent." In different words, this kind of definition can be called a *behavioral* or *observational* definition. Both "other word" and "observational" definitions are used constantly in everyday living.

There is a disturbing looseness about this discussion. Although scientists use the types of definitions just described they do so in a more precise manner. We express this usage by defining and explaining Margenau's (1950/1977) distinction between constitutive and operational definitions. A *constitutive* definition defines a construct using other constructs. For instance, we can define *weight* by saying that it is the "heaviness" of objects. Or we can define *anxiety* as "subjectified fear." In both cases we have substituted one concept for another. Some of the constructs of a scientific theory may be defined constitutively. Torgerson (1958/1985), borrowing from Margenau, says that all constructs, in order to be useful scientifically, must possess constitutive meaning. This means that they must be capable of being used in theories.

An *operational* definition assigns meaning to a construct or a variable by specifying the activities or "operations" necessary to measure it and evaluate the measurement. Alternatively, an operational definition is a specification of the activities of the researcher in measuring a variable or in manipulating it. An operational definition is a sort of manual of instructions to the investigator. It says, in effect, "Do such-and-such in so-and-so a manner." In short, it defines or gives meaning to a variable by spelling out what the investigator must do to measure it and evaluate that measurement.

Michel (1990) gives an excellent historical account on how operational definitions became popular in the social and behavioral sciences. Michel cites P. W. Bridgeman, a Nobel laureate, for creating the operational definition in 1927. Bridgeman as quoted in Michel (1990, p. 15) states: "In general we mean by any concept nothing more than a set of operations; *the concept is synonymous with the corresponding set of operations*." Each different operation would define a different concept.

A well-known, if extreme, example of an operational definition is: Intelligence (anxiety, achievement, and so forth) is scores on *X* intelligence test, or intelligence is what *X* intelligence test measures. Also high scores indicate a greater level of intelligence than low scores. This definition tells us what to do to measure intelligence. It says nothing about how well intelligence is measured by the specified instrument. (Presumably the adequacy of the test was ascertained prior to the investigator's use of it.) In this usage, an operational definition is an equation where we say, "Let intelligence equal the scores on *X* test of intelligence and high scores indicate a higher degree of intelligence than low scores." We also seem to be saying, "The meaning of intelligence (in this research) is expressed by the scores on *X* intelligence test."

There are, in general, two kinds of operational definitions: (1) *measured*, and (2) *experimental*. The definition given above is more closely tied to measured than to experimental definitions. A *measured* operational definition describes how a variable will be measured. For example, achievement may be defined by a standardized achievement test, by a teacher-made achievement test, or by grades. Doctor, Cutris, and Isaacs (1994), studying the effects of stress counseling on police officers, operationally defined psychiatric morbidity as scores on the General Health Questionnaire and the number of sick-leave days taken. Higher scores and large number of days indicated elevated levels of morbidity. Little, Sterling, and Tingstrom (1996) studied the effects of race and geographic origin on attribution. Attribution was operationally defined as a score on the Attributional Style Questionnaire. A study may include the variable *consideration*. It can be defined operationally by listing behaviors of children that are presumably considerate behaviors and then requiring teachers to rate the children on a five-point scale. Such behaviors might be when children say to each other, "I'm sorry," or "Excuse me." Or when one child yields a toy to another on request (but not on threat of aggression), or when one child helps another with a school task. It can also be defined as counting the number of considerate behaviors. The greater the number, the higher the level of consideration.

An *experimental* operational definition spells out the details (operations) of the investigator's manipulation of a variable. Reinforcement can be operationally defined by giving the details of how subjects are to be reinforced (rewarded) and not reinforced (not rewarded) for specified behaviors. Hom, Berger, Duncan, Miller, and Belvin (1994) operationally defined reinforcement experimentally. In this study, children were assigned to one of four groups. Two of the groups received a cooperative reward condition while the other two groups received an individualistic reward condition. Bahrick (1984) defines long-term memory in terms of at least two processes when it comes to the retention of academically oriented information. One process, called "permastore," selectively chooses some information to be stored permanently and is highly resistant to decay (forgetting). The other process appears to select certain apparently less-significant information, and hence appears less resistant to forgetting. This definition contains clear implications for experimental manipulation. Strack, Martin, and Stepper (1988) operationally defined smiling as the activation of the muscles associated with the human smile. This was done by having a person hold a pen in his or her mouth in a certain way. This was unobtrusive in that the participants in the study were not asked to pose with a smiling face. Other examples of both kinds of operational definitions will be given later.

Scientific investigators must eventually face the necessity of measuring the variables of the relations they are studying. Sometimes measurement is easy, sometimes difficult. To measure gender or social class is easy; to measure creativity, conservatism, or organizational effectiveness is difficult. The importance of operational definitions cannot be overemphasized. They are indispensable ingredients of scientific research because they enable researchers to measure variables and because they are bridges between the theory–hypothesis–construct level and the level of observation. There can be no scientific research without observations, and observations are impossible without clear and specific instructions on what and how to observe. Operational definitions are such instructions.

Although indispensable, operational definitions yield only limited meanings of constructs. No operational definition can ever express the rich and diverse aspects of some variables, such as human prejudice. This means that the variables measured by scientists are always limited and specific in meaning. The "creativity" studied by psychologists is not necessarily the "creativity" referred to by artists, though there will of course be common elements. A person who thinks of a creative solution for a math problem may show little creativity as a poet (Barron & Harrington, 1981). Some psychologists have operationally defined creativity as performance on the Torrance Test of Creative Thinking (Torrance, 1982). Children who score high on this test are more likely to make creative achievements as adults.

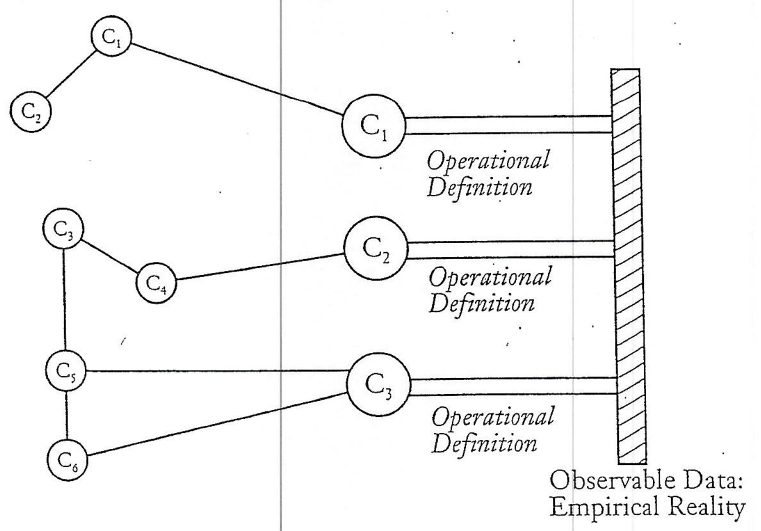
Some scientists claim that such limited operational meanings are the only meanings that "mean" anything, that all other definitions are metaphysical nonsense. They say that discussions of anxiety are metaphysical nonsense, unless adequate operational definitions of anxiety are available and used. This view is extreme, though it has healthy aspects. To insist that every term we use in scientific discourse be operationally defined would be too narrowing, too restrictive, and, as we shall see, scientifically unsound. Northrop (1947/1983, p. 130) says, for example, "The importance of operational definitions is that they make verification possible and enrich meaning. They do not, however, exhaust scientific meaning." Margenau (1950/1977, p. 232) makes the same point in his extended discussion of scientific constructs.

Despite the dangers of extreme operationalism, it can be safely said that operationalism has been and still is a healthy influence. As Skinner (1945, p. 274) puts it,

> The operational attitude, in spite of its shortcomings, is a good thing in any science, but especially in psychology, because of the presence there of a vast vocabulary of ancient and nonscientific origin.

When the terms used in education are considered, clearly education, too, has a vast vocabulary of ancient and nonscientific terms. Consider these: the whole child, horizontal and vertical enrichment, meeting the needs of the learner, core curriculum, emotional adjustment, and curricular enrichment. This is also true in the field of geriatric nursing. Here nurses deal with such terms as the aging process, self-image, attention span, and unilateral neglect (Eliopoulos, 1993; Smeltzer & Bare, 1992).

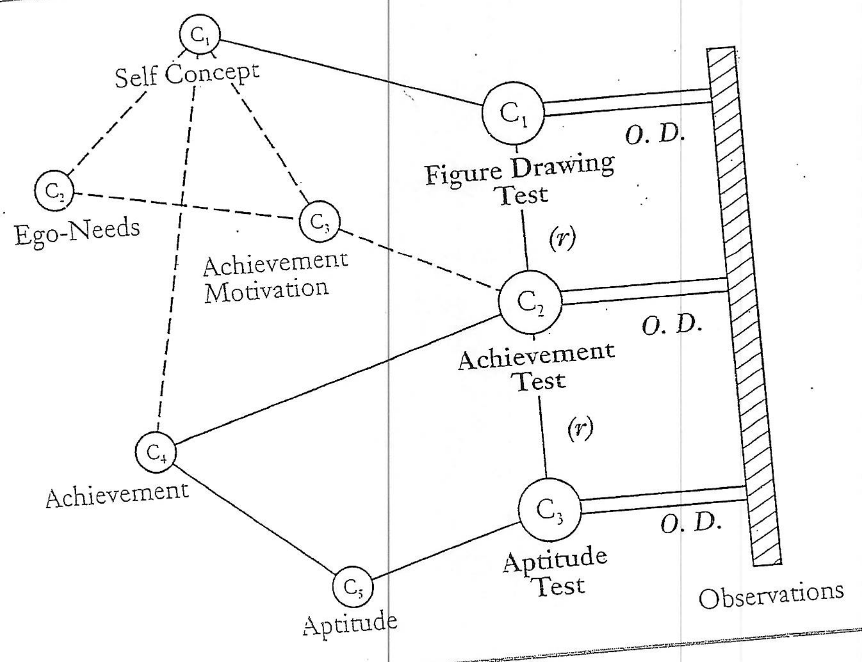
FIGURE 3.1



To clarify constitutive and operational definitions (as well as theory) look at Figure 3.1, which has been adapted after Margenau (1950/1977) and Torgerson (1958/1985). The diagram is intended to illustrate a well-developed theory. The single lines represent theoretical connections or relations between constructs. These constructs, labeled with lowercase letters, are defined constitutively; that is, c_4 is somehow defined by c_3, or vice versa. The double lines represent operational definitions. The constructs are directly linked to observable data; they are indispensable links to empirical reality. However, not all constructs in a scientific theory are defined operationally. Indeed, it is a rather thin theory that has all its constructs so defined.

Let us build a "small theory" of underachievement to illustrate these notions. Suppose an investigator believes that underachievement is in part a function of pupils' self-concepts. The investigator believes that pupils who perceive themselves as inadequate and have negative self-perceptions, also tend to achieve less than their potential capacity and aptitude indicate they should achieve. It follows that ego-needs (which we will not define here) and motivation for achievement (call this nach, or need for achievement) are tied to underachievement. Naturally, the investigator is also aware of the relation between aptitude and intelligence and achievement in general. A diagram to illustrate this "theory" might look like Figure 3.2.

FIGURE 3.2



The investigator has *no direct* measure of self-concept, but assumes that inferences can be drawn about an individual's self-concept from a figure drawing test. Self-concept is operationally defined, then, as certain responses to the figure drawing test. This is probably the most common method of measuring psychological (and educational) constructs. The heavy single line between c_1 and C_1 indicates the relatively direct nature of the presumed relation between self-concept and the test. (The double line between C_1 and the level of observation indicates an operational definition, as it did in Figure 3.1.)

Similarly, the construct achievement (c_4) is operationally defined as the discrepancy between measured achievement (C_2) and measured aptitude (c_5). In this model the investigator has no direct measure of achievement motivation, no operational definition of it. In another study an investigator may specifically hypothesize a relationship between achievement and achievement motivation, in which case he or she will try to define achievement motivation operationally.

A single solid line between concepts, for example, the one between the construct achievement (c_4) and achievement test (C_2), indicates a relatively well-established relation between postulated achievement and what standard achievement tests measure. The single solid lines between C_1 and C_2 and between C_2 and C_3 indicate obtained relations between the test scores of these measures. (The lines between C_1 and C_2 and between C_2 and C_3 are labeled (r) for "relation," or "coefficient of correlation.")

The broken single lines indicate postulated relations between constructs that are not relatively well established. A good example of this is the postulated relation between self-concept and achievement motivation. One of the aims of science is to make these broken lines solid lines by bridging the operational definition–measurement gap. In this case, it is quite conceivable that both self-concept and achievement motivation can be operationally defined and directly measured.

In essence, this is the way a behavioral scientist operates. The scientist shuttles back and forth between the level of construct and the level of observation. This is done by operationally defining the variables of the theory that are amenable to such definition. Then the relations are estimated between the operationally-defined and measured variables. From these estimated relations the scientist draws inferences as to the relations between the constructs. In the above example, the behavioral scientist calculates the relation between C_1 (figure drawing test) and C_2 (achievement test). If the relation is established on this observational level, the scientist infers that a relation exists between c_1 (self-concept) and c_4 (achievement).

Types of Variables

Independent and Dependent Variables

With definitional background behind us, we return to variables. Variables can be classified in several ways. In this book three kinds of variables are very important and will be emphasized: (1) independent and dependent variables, (2) active and attribute variables, and (3) continuous and categorical variables.

The most useful way to categorize variables is either as independent or dependent. This categorization is highly useful because of its general applicability, simplicity, and special importance, both in conceptualizing and designing research and in communicating the results of research. An *independent variable* is the *presumed* cause of the *dependent variable*, the *presumed* effect. The independent variable is the antecedent; the dependent is the consequent. Since one of the goals of science is to uncover relations between different phenomena, looking at the relation between independent and dependent variables accomplishes this. It is the independent variable that is assumed to influence the dependent variable. In some studies, the independent variable "causes" changes in the dependent variable. When we say: If *A*, then *B*, we have the conditional conjunction of an independent variable (*A*) and a dependent variable (*B*).

The terms "independent variable" and "dependent variable" come from mathematics, where *X* is the independent and *Y* the dependent variable. This is probably the best way to think of independent and dependent variables because there is no need to use the touchy word *cause* and related words, and because use of such symbols applies to most research situations. There is no theoretical restriction on numbers of *X*s and *Y*s. When we later consider multivariate thinking and analysis, we will deal with several independent and dependent variables.

In experiments the independent variable is the variable manipulated by the experimenter. Changes in the values or levels of the independent variable produce changes in the dependent variable. When educational investigators studied the effects of differing teaching methods on math test performance, they varied the method of teaching. In one condition they may have "lecture only," in the other it might be "lecture plus video." Teaching method is the independent variable. The outcome variable, test score on mathematics, is the dependent variable.

The assignment of participants to different groups based on the existence of some characteristic is an example of where the researcher was not able to manipulate the independent variable. The values of the independent variable in this situation preexist. The participant either has the characteristic or not. Here, there is no possibility of experimental manipulation, but the variable is considered to "logically" have some effect on a dependent variable. Subject characteristic variables make up most of these types of independent variables. One of the more common independent variables of this kind is gender (female and male). So, if a researcher wanted to determine if females and males differ on math skills, a math test would be given to representatives of both groups, and the test scores then compared. The math test would be the dependent variable. A general rule is that when the researcher manipulates a variable or assigns participants to groups according to some characteristic, that variable is the independent variable. Table 3.1 gives a comparison between the two types of independent variable and their relation to the dependent variable. The independent variable must have at least two levels or values. Notice in Table 3.1 that both situations have two levels for the independent variable.

TABLE 3.1 *Relation of Manipulated and Nonmanipulated Independent Variables to the Dependent Variable*

Levels of Independent Variable

Teaching Method		Gender	
Lecture Only	Lecture plus Video	Female	Male
Math Test Scores	Math Test Scores	Math Test Scores	Math Test Scores
Dependent variables		Dependent variables	

The dependent variable is of course the variable predicted *to*, whereas the independent variable is predicted *from*. The dependent variable, Y, is the presumed effect, which varies concomitantly with changes or variations in the independent variable, X. It is the variable that is observed for variation as a presumed result of variation in the independent variable. The dependent variable is the outcome measure that the researcher uses to determine if changes in the independent variable had an effect. In predicting from X to Y, we can take any value of X we wish, whereas the value of Y we predict to is "dependent on" the value of X we have selected. The dependent variable is ordinarily the condition we are trying to explain. The most common dependent variable in education, for instance, is "achievement" or "learning." We want to account for or explain achievement. In so doing we have a large number of possible Xs or independent variables from which to choose.

When the relation between intelligence and school achievement is studied, intelligence is the independent and achievement is the dependent variable. (Is it conceivable that it might be the other way around?) Other independent variables that can be studied in relation to the dependent variable achievement, are social class, methods of teaching, personality types, types of motivation (reward and punishment), attitudes toward school, class atmosphere, and so on. When the presumed determinants of delinquency are studied, such determinants as slum conditions, broken homes, lack of parental love, and the like, are independent variables and, naturally, delinquency (more accurately, delinquent behavior) is the dependent variable. In the frustration–aggression hypothesis, frustration is the independent variable and aggression the dependent variable. Sometimes a phenomenon is studied by itself, and either an independent or a dependent variable is implied. This is the case when teacher behaviors and characteristics are studied. The usual implied dependent variable is achievement or child behavior. Teacher behavior can of course be a dependent variable. Consider an example in nursing science. When cognitive and functional measures of Alzheimer's patients are compared between traditional nursing homes and special care units (SCU), the independent variable is the place of care. The dependent variables are the cognitive and functional measures (Swanson, Maas, & Buckwalter, 1994).

The relation between an independent variable and a dependent variable can perhaps be more clearly understood if we lay out two axes at right angles to each other. One axis represents the independent variable and the other represents the dependent variable. (When two axes are at right angles to each other, they are called *orthogonal* axes.) Following mathematical custom, x, the independent variable, is the horizontal axis and y, the dependent variable, is the vertical axis (x is called the *abscissa* and y the *ordinate*). The values for x are laid out on the x-axis, and y values on the y-axis.

A very common and useful way to "see" and interpret a relation is to plot the pairs of xy values, using the x and y axes as a frame of reference. In a study of child development, let us suppose that we have two sets of measures. The x measures chronological age and the y measures reading age. *Reading age* is a so-called growth age. Seriatim measurements of individuals' growths—in height, weight, intelligence, and so forth—are expressed as the average chronological age at which they appear in the standard population.

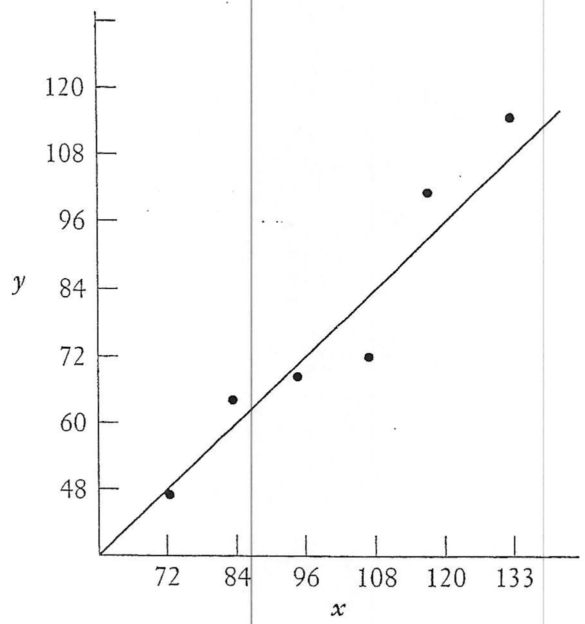
x: Chronological Age (in Months)	y: Reading Age (in Months)
72	48
84	62
96	69
108	71
120	100
132	112

These measures are plotted in Figure 3.3.

The relation between chronological age (CA) and reading age (RA) can now be "seen" and roughly approximated. Note that there is a pronounced tendency (as might be expected) for more advanced CA to be associated with higher RA, medium CA with medium RA, and less advanced CA with lower RA. In other words, the relation between the independent and dependent variables, in this case between CA and RA, can be seen from a graph such as shown in Figure 3.3. A straight line has been drawn in to "show" the relation. It is a rough average of all the points of the plot. Note that if one has knowledge of independent variable measures and a relation such as that shown in Figure 3.3, one can predict—with considerable accuracy—the dependent variable measures. Plots like this can, of course, be used with any independent and dependent variable measures.

The student should be alert to the possibility of a variable being an independent variable in one study and a dependent variable in another, or even both in the same study. An example is job satisfaction. A majority of the studies involving job satisfaction use it as a dependent variable. Day and Schoenrade (1997) show the effect of sexual orientation on work attitudes. One of these work attitudes is job satisfaction.

FIGURE 3.3



Likewise, Hodson (1989) studies gender differences in job satisfaction. Scott, Moore, and Miceli (1997) find job satisfaction linked to the behavior patterns of workaholics. There are studies where job satisfaction is used as an independent variable. Meiksins and Watson (1989) show how much job satisfaction influences the professional autonomy of engineers. Studies by Somers (1996); Francis-Felsen, Coward, Hogan, and Duncan (1996); and Hutchinson and Turner (1988) examined job satisfaction's effect on nursing personnel turnover.

Another example is anxiety. Anxiety has been studied as an independent variable affecting the dependent variable achievement. Oldani (1997) found mother's anxiety during pregnancy influenced the achievement (measured as success in the music industry) of the offspring. Capaldi, Crosby, and Stoolmiller (1996) used the anxiety levels of teenage boys to predict the timing of their first sexual intercourse. Onwuegbuzie and Seaman (1995) studied the effects of test anxiety on test performance in a statistics course. Anxiety can also be readily conceived and used as a dependent variable. For example, it could be used to study the difference between types of culture, socioeconomic status and gender (see Guida & Ludlow, 1989; Murphy, Olivier, Monson, & Sobol, 1991). In other words, the independent and dependent variable classification is really a classification of uses of variables rather than a distinction between different kinds of variables.

Active and Attribute Variables

A classification that will be useful later in our study of research design is based on the distinction between experimental and measured variables. It is important when planning and executing research to distinguish between these two types of variables. Manipulated variables will be called *active* variables; measured variables will be called *attribute* variables. For example, Colwell, Foreman, and Trotter (1993) compared two methods of treating pressure ulcers of bedridden patients. The dependent variables were efficacy and cost effectiveness. The two treatment methods were moist gauze dressing and hydrocolloid wafer dressing. The researchers had control over who got which type of treatment. As such, the treatment or independent variable was an active or manipulated variable.

Any variable that is manipulated, then, is an active variable. "Manipulation" means, essentially, doing different things to different groups of subjects, as we will see clearly in a later chapter where we discuss in depth the differences between experimental and nonexperimental research. When a researcher does one thing to one group (for example, positively reinforces a certain kind of behavior), and does something else to another group, or has the two groups follow different instructions, this is manipulation. When one uses different methods of teaching, or rewards the subjects of one group and punishes those of another, or creates anxiety through worrisome instructions, one is *actively* manipulating the variables methods, reinforcement, and anxiety.

Another related classification, used mainly by psychologists, is *stimulus* and *response* variables. A *stimulus variable* is any condition or manipulation by the experimenter of the environment that evokes a response in an organism. A *response variable* is any kind of behavior of the organism. The assumption is made that for any kind of behavior there is always a stimulus. Thus the organism's behavior is a response. This classification is reflected in the well-known equation: $R = f(O, S)$, which is read: "Responses are a function of the organism and stimuli," or "Response variables are a function of organismic variables and stimulus variables."

Variables that cannot be manipulated are *attribute variables* or *subject-characteristic* variables. It is impossible, or at least difficult, to manipulate many variables. All human characteristic variables such as intelligence, aptitude, gender, socioeconomic status, conservatism, field dependence, need for achievement, and attitudes are attribute variables. Subjects come to our studies with these variables (attributes) ready-made or preexisting. Early environment, heredity, and other circumstances have made individuals what they are. Such variables are also called *organismic* variables. Any property of an individual, any characteristic or attribute, is an organismic variable. It is part of the organism, so to speak. In other words, organismic variables are those characteristics that individuals have in varying degrees when they come to the research situation. The term *individual differences* implies organismic variables. One of the more common attribute variables in the social and behavioral sciences is gender: female–male. Studies designed to compare gender differences involve an attribute variable. Take, for example, the study by de Weerth and Kalma (1993). These researchers compared females to males on their response to spousal or partner infidelity. The attribute variable here is gender. Gender is *not* a manipulated variable. There are studies where a test score or a collection of test scores were used to divide a group of people into two or more groups. In this case the group differences are reflected in an attribute variable. For example, the study by Hart, Forth, and Hare (1990) administered a psychopathology test to male prison inmates. Based on their scores, inmates were assigned to one of three groups: low, medium, and high. They were then compared on their score on a battery of neuropsychological tests. The level of psychopathology preexists and is not manipulated by the researcher. If an inmate scored high, he was placed in the high group. Hence psychopathology is an attribute variable in this study. There are some studies where the independent variable could have been manipulated; however, for logistical or legal reasons, they were not. An example of where the independent variable could have been manipulated but was not is the study by Swanson, Maas, and Buckwalter (1994). These researchers compared different care facilities' effect on cognitive and functional measures of Alzheimer's patients. The attribute variable was the type of facility. The researchers were not allowed to place patients into the two different care facilities (traditional nursing home versus special care unit). The researchers were forced to study the subjects after they had been assigned to a care facility. Hence the independent variable can be thought of as a nonmanipulated variable. The researchers inherited intact groups.

The word *attribute*, moreover, is accurate enough when used with inanimate objects or referents. However, organizations, institutions, groups, populations, homes, and geographical areas also have attributes—*active attributes*. Organizations are variably productive; institutions become outmoded; groups differ in cohesiveness; geographical areas vary widely in resources.

This active attribute distinction is general, flexible, and useful. We will see that some variables are by their very nature always attributes, but other variables that are attributes can also be active. This latter characteristic makes it possible to investigate the "same" relations in differing ways. Again, using the variable anxiety example, we can measure the anxiety of subjects. Anxiety is in this case obviously an attribute variable. However, we can also manipulate anxiety by inducing different degrees of anxiety. For example, telling the subjects of one experimental group that the task they are about to do is difficult, that their intelligence is being measured, and that their futures depend on the scores they get. The subjects of another experimental group are told to do their best but to relax. They are told the outcome is unimportant and will have no influence on their futures. Actually, we cannot assume that the measured (attribute) and the manipulated (active) "anxieties" are the same. We may assume that both are "anxiety" in a broad sense, but they are certainly not the same.

Continuous and Categorical Variables

A distinction especially useful in the planning of research and the analysis of data between continuous and categorical variables has already been introduced. Its later importance, however, justifies more extended consideration.

A *continuous* variable is capable of taking on an ordered set of values within a certain range. This definition means, first, that the values of a continuous variable reflect at least a rank order, a larger value of the variable meaning more of the property in question than a smaller value. The values yielded by a scale to measure dependency, for instance, express differing amounts of dependency from high through medium to low. Second, continuous measures in actual use are contained in a range, and each individual obtains a "score" within that range. A scale to measure dependency may have the range 1 through 7. Most scales in use in the behavioral sciences also have a third characteristic: there is a theoretically infinite set of values within the range. (Rank-order scales are somewhat different; they will be discussed later in the book.) That is, a particular individual's score may be 4.72 rather than simply 4 or 5.

Categorical variables, as we will call them, belong to a kind of measurement called nominal (explained in Chapter 25). In nominal measurement, there are two or more subsets of the set of objects being measured. Individuals are categorized by their possession of the characteristic that defines any subset. "To categorize" means to assign an object to a subclass (or subset) of a class (or set) on the basis of the object's having or not having the characteristic that defines the subset. The individual being categorized either has the defining property or does not have it; it is an all-or-none kind of thing. The simplest examples are dichotomous categorical variables: female–male, Republican–Democrat, right–wrong. Polytomies—variables with more than two subsets or partitions—are fairly common, especially in sociology and economics: religious preference, education (usually), nationality, occupational choice, and so on.

Categorical variables and nominal measurement have simple requirements: all the members of a subset are considered the same and all are assigned the same name (nominal) and the same numeral. If the variable is religious preference, for instance, all Protestants are the same, all Catholics are the same, and all "others" are the same. If an individual is a Catholic (operationally defined in a suitable way), that person is assigned to the category "Catholic" and also assigned a "1" in that category. In brief, that person is counted as a "Catholic." Categorical variables are "democratic." There is no rank order, or greater than and less than, among the categories, and all members of a category are assigned the same value.

The expression "qualitative variables" has sometimes been applied to categorical variables, especially to dichotomies, probably in contrast to "quantitative variables" (our continuous variables). Such usage reflects a somewhat distorted notion of what variables are. They are always quantifiable, or they are not variables. If x has only two subsets and can take on only two values (1 and 0), these are still values, and the variable varies. If x is a polytomy, like political affiliation, we quantify again by assigning integer values to individuals. If an individual, say, is a Democrat, then put that person in the Democrat subset. That individual is assigned a 1. All individuals in the Democrat subset would be assigned a value of 1. It is extremely important to understand this because, for one thing, it is the basis of quantifying many variables, even experimental treatments, for complex analysis. In multiple regression analysis, as we will see later, all variables—continuous and categorical—are entered as variables into the analysis. Earlier, the example of gender was given, 1 being assigned to one gender and 0 to the other. We set up a column of 1s and 0s just as we would set up a column of dependency scores. The column of 1s and 0s is the quantification of the variable gender. There is no mystery here. Such variables have been called "dummy variables." Since they are highly useful and powerful, even indispensable in modern research data analysis, they need to be understood clearly. A deeper explanation of this can be found in Kerlinger and Pedhazur (1973) and Chapter 34 of this book. The method is easily extended to polytomies. A *polytomy* is a division of the members of a group into three or more subdivisions.

Constructs, Observables, and Latent Variables

In much of the previous discussion of this chapter it has been implied, though not explicitly stated, that there is a sharp difference between constructs and observed variables. Moreover, we can say that constructs are nonobservables; and variables, when operationally defined, are observables. This distinction is important because, if we are not always keenly aware of the level of discourse we are on when talking about variables, we can hardly be clear about what we are doing.

An important and fruitful expression, which we will encounter and use extensively later in this book, is "latent variable." A latent variable is an unobserved "entity" presumed to underlie observed variables. The best-known example of an important latent variable is "intelligence." We can say that three ability tests—verbal, numerical, and spatial—are positively and substantially related. This means, for the most part, that people high on one tend to be high on the others; similarly, persons low on one tend to be low on the others. We believe that something is common to the three tests or observed variables, and name this something "intelligence." It is a latent variable.

We have encountered many examples of latent variables in previous pages: achievement, creativity, social class, job satisfaction, religious preference, and so on. Indeed, whenever we utter the names of phenomena on which people or objects vary, we are talking about latent variables. In science, our real interest is more in the relations among latent variables than it is in the relations among observed variables, because we seek to explain phenomena and their relations. When we enunciate a theory, we enunciate in part systematic relations among latent variables. We are not too interested in the relation between observed frustrated behaviors and observed aggressive behaviors, for example, though we must of course work with them at the empirical level. We are really interested in the relation between the latent variable frustration and the latent variable aggression.

We must be cautious, however, when dealing with nonobservables. Scientists, using such terms as "hostility," "anxiety," and "learning," are aware that they are talking about invented constructs. The "reality" of these constructs is inferred from behavior. If they want to study the effects of different kinds of motivation, they must know that "motivation" is a latent variable, a construct invented to account for presumably "motivated" behavior. They must know that its "reality" is only postulated. They can only judge that youngsters are motivated or not motivated by observing their behaviors. Still, in order to study motivation, they must measure or manipulate it. But they cannot measure it directly because it is, in short, an "in-the-head" variable, an unobservable entity, a latent variable. The construct was invented for "something" *presumed to be* inside individuals, "something" prompting them to behave in such-and-such a manner. This means that researchers must always measure presumed indicators of motivation and not motivation itself. They must, in different words, always measure some kind of behavior, be it marks on paper, spoken words, or meaningful gestures, and then draw inferences about presumed characteristics—or latent variables.

Other terms have been used to express more or less the same ideas. For example, Tolman (1951 pp. 115–129.) calls constructs intervening variables. *Intervening variable* is a term invented to account for internal, unobservable psychological processes that in turn account for behavior. An intervening variable is an "in-the-head" variable. It cannot be seen, heard, or touched. It is inferred from behavior. "Hostility" is inferred from presumably hostile or aggressive acts. "Anxiety" is inferred from test scores, skin responses, heartbeat, and certain experimental manipulations. Another term is "hypothetical construct." Since this expression means much the same as latent variable with somewhat less generality, we need not pause over it. We should mention, however, that "latent variable" appears to be a more general and applicable expression than "intervening variable" and "hypothetical construct," because it can be used for virtually any phenomena that presumably influence or are influenced by other phenomena. In other words, "latent variable" can be used with psychological, sociological, and other phenomena. "Latent variable" seems to be the preferable term because of its generality. Also, because it is now possible, in the analysis of covariance structures approach, to assess the effects of latent variables on each other and on so-called manifest or observed variables. This rather abstract discussion will later be made more concrete and, it is hoped, meaningful. We will then see that the idea of latent variables and the relations between them is an extremely important, fruit-ful, and useful one, that is helping to change fundamental approaches to research problems.

Examples of Variations and Operational Definitions

A number of constructs and operational definitions have already been given. To illustrate and clarify the preceding discussion, especially where the distinction was made between experimental and measured variables and between constructs and operationally defined variables, several examples of constructs or variables and operational definitions are given below. If a definition is experimental, it is labeled (E); if it is measured, it is labeled (M).

Operational definitions differ in degree of specificity. Some are quite closely tied to observations. "Test" definitions, like "intelligence is defined as a score on *X* intelligence test," are very specific. A definition like "frustration is prevention from reaching a goal" is more general and requires further specification to be measurable.

Social Class ". . . two or more orders of people who are believed to be, and are accordingly ranked by the members of a community, in socially superior and inferior positions" (M) (Warner & Lunt, 1941, p. 82). To be operational, this definition has to be specified by questions aimed at people's beliefs about other people's positions. This is a subjective definition of social class. Social class, or social status, is also defined more objectively by using such indices as occupation, income, and education, or by combinations of such indices. For example, ". . . we converted information about the education, occupation and income of the parents of the NLSY youths into an index of socioeconomic status (SES) in which the highest scores indicate advanced education, affluence and prestigious occupations. Lowest scores indicate poverty, meager education and the most menial jobs" (M) (Herrnstein & Murray, 1996, p. 131).

Achievement (School, Arithmetic, and Spelling) Achievement is customarily defined operationally by citing a standardized test of achievement (for example, Iowa Tests of Basic Skills, Elementary or the Achievement Test of the Kaufman Assessment Battery for Children [K-ABC]), by grade-point averages, or by teacher judgments. "Student achievement was measured by the combined test scores of reading and mathematics" (M) (Peng & Wright, 1994). Occasionally, achievement is in the form of a performance test. Silverman (1993) examined students on two skills in volleyball: the serve test and the forearm passing test. In the serve test, students received a score between 0 and 4 depending on where the served ball dropped. The forearm passing test involved bouncing the ball off of one's forearm. The criteria used was to count the number of times a student could pass the ball above an 8-foot line against the wall within a 1-minute period (M). Also used in some educational studies is an operational definition of the concept *student achievement perception*. Here, students are asked to evaluate themselves. The question used by Shoffner (1990) was "What kind of student do you think you are?" The response choices available were "A student," "B student," and "C student" (M).

Achievement (Academic Performance) "As a result, grades for all students in all sections were obtained and used to determine the section-rank for each student participating in the study. Section percentile rank was computed for each of these students and was used as the dependent measure of achievement in the final data analysis" (M) (Strom, Hocevar, & Zimmer, 1990).

Intrinsic Motivation is defined operationally by Hom, Berger, et al. (1994) as "The cumulative amount of time that each student played with the pattern blocks with the reward system absent" (M).

Popularity. Popularity is often defined operationally by the number of sociometric choices an individual receives from other individuals (in his or her class, play group, and so on). Individuals are asked: "With whom would you like to work?" "With whom would you like to play?" and the like. Each individual is required to choose one, two, or more individuals from his or her group on the basis of such criterion questions (M).

Task Involvement ". . . each child's behavior during a lesson was coded every 6 sec. as being appropriately involved, or deviant. The task involvement scores for a lesson was the percentage of 6-sec. units in which the children were coded as appropriately involved" (M) (Kounin & Doyle, 1975).

Reinforcement. Reinforcement definitions come in a number of forms. Most involve, in one way or another, the principle of reward. However, both positive and negative reinforcement may be used. Specific experimental definitions of "reinforcement" follow.

In the second 10 minutes, every opinion statement S made was recorded by E and reinforced. For two groups, E agreed with every opinion statement by saying: "Yes, you're right," "That's so," or the like, or by nodding and smiling affirmation if he could not interrupt (E).

> . . . the model and the child were administered alternately 12 different sets of story items. . . . To each of the 12 items, the model consistently expressed judgmental responses in opposition to the child's moral orientation . . . and the experimenter reinforced the model's behavior with verbal approval responses such as "Very good," "That's fine," and "That's good." The child was similarly reinforced whenever he adopted the model's class of moral judgments in response to his own set of items [this is called "social reinforcement"] (E) (Bandura & MacDonald, 1994).

The teacher gives verbal praise each time the child exhibits the target behavior. The target behaviors are attending to instruction, schoolwork, and responding aloud. The recording is done every 15 seconds (E) (Martens, Hiralall, & Bradley, 1997).

Attitudes Toward AIDS is defined by an 18-item scale. Each item consisted of a Likert-type format reflecting different attitudes toward AIDS patients. Some sample items are: "People with AIDS should not be permitted to use public toilets," and "There should be mandatory testing of all Americans for AIDS" (M) (Lester, 1989).

Borderline Personality is defined by Comrey (1993) as having low scores on three scales of the Comrey Personality Scales. The three scales are: Trust versus Defensiveness, Social Conformity versus Rebelliousness, and Emotional Stability versus Neuroticism.

Employee Delinquency is defined operationally as a combination of three variables. The variables are the number of chargeable accidents, the number of warning letters, and the number of suspensions (M) (Hogan & Hogan, 1989).

Religiosity is defined as a score on the Francis Scale of Attitudes toward Christianity. This scale consists of 24 items. Each item has a Likert-type response scale. Sample items include: "Saying my prayers helps me a lot," and "God helps me to lead a better life" (M) (Gillings & Joseph, 1996). Religiosity should not be confused with religious preference. Here religiosity refers to the strength of devotion to one's chosen religion.

Self-esteem is a manipulated independent variable in the study by Steele, Spencer, and Lynch (1993). Here subjects are given a self-esteem test, but when they are given feedback, the information on the official-looking feedback report is bogus. Subjects of the same measured level of self-esteem are divided into three feedback groups: positive, negative, and none. In the positive feedback condition (positive self-esteem), subjects are described with statements such as "clear thinking." Those in the negative group (negative self-esteem) are given adjectives like "passive in action." The "no feedback" group are told that their personality profiles (self-esteem) were not ready due to a backlog in scoring and interpretation (E). Most studies on self-esteem use a measured operational definition. In the above example, Steele, Spencer, and Lynch also used the Janis-Field Feelings of Inadequacy Self-esteem Scale (M). In another example, Luhtanen and Crocker (1992) define collective self-esteem as a score on a scale containing 16 Likert-type items. These items ask respondents to think about a variety of social groups and membership such as gender, religion, race, and ethnicity (M).

Race is usually a measured variable. However, in a study by Annis and Corenblum (1986), 83 Canadian Indian kindergartners and first graders were asked questions on racial preferences and self-identity by either a white or Indian experimenter (E). The interest here was on whether or not the race of the experimenter influenced responses.

Loneliness. One definition of this is a score on the UCLA Loneliness Scale. This scale includes items such as "No one really knows me well," or "I lack companionship." There is also the Loneliness Deprivation Scale that has items such as "I experience a sense of emptiness," or "There is no one who shows a particular interest in me" (M) (Oshagan & Allen, 1992).

Halo. There have been many operational definitions of the halo effect. Balzer and Sulsky (1992) found and summarized 108 definitions that fit into six categories. One of the definitions states that halo is ". . . the average within-rate variance or standard deviation of ratings." Another would be "comparing obtained ratings with true ratings provided by expert raters" (M).

Memory: Recall and Recognition ". . . recall is to ask the participant to recite what he or she remembers of the items shown him or her, giving a point for each item that matches one on the stimulus list (M) (Norman, 1976, p. 97). "The recognition test consisted of 62 sentences presented to all subjects . . . subjects were instructed to rate each sentence on their degree of confidence that the sentence had been presented in the acquisition set" (M) (Richter & Seay, 1987).

Social Skills. These can be operationally defined as a score on the Social Skills Rating Scale (Gresham & Elliot, 1990). There is the possibility of input from the student, parent and teacher. Social behaviors are rated in terms of frequency of occurrence and also on the level of importance. Some social skill items include: "Gets along with people who are different [teacher]," "Volunteers to help family members with tasks [parent]," and "I politely question rules that may be unfair [student]" (M).

Ingratiation. One of many impression management techniques (see Orpen, 1996; Gordon, 1996). Ingratiation is defined operationally as a score on the Kumar and Beyerlein (1991) Scale. This scale consisted of 25 Likert-type items and designed to measure the frequency that subordinates, in a superior–subordinate relationship, use ingratiatory tactics (M). Strutton, Pelton, and Lumpkin (1995) modified the Kumar–Beyerlein scale. Instead of measuring ingratiation between and employee and employer–supervisor, it measured ingratiation behavior between a salesperson and a customer (M).

Feminism. This is defined by a score on the Attitudes toward Women Questionnaire. This instrument consists of 18 statements to which the respondent registers agreement on a 5-point scale. Items include: "Men have held power for too long"; "Beauty contests are degrading to women"; "Children of working mothers are bound to suffer" (Wilson & Reading, 1989).

Values. "Rank the ten goals in the order of their importance to you. (1) financial success; (2) being liked; (3) success in family life; (4) being intellectually capable; (5) living by religious principles; (6) helping others; (7) being normal, well-adjusted; (8) cooperating with others; (9) doing a thorough job; (10) occupational success" (M) (Newcomb, 1978).

Democracy (Political Democracy) "The index [of political democracy] consists of three indicators of popular sovereignty and three of political liberties. The three measures of popular sovereignty are: (1) fairness of elections, (2) effective executive selection, and (3) legislative selection. The indicators of political liberties are: (4) freedom of the press, (5) freedom of group opposition, and (6) government sanctions" (M). Bollen (1979) gives operational details of the six social indicators in an appendix (pp. 585–586). This is a particularly good example of the operational definition of a complex concept. Moreover, it is an excellent description of the ingredients of democracy.

The benefits of operational thinking have been great. Indeed, operationalism has been and is one of the most significant and important movements of our times. Extreme operationalism, of course, can be dangerous because it clouds recognition of the importance of constructs and constitutive definitions in behavioral science, and because it can also restrict research to trivial problems. There can be little doubt, however, that it is a healthy influence. It is the indispensable key to achieving objectivity (without which there is no science), because its demand that observations must be public and replicable helps to put research activities outside of and apart from researchers and their predilections. And, as Underwood (1957, p. 53) has said in his classical text on psychological research:

> I would say that operational thinking makes better scientists. The operationist is forced to remove the fuzz from his empirical concepts . . . operationism facilitates communication among scientists because the meaning of concepts so defined is not easily subject to misinterpretation.

CHAPTER SUMMARY

1. A *concept* is an expression of an abstraction formed from generalization of particulars, for example, weight. This expression is from observations of certain behaviors or actions.
2. A *construct* is a concept that has been formulated so that it can be used in science. It is used in theoretical schemes. It is defined so that it can be observed and measured.
3. A *variable* is defined as a property that can take on different values. It is a symbol to which values are assigned.
4. Constructs and words can be defined by
   a. other words or concepts,
   b. description of an implicit or explicit action or behavior.

5. A *constitutive definition* is where constructs are defined by other constructs.
6. An *operational definition* is where meaning is assigned by specifying the activities or operations necessary to measure and evaluate the construct. Operational definitions can give only limited meaning of constructs. They cannot completely describe a construct or variable. There are two types of operational definitions:
   a. measured—tells us how the variable or construct will be scaled.
   b. experimental—lays out the details of how the variable (construct) is manipulated by the experimenter.
7. Types of variables
   a. The *independent* variable is varied and has a presumed cause on another variable, the dependent variable. In an experiment, it is the manipulated variable. It is the variable under the control of the experimenter. In a nonexperimental study, it is the variable that has a logical effect on the dependent variable.
   b. The *dependent* variable's effect alters concomitantly with changes or variations in the independent variable.
   c. An *active* variable is manipulated. Manipulation means that the experimenter has control over how the values change.
   d. An *attributive* variable is measured and cannot be manipulated. A variable that cannot be manipulated is one where the experimenter has no control over the values of the variable.
   e. A *continuous* variable is capable of taking on an ordered set of values within a certain range. Between two values there are an infinite number of other values. These variables reflect at least a rank order.
   f. *Categorical* variables belong to a kind of measurement where objects are assigned to a subclass or subset. The subclasses are distinct and nonoverlapping. All objects put into the same category are considered to have the same characteristic(s).
   g. *Latent* variables are unobservable entities. They are assumed to underlie observed variables.
   h. *Intervening* variables are constructs that account for internal unobservable psychological processes that account for behavior. It cannot be seen but is inferred from behavior.

STUDY SUGGESTIONS

1. Write operational definitions for five or six of the following constructs. When possible, write two such definitions: an experimental and a measured definition.

reinforcement	punitiveness
achievement	reading ability