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1 A Constructivist Perspective on Assessing Personal Cognitive Structures

James C. Mancuso and Mildred L. G. Shaw

To build a theory of persons, a radical constructivist first accepts the premise that an organized cognitive system occupies any psychological context as definitively as does the energy-emitting event that interfaces with that system (Gergen 1985; von Glasersfeld 1984). A behavior scientist working from a constructivist/contextualist perspective builds explanations from the assumption that event-derived input will function as a psychological variable only when that input has been assimilated into a structured cognitive system. Further, that system ultimately can be represented quantitatively, so that one may relate its parameters to other aspects of psychological functioning. In other terms, meaning is assigned to a stimulus pattern only through its absorption into the acquired knowledge system the person has available, and the psychological process of assigning meaning can be studied through, among other things, assessing and quantitatively representing a person's cognitive system.

Empirically based constructivist explanation, as Shepard (1984) has illustrated, had been cogently advanced by Wertheimer's (1912) demonstration of the ways in which a person will impose the meaning "moving" onto the sensory input pattern that emanates from two stationary stimulus events. Shepard's recent (1984) work extends Wertheimer's studies well beyond their elementary significance. Shepard
has amply shown that the trajectory of a light's movement across an intervening space represents an instance of a general principle of *kinematic geometry*. In a typical investigation of the ways in which people attribute motion to rigid objects, Shepard and his associates asked a subject to watch a surface in the picture plane spread before his or her line of sight. A multi-edged polygon was then projected onto that surface. The projection was terminated, and within an appropriate time interval the same polygon was projected, for example, onto a point to the right of the initial projection. Observers report having seen the polygon move across the intervening space and the two locations of the separate projections. Like the two single light points used in Wertheimer's phi-phenomenon demonstration, the two projections of the polygon, as input-producing events, are assimilated into a complex cognitive structure that imposes the meaning of "motion" onto the input. When the right-left alternation continues, observers see the two successive projections of the polygon as a single polygon moving rapidly back and forth across the intervening space.

Other transformations of the position and the orientation of the second presentations of the polygon more dramatically illustrate the proposition that apparent motion proceeds through the most direct, single unique axis between points on the surface of the consecutively presented polygons. For example, the second projection, presented to the right of the position of the first projection, might represent the polygon in enlarged size. With this arrangement, an observer "liberates" the polygon from the picture plane. The polygon would appear to pop out toward the observer while simultaneously moving from left to right. A similar liberation from the picture plane is effected when the investigator presents, as the second projection, a straight vertical line in the exact center of the field onto which the polygon had first been projected. In this case the observer reports that the polygon had rotated 90 degrees through the near-far axis (some observers see it move from the right to the left, whereas others see it move from the left to the right).

One can have little cognitive difficulty if he or she were to apply the constructivist assumption to these reported observations. Event-associated input becomes part of a psychological process only when that input is assimilated to an available cognitive structure. The sense of an event derives from the ways in which its input-producing energy patterns are translated into neural impulses at sensory endings and are then assimilated to a person's existing cognitive structures. In Shepard's demonstrations of apparent movement, a person's system functions to
“fill in the space” between successive actual presentations, using an attributed representation of the rigid object. When it is necessary to do so in order to assimilate the input in a way that maintains the coherence of the system, the system will “fill in” within the third dimension. When, for example, the polygon is presented in the picture plane and is then replaced with a straight vertical line that can be experienced as an edge-on view of the rigid two-dimensional object, a person will make sense of the stimulus change by experiencing the figure moving through the third dimension.

In sum, then, these demonstrations of specific instances of constructive psychological functions provide validation of general constructivist assumptions, and they encourage investigators to search out and describe those aspects of a person’s psychological system which, in conjunction with input from an event, form an integral part of any psychological action.

CONSTRUCTIVIST PRINCIPLES IN PERSONALITY THEORY, MEASUREMENT, AND APPLICATIONS

Concurrent with the cognitive scientist’s affirmation of the utility of constructivist principles, other psychologists have explored the utility of constructivist approaches to explanations of person functioning (Averill 1982; Carver and Scheier 1981; Mancuso and Adams-Webber 1982a; Mandler 1984). With this redirecting of focus by general theorists, applied psychologists, as well, have increasingly investigated the advantages of using constructivist principles to guide their work (Adams-Webber and Mancuso 1983; Guidano and Liotti 1983; Goldfried and Robins 1983; Landfield and Leitner 1980; Neimeyer 1985; Neimeyer and Neimeyer, 1987).

A personality theorist using a total constructivist position would assume that a person would be defined in terms of the complete, integrated system of internal representations that he or she can retrieve to impose on and to anticipate the steady flow of input that he or she encounters in the continuous movement of psychological adaptation. From this position one would believe that every input must be processed in terms of the idiosyncratic, organized system the person has acquired in the pre- and postnatal period during which she or he has developed psychologically. The person, then, comprises that cognitive system — a system which is stored in long-term memory and which is carried from situation to situation.
With the rise of interest in and use of innovations by which to conceptualize cognitive processes, investigators have developed a variety of techniques for assessing the content and organization of a person’s cognitive structures. Often investigators (Cantor and Mischel 1979; Murphy and Wright 1984) have borrowed directly from the technology that cognitive scientists (Posner 1978; Rosch and Lloyd 1978) have used in laboratory studies. In many cases the investigator’s use of theory implicates a structure for the subject’s cognitive systems through the assumptions that guide the study. The investigator then accepts the outcome of the study as a suitable demonstration that the implied, but not directly assessed, system had functioned to produce particular results.

The work of Bargh (1982) illustrates the use of standard laboratory technology to deduce the structural properties of the construction systems that people apply to processing self- and person-relevant input. Bargh set out to add to the demonstrative base for regarding a personality as the cognitive processing systems that a person takes into interactions with his or her world (Wyer and Srull 1984). Bargh (1982) explored the ways in which an existing cognitive organization becomes implicated in the directing of attentional processes. To demonstrate the validity of his assumptions, Bargh, among other procedures, classified the persons who participated in his study as either schematics or aschematics. He placed his subjects in one or the other category on the basis of their responses to self-report rating scales. Essentially, those participants who rated themselves on the high end of scales assumed to be “independence-relevant” were judged to be persons who would readily access independence-defining schemata as they processed the flow of inputs. Bargh then used the standard dichotic listening task (a separate message to each ear) to assess the extent to which schematics would apply automatic attentional processes to cognize adjectives judged to be synonymous with the term independence.

In his attempt to work from a base of constructivist assumptions, Bargh, as noted (1982), chose his schematics on the basis of participants’ self-ratings with reference to scales purportedly describing self characteristics of independence. Bargh assumed that those persons who rated their selves (this pronomial construction is used deliberately to show that participants rated self as an object that can be ordered into categories) to be highly independent would have acquired a highly accessible independence construct; whereas persons who had rated themselves low on independence would not have done so. Although this assumption would have an immediate face validity, it cannot be accepted
without further consideration, and its ultimate acceptance must depend on
the availability of evidence based on technologies that allow quantititative
representation of an individual’s person-construing system. After those
technologies have been developed, an investigator may better test the
hypotheses that persons who rate their selves highly on a particular
dimension also use that dimension as a superordinating self-construing
dimension.

Note that Landfield and Schmittdiel (1983) report an exploration of
the concept of meaningfulness within a person’s construing system.
Building on earlier investigations of the concept (Bonarius 1970a,
1970b), Landfield and Schmittdiel have shown the utility of a
meaningfulness measure based on the assumption that the
meaningfulness of a construct, in a particular person’s system, is
reflected by the person’s use of both extreme ends of rating scales
(which, in their studies, are embedded in a Role Repertory Grid Analysis;
see Kelly 1955). Extending this proposition, then, one would need to
conclude that Bargh’s aschematic participants, who had been selected on
the basis of their having rated their selves at the dependent end of the
dependent–independent construct, would use that construct as
“meaningfully” as would the schematics. One would hesitate, then, to
endorse Bargh’s expectation of a processing difference attributable to his
schematics’ ability to easily access an independence construct, whereas
the aschematics would less readily access that construct.

In short, those investigators who would undertake studies based on
constructivist assumptions will ultimately profit from having available a
variety of sound methods for representing the cognitive systems that a
participant brings into a study. Such methods will be useful not only for
establishing the parameters of the cognitive system that participants can
access while being exposed to the experimental procedures, but those
methods can also serve to quantify the system’s changes following the
applications of experimental and clinical manipulations.

APPROACHES TO ASSESSMENT
OF COGNITIVE STRUCTURE

Investigators who have worked to expand on personal construct
psychology, which was originally formalized by George Kelly (1955),
have given special attention to specific methods of quantifying and
assessing the contents and structural properties of an individual’s
cognitive systems. In the original presentation of his theory, Kelly
described a methodology by which to obtain quantitative summaries of patterns of organization within an individual's person-perceiving system. Kelly's first applications of role repertory analysis required that a respondent produce a grid or matrix whose rows would be labeled with bipolar, person-defining constructs and whose columns would be labeled as persons significant in the life of the participant. The completed role repertory grid, which contained ratings of each person relative to each construct, could then be subjected to a wide variety of multidimensional quantitative analyses. From Kelly's first explorations there grew a large body of investigations based on repertory analysis (Adams-Webber 1979; Stringer and Bannister 1979). To conduct these studies investigators (Fransella and Bannister 1977; Landfield and Schmittdiel 1983; Shaw 1980, 1981; Slater 1977) have adapted the original assessment techniques to the wide range of computing technologies that have appeared since the introduction of role repertory analysis.

Beyond this plethora of studies of people's constructions of people, investigators have adopted the technology of analyzing role repertory grids to the analysis of a wide variety of cognized elements. Construct grid technology has been used to study conceptualizations of seaside resorts (Riley and Palmer 1976), of architectural and environmental designs (Honikman 1976), of automobiles (Boxer 1981), and of postgraduate students' activities as they progress through research training (Phillips 1981). Shaw and McKnight (1981a) have devised and published methods of using grid technology for personal decision making. Role repertory technology holds particular promise as a method for the analysis of expert systems (Boose 1985a, 1985b; Shaw and Gaines 1984).

As personal construct theorists have pushed forward their techniques, investigators working outside of this specific framework also have provided methods to be used in the analysis of cognitive structures. Rosenberg and his associates (Rosenberg 1977; Gara and Rosenberg 1979), who have concentrated on person cognition, have developed extended analytic methods. Following their interest in communication processes, Woelfel and his associates (Woelfel and Fink 1980) have devised procedures by which to track the cognitive changes that follow from the delivery of a constant flow of information. Jaccard (Jaccard and Wood 1986; Jaccard and Wan 1986) has devised methods for extracting the idiosyncratic cognitive systems that underlie decision-making processes.
THE UTILITY OF MULTIDIMENSIONAL ANALYSES AND MICROCOMPUTERS

Much of this work has been enhanced by analytic procedures that have become feasible with the advent of high-speed computing. A variety of multidimensional analyses have been adapted to the assessment of construction systems (Massaro and Schmuller 1975; Rosenberg 1977; Shaw 1980; Tversky and Gati 1982; Woelfel and Fink 1980), and these applications have served particularly well to advance conceptualizations of cognitive processes. Such techniques allow quantitative representations of the structural properties of cognitive systems, and with such representations an investigator may frame hypotheses that are then amenable to additional quantified assessment.

In the last five years the rapid development of microcomputers, coupled with statisticians’ greater attention to multidimensional analytic procedures, has created an ambience that presages a huge burst of activity in multidimensional approaches to analysis of cognitive structures. Portable, inexpensive computers now have the capacity to complete computations that recently were accessible to only the small number of investigators who could employ data tabulators and who could purchase expensive computer time. Additionally, the microcomputer allows for the easy collection and filing of data. In the recent past only well-financed investigators could collect data interactively by the use of computers. At this moment an investigator or an applied psychologist can collect and arrange large blocks of data by having respondents engage in tasks they find simple and stimulating. In short, one may now collect and analyze large data sets through relatively time-economical and inexpensive procedures.

Additionally, the use of the microcomputer facilitates the transmission of data, technologies, and information. Once collected, data may be transmitted in electronic form, either through direct linkage between computers or through the exchange of light-weight records of data (floppy discs, tapes). Investigators may similarly transmit programs designed to collect or process data.

ORGANIZATION OF THIS VOLUME

This volume has been planned to provide a wide range of potential readers with a readily accessible compendium of illustrative descriptions of techniques that have been developed to assess individual construct
systems. A variety of these techniques have been developed by theorists and practitioners who have described their work in widely spread outlets. In many instances the techniques have been described incidentally as investigators have reported the results of investigations.

These descriptions should highlight the significance of this research in ways that have not been realized by the less systematic presentations that have thus far been assembled. In the first place, by the study of these juxtaposed descriptions an interested reader can become aware of the intertwined technological and theoretical problems the designers of these techniques have considered. It will be seen that the development of these methodologies depends on and facilitates the reciprocal refinement of theories about cognitive process and measurement.

Additionally, by consulting this single source a reader can become acquainted with the workings of a variety of techniques, any one of which might be adaptable to the kinds of problems that he or she might pose and might wish to explore. As a reader surveys the available techniques, he or she will become aware that the people who have developed these techniques have tried to develop their methods toward greater flexibility of application. Although many of these techniques had been developed originally for the assessment of a person's construction systems relative to one event domain (persons, for example), the inventors of the techniques have attempted to make allowances for adapting the techniques to any domain in which an investigator might be interested.

The presentations in this volume will also illustrate the constant interplay of applied and theoretical problems that have informed the work of those people who have developed the described technologies. As will be seen, some of the chapters focus primarily on measurement and theoretical considerations. Other chapters are written from an applied perspective. Nonetheless, the activity described herein attests to the investigator's belief that technologies can usefully guide thought about day-to-day psychological functioning.

Nine chapters in this volume describe programs the authors have developed for use on microcomputers. (The programs described in a tenth chapter have been used on a large computer, and are not yet translated for microcomputer use.) Each of the authors has worked toward the goal of devising a suite of programs that would allow a quantitative representation of the cognitive system a person would use as he or she processes the input from one or another set of events.

As a reader can see, the authors' work represents a range of concerns, as those concerns are reflected in the chosen elicitation
techniques and in the analysis strategies. Shaw and Gaines report on an extended suite of programs (PLANET) that one can use to elicit and then to analyze, in a variety of ways, the cognitive system a person would use to think about any domain of events. They have designed elicitaiton and analysis programs of wide generality. Their chapter contains a description of the intricate detail that they have worked into their programs to ensure that clinicians and investigators will be able to take into account and adequately meet the many contingencies that can arise as one attempts to access and to assess cognitive systems relative to any domain of input a person might receive from his or her environment.

Landfield, one of the first investigators to develop computer programs to assess grids based on Kelly's Role Repertory Test, describes (with Cannell) the analysis programs Landfield and his associates have devised. These programs extract scores related to concepts that are important to the tenets of Personal Construct Psychology. With their programs Landfield's group has focused sharply on measure of hierarchy in the organization of those construction systems that people apply as they construe other persons. Landfield and Cannell describe the theoretical base of their measure of hierarchical organization, report on the computerized techniques by which the measures are extracted, and point to the research and clinical questions that one may answer with the extracted measures.

Mitterer and Adams-Webber take yet another task. They have programmed a method through which an investigator or clinician can construct a wide variety of instruments by which to elicit and analyze the system a person would use to construe events. They aimed at high flexibility in constructing and analyzing the data produced by any kind of instrument that would be of interest to the administrator of an assessment process. The content of their chapter illustrates the diversity of approaches that have become available to behavior analysts who wish to explore the complexity of personal systems of cognitive structures.

In Boose's chapter one sees the results of a more precise focus of cognitive assessment methodologies on the problems that interest a specific investigator. Boose set out to find an efficient method of extracting the knowledge system of experts. Building on the work of Shaw and Gaines (Shaw 1979; Gaines and Shaw 1981), Boose has developed a computer-assisted methodology for representing the knowledge base of an expert construer: the Expert Transfer System. Among other things, Boose's methods simulate the rules that would be
embedded in the cognitive systems of experts, and constantly refine representations of the systems.

The work of Jaccard, Wan, and Wood parallels that of Boose, in that it reflects the development of techniques by which one can usefully quantify personal cognitive systems that are of interest to a special line of investigation. Jaccard and his co-workers have developed their methods to enhance work related to Jaccard's long-time interest in decision-making processes. The computerized operations, described in Chapter 7, facilitate the collection and analysis of information about the cognitive organizations that guide a person's decision-making processes relative to any product, event, or issue.

Knowledge of the cognitive systems underlying decision making would be of special interest to scholars and practitioners of communications technology. Woelfel, who studies communications processes, has built a highly refined system for analyzing the development and change of personal cognitive systems. In his chapter he describes programs with which he can analyze the ways in which people construe any topic, for example, that might be a matter of current public discussion. Woelfel's analysis programs are of particular interest to persons in communications, because they include procedures by which one can project the state of a person's system in the event that one or another part of the system changes.

Lehrer and Mancuso, who share a strong interest in developmental processes, write about programs that take an even narrower focus. Lehrer has been particularly interested in the structures that young people bring to their school learning. That specialization led him to consider the connections between learning to read, personal narrative grammar, and the ways in which a person constructs his or her self within the narrative grammar structure that he or she uses implicitly to process all input. Mancuso's programs have been put together to explore a specific area of personal role construction. His ParRep analysis programs systematize the cognitive organizations a person uses as he or she construes enactments of parent roles.

Ashbrook, Spaulding, and Cromwell have followed yet another direction. Their studies have focused on the cognitive processes of persons who have been diagnosed in clinical settings. They have followed a theoretical position from which they have explored the deficits in the processing functions these persons bring to their interactions with inputs. In their chapter they describe the instruments by which they, using microcomputers, have assessed the various cognitive functions.
psychopathologists have implicated in the processes underlying the development of deviant behaviors.

In the last chapter, Pruzek reminds readers that the selection and justification of methods of analysis demand constant attention to measurement theory. Pruzek has devoted years of his career to the study of the intricacies of factor analytic methods, and remains a strong advocate of model-based methods for psychometric and statistical inference. He presents a strong brief for common factor analysis as a means of drawing inferences. He illustrates the ways in which common factor analysis can be of special value to investigators who rely on the analysis of two-dimensional matrices, to develop representations of the structures one presumes to underlie cognitive processes.

A FINAL WORD

Ultimately, the contributors to this book intend to convince investigators of the immense possibilities of exploration that have been created by the development of useful theory and technologies. The field has progressed beyond the "blood and sweat era." Persons who have not mastered the first principles of computer programming may implement available programs, although one could safely guarantee that anyone who begins to use one of the systems described in this volume will not remain at that rudimentary level. In the long run, the further development of theory and technology will depend on the versatility of investigators who can envision the multiple possibilities of adapting programs for analysis and re-analysis of data.

The state of affairs presented by this volume can satisfy only the scholar of cognitive processes who has observed the recent immense acceleration of activity devoted to building a theory base from which to investigate cognitive processes, to inventing methods for accessing and representing cognitive structure, and to extending the territory under exploration. Consider that 15 years ago the ambience surrounding the behavioral sciences and the then current state of technological developments would have seriously constrained the assembling of a book like this. Currently, one can easily introduce undergraduate students to the contents of this book. What is more, some of those undergraduates will readily add elaborations to the conceptualizations and techniques discussed in these chapters.

As editors of this volume, we regard this collection of papers as an invitation. Some readers, we hope, will be invited to elaborate on this
work by reasoned criticism. We want other readers to accept the book as an invitation to become acquainted with the diversity and ready availability of computer-assisted approaches to assessing cognitive systems. More than anything, of course, we invite readers to collaborate with the writers who have built these systems. Each of the authors anticipates the opportunity to share his or her excitement and enthusiasm.
2 Modeling Cognitive Processes

Mildred L. G. Shaw and James C. Mancuso

CONSTRUCTIVIST PARADIGM AND COGNITIVE SCIENCE

The constructivist paradigm that underlies personal construct psychology is an alternative to the positivistic, behavioristic approaches that have rested on mechanistic paradigms. Although mechanistic paradigms have been difficult to dislodge from the favored position they have held in the behavioral sciences, scholars have steadily moved toward constructivist approaches. It is not a surprise that a new metaphor, the computational model, has carried forward the constructivist metaphors. The development of computer-based modeling systems has allowed the operationalization of constructivist formulations. Work in artificial intelligence, the emulation of high-level human capabilities on the computer, has led to representations of systems that model human performance. Parallel to this, the acceleration of the development of cognitive science follows from the use of such computer-based emulations of human performance to provide a model of human functioning.

Whereas strict behaviorism legitimated only models of human functioning that could be inferred from human behavior, cognitive science legitimates mental models whose functioning parallels that of
people, but whose processing structures cannot necessarily be inferred from observable output (Gentner and Stevens 1983). Such models are possible inferences from human behavior in that they are consistent with it, rather than necessary inferences in that they are strictly derivable from it. The influences of positivism and early computer technology are evident in the information-processing models of the first accounts of cognitive science (Lindsay and Norman 1977). However, in recent years the role of a wider variety of mental processes has been realized, and the models are being extended to account for such phenomena as emotions and consciousness (Norman 1980).

Parallel to this legitimation of mentalistic concepts through developments in artificial intelligence and computer modeling, one observes an increased acceptance of such concepts as those expressed in studies of the social construction of self and others (Gergen and Davis 1985) and in personal construct psychology. In particular, Kelly’s (1955) construct of anticipatory construction (p. 46), which stands in his theory as the fundamental dynamic of human functioning, resonates with the cognitive science emphasis on the key role of planning and of hierarchical goal structures (Anderson 1983: 33). In effect then, personal construct theory and cognitive science share a heavy reliance on the concept of anticipation as a constructive process that underlies all human activity. With this reliance comes an ancillary dependence on the concept of a schema, which designates an inner representation of events that is constructed through the use of organized cognitive systems. This concept was first put forward by Head in 1920, and has had a long history in psychological science (Bartlett 1932; Kant 1934; Vernon 1955; Bruner, Goodnow, and Austin 1956; Neisser 1967), but it assumes new significance with the legitimation of mental models.

Bartlett (1932: 201) developed the idea of a schema in his widely cited work on remembering. He defined schema as follows:

“Schema” refers to an active organization of past reactions, or of past experiences, which must always be supposed to be occurring in any well-adapted organic response. That is, whenever there is any order or regularity of behavior, a particular response is possible only because it is related to other similar responses which have been serially organized, yet which operate, not simply as individual members coming after one another, but as a unitary mass.

Bartlett further suggested that there is a gradual buildup of such cognitive structures which are nonspecific, but organized, classifications of many events. These events are linked by a classification schema that he described as “effort after meaning,” that is, the perception or construction of similarity in the events themselves. It seems that it is anticipation that determines the meaning of an event, and that one construes an event as being the same or different from the anticipated schema.

Piaget emphasizes the dynamic nature of schemata by stating that a person constructs events in his or her world by assimilating schemata, while accommodating these schemata to input-associated constraints (Flavell 1963). Neisser (1967, 1976) similarly suggests that a person forms cognitive structures that are the result of the constructive processes involved, and emphasizes their anticipatory role: “At each moment the perceiver is constructing anticipations of certain kinds of information, that enable him to accept it as it becomes available” (1976: 20).

Osgood, Suci, and Tannenbaum (1957) introduce the social aspect of schemata by noting that while each person has a unique system of dimensions that are used to perceive and judge the environment, some of these are common to large segments of people who share a common culture.

The underlying theme of all these approaches is that an individual uses a system of organization together with interrelationships between components in the system, which, by interacting with the structure, produce interdependencies. Kelly’s (1955) personal construct psychology provides a systematic, comprehensive framework for this kind of cognitive psychology. In particular, Kelly suggests that if the person becomes aware of the structure and of the organization within the structure, he or she becomes more able to make adequate predictions and to act according to those anticipations. Kelly (1955) explains construing as a process of abstraction: “We look at the undifferentiated stream of circumstance flowing past us, and we try to find something about it that repeats itself. Once we have abstracted that property, we have a basis for slicing off chunks of time and reality and holding them up for inspection one at a time . . . this is done by construing” (p. 120).

He also describes the relation between construing and anticipation of events: “When one abstracts replicated properties in the events he has already experienced, it becomes possible for him to chart events to come in terms of these same properties . . . What one predicts is not a fully fleshed-out event, but simply the common intersect of a set of properties. If an event comes along in which all the properties intersect in the prescribed way, one identifies it as the event he expected” (p. 121).
Kelly proposes that each person constructs his own version of reality using a hierarchical system of personal constructs. These processes, to him, constitute a personality — the ways in which each person constructs his or her view of reality and lives within it. In the context of a person learning from experience, the theory describes the ways in which one can negotiate a viable position in his or her own reality, review it, revise it, and refine it within his or her own world.

PERSONAL CONSTRUCT PSYCHOLOGY
AS A THEORY OF THE PERSON

Kelly expresses personal construct psychology as a postulate and eleven corollaries. The Fundamental Postulate states that “a person’s processes are psychologically channelized by the ways in which he anticipates events” (p. 46). It has been noted:

Kelly was careful in wording the central statement of this theory to surmount or avoid three of the most persistently knotty problems in psychology — namely, why people do anything at all; why over a period of time, or at any choice point, they do certain things rather than others; and how people who are so obviously different in so many ways can yet be compared within some consistent conceptual framework. (Bannister and Mair 1968: 10)

The anticipatory emphasis of personal construct psychology is inherent in Kelly’s approach:

According to his Fundamental Postulate, all of our representation, including the represented action elements, are anticipatory. Human action, from the standpoint of Kelly’s theory, flows from an intention to bring about a correspondence between a person’s constructions of the future and his mental representations (personal constructions) of information-producing events. (Mancuso and Adams-Webber 1982b: 8)

ORGANIZATION AND DYNAMICS OF CONSTRUCTS

Kelly (1955) states the corollaries as necessary extensions of the foregoing proposition. They are attempts to expand the theory in a strict formulation, and hence they may appear to be of different types and levels. The Construction Corollary states that “a person anticipates events by construing their replications” (p. 46). In construing or placing an interpretation on events, the individual places into categories those which he/she determines to be similar to and different from others, building up a set of constructs which enable him/her to pick out recurring patterns that he/she can then use to anticipate and predict. It is this tendency which makes an adequate model an essential part of success in any field. One does not always build a new model when faced with new events, but anticipates on the basis of the models which he or she has already developed.

Kelly states his Individuality Corollary as follows: “Persons differ from each other in their constructions of events” (p. 55). This corollary expresses Kelly’s stress on the personal nature of construing, but he emphasizes also that “persons can find common ground through construing the experiences of their neighbors along with their own” (p. 56), although “individuals can be found living out their existence next door to each other but in altogether different subjective worlds” (p. 56). He suggests that to obtain the best explanation of a person’s organization of experience or behavior, one should find ways to inquire of the person who does the organizing.

The Organization Corollary states that “each person characteristically evolves, for his convenience of anticipating events, a construction system embracing ordinal relationships between constructs” (p. 56). Kelly recognized that “different constructs sometimes lead to incompatible predictions” (p. 56), and he saw a hierarchical relationship that ordered constructs relative to one another as a basis for explaining such contradictions. He conceptualized hierarchic functioning as a process in which the stability of the upper levels allowed for change in the lower ones, so that the arrangement of constructs in a particular hierarchy would be more a determinant of personality than are the constructs themselves.

On stating the Dichotomy Corollary, Kelly proposed that “a person’s construction system is composed of a finite number of dichotomous constructs” (p. 59). Kelly saw concepts of similarity and contrast between elements forming the two “poles” of a construct. This does not necessarily involve a binary evaluation of elements; a person can locate an element somewhere between the poles of a construct.

On what basis would a human psychological system process an event in terms of one construction rather than another? To answer this quasi-motivational question, Kelly included a Choice Corollary in his theory: “A person chooses for himself that alternative in a dichotomized construct through which he anticipates the greater possibility for extension and definition of his system” (p. 64). To explicate the system’s functions one must keep in mind that constructs are dichotomous, and that they are
hierarchically organized. A person locates an event at one or another end of a hierarchically interconnected construct in ways that will maintain the greatest contextualist motivational power of which the system is capable. To contrast his contextualist motivational position with that of the mechanists Kelly explained that “there is a continuing movement toward the anticipation of events, rather than a series of barter for temporal satisfactions” (p. 68).

Correlatively, not every construct can allow convenient anticipation of every event. Convenience in psychological processes refers to the extent of revision and alteration of the hierarchical structure that would be occasioned by fitting one or another event into one or another pole of a particular construct. The necessary constraints on haphazard, immediate construing is expressed in the theory’s Range Corollary: “A construct is convenient for the anticipation of a finite range of events only” (p. 68). This may be thought of as introducing a concept of relevance into the definition of construct systems.

Each of a person’s attempted anticipatory constructions represents a hypothesis to be tested not only for its convenience in anticipation, but also for its extending and defining capabilities. Such continual experience leaves a residue of change in the person’s system; to formalize his view that the resulting accommodations of the system constitute learning, Kelly stated an Experience Corollary: “A person’s construction system varies as he successively construes the replications of events” (p. 77). In a way, the Modulation Corollary takes into account the metaphorizing character of a person’s constructs. Novel inputs to the system will be anticipated and will change the system if the system can access permeable constructs, that is, constructs that are “so constituted that new experience and new events can be discriminatively added to those which it already embraces” (p. 81).

The theory’s Fragmentation Corollary states that “a person may successively employ a variety of construction subsystems which are inferentially incompatible with each other” (p. 83). Through this corollary Kelly allows for the operations of different psychological systems and hence different methods of inference and forms of rationality within a single individual.

Kelly completed his system of formal propositions by giving two corollaries that relate construing processes to social interaction events. Another person’s constructions of events, as well as the events themselves, provide input relative to those events, and, thereby, become a part of the experience of those events. A personal construct theorist must consider that “to the extent that one person embraces a construction of experience which is similar to that employed by another, his psychological processes are similar to those of the other person” (the Commonality Corollary, p. 90). This corollary complements the Individuality Corollary and allows for the “fact that certain groups of people behave in certain respects” (p. 93).

The Sociality Corollary states that “to the extent that one person construes the construction processes of another, he may play a role in a social process involving the other person” (p. 95). Kelly here acknowledges that the construal processes of one person can become elements for construal by another and hence can model the process by which we anticipate the actions of others.

CONSTRUCTIVISM AND CONSTRUCTIVE ALTERNATIVISM

In light of the difficulties in which personality theorists still become ensnared when they take up issues related to reality, or subjectivity, or objectivism, one could easily agree that Kelly’s most radical departure from standard theorizing is reflected in his stance on the issue of constructive alternativism. Maddi (1984) very cogently disassembles Fiske’s (1977) suggestion that small concrete data units are more real, and that objectivity is to be found in avoiding interpretation or abstraction. He neatly counters Fiske’s effort to promote objectivity with the observation, “While there may be an immutable thingness out there, we have only our perceptual systems with which to apprehend it” (p. 18). But nowhere in his prescription for a personology for the 1980s does Maddi advocate, as did Kelly, that the behavioral scientist approach his target of study from that same ontological position. Maddi, as a representative mid-twentieth century scientist, seems unable to acknowledge that individual persons, like individual scientists, cannot render “objective” statements about the universe of events, and hence unable to grasp the radical significance of Kelly’s emphatic assumption that “all of our present interpretations of the universe are subject to revision or replacement” (p. 15).

Although Kelly specified his conclusion that “the universe is really existing and that man is gradually coming to understand it” (p. 6), he also was astute enough to avoid equating reality with “immutable thingness.” He notes specifically that “within our universe something is always going on. In fact, that is the way the universe exists; it exists by happening” (p. 7). To come gradually to understand the universe, for both the scientist
and the target of the scientist’s work, is to come gradually to construct a system of understanding the processes of a “happening world.” As personologists who adopt constructivism, and as construing persons (Mancuso and Adams-Webber 1982a), we take it as a given that we create the shared and the private meanings of events. A personal construct theorist cannot have the construct objectivity-subjectivity as a core construct because “it is fundamental to the constructivist’s view that the environment can never be directly known but that conception determines perception. We know reality only by acting upon it… The active interaction between the individual and the environment is mediated by the cognitive structures of the individual” (Nystedt and Magnusson 1982: 34). Or as Kelly (1955) said, “No one needs to paint himself into a corner; no one needs to be completely hemmed in by circumstances; no one needs to be a victim of his biography” (p. 15).

PROBING THE CONSTRUCT SYSTEM — REPERTORY GRIDS

Each person may be seen as a personal scientist (Shaw 1980), classifying, categorizing and theorizing about his/her world, anticipating on the basis of his/her theories, and acting on the basis of his/her anticipation. The personal scientist models his/her world, using his/her theory or model to make predictions or to act in the world, and experiencing events that may or may not be influenced by his/her actions. This experience of events is then fitted to the model, which may be reviewed or revised in light of experience to make more “successful” predictions.

A theory is a device to enable man to deal comprehensively with what might otherwise be an overwhelming variety of events. . . . Strictly speaking, man invents his theory; he never discovers it. . . . The process by which a theory is derived is known as abstraction, and the complementary process by which it is extended to events is known as generalization. Both may properly be regarded as psychological processes, or even as aspects of the same psychological process. . . . Thus meaning is not extracted from nature, but projected by man upon it. (Kelly 1965: 289, 290)

THE REPERTORY GRID AS A REPRESENTATION OF PERSONAL MODELS

Kelly suggested the technique of the repertory grid to represent the repertoire of constructions that the individual has acquired from his or her personal observations of the world. A repertory grid or “construction matrix” is essentially a two-way classification of data in which events and abstractions, or constructs, are interleaved. In his own terms, “it expresses one’s own finite system of cross-references between the personal observations he has made and the personal constructs he has erected” (Kelly 1965: 291).

The personal observations are known as elements. Elements were originally constituted from the role titles of significant people in the life of the particular individual. The personal constructs are bipolar dimensions that group the elements into varying clusters according to their similarities and differences within the individual’s frames of reference. Kelly used the repertory grid as a tool to assist with psychotherapy, using significant others as elements. Since its introduction, it has been used in many settings to probe the construct systems of psychiatric patients, student teachers, effective managers, knitwear inspectors, and rivet selectors in the aircraft industry. The elements may be people, things, events, or experiences, which are related to the particular problem or purpose for using the grid.

PRECOMPUTER ELICITATION TECHNIQUES

Constructs may be elicited by many means, the most common being the minimal context form or triadic method (i.e., “Can you say in what way two of these elements are alike, and in the same way different from the third?”), and the full context form (“Considering the whole set of elements, think of an important way they divide into two [or more] groups”). Other methods derived from these are splitting the two most similar elements to put one on each pole of a new construct, and naming of a construct to describe the difference between the two most dissimilar elements.

Another useful form of construct elicitation is a technique developed by Hinkle (1965) called laddering. Initially, constructs are elicited by a standard method, then one construct is selected and the question asked, “Which pole is the one you would prefer to be rated on?” then “Why would you prefer that pole?” and “What is the opposite of that?” This then provides a new construct that is more superordinate or generalized than the original one. As this process is repeated, a hierarchy or heterarchy of superordinate constructs is elicited.
THE ROLE AND SIGNIFICANCE OF COMPUTERS

During the past 20 years, the digital computer has come to assume a role of increasing importance in psychology and in the application of psychological techniques. During this period also, the nature of available computer resources has itself changed dramatically. In the early 1960s we submitted massive computations of variance and factor analyses to some remote computing center that punched our data onto cards and sent back the results, often days later. By the early 1970s we had our own minicomputers in our laboratories giving a hands-on system for direct experimental control, but they were so expensive that they were available only as a shared resource to a group of researchers on a booking basis. The central computers also changed during that period, to allow some form of interactive time-sharing whereby we could enter our own data on a local terminal and receive the analysis back reasonably rapidly on the same terminal. In the last few years, a further development has taken place in that so-called personal computers have become available, offering us great power and a wide range of facilities at such a low cost that an individual can have one or more such machines dedicated to his or her work.

These advances in computer technology have offered opportunities for the automation of psychological testing, which have been widely taken advantage of (Elithorn and Telford 1969; Gedye and Miller 1969; Elwood 1972a, 1972b, 1972c; Klinge and Rodziewicz 1976; Thompson and Wilson 1982; Volans and Levy 1982). Direct interaction between patients and computers has now been shown to be successful and acceptable in an experimental environment (Card et al. 1974; Lucas 1977), and it has even proved possible for the computer to act as an effective therapist (Stodolsky 1970). Automated psychological testing has also been widely validated against experts administering the same test (Ridgway, MacCulloch, and Mills 1982; Calvert and Waterfall 1982; Watts, Baddeley, and Williams 1982; Acker 1982). These advances in technology have also offered the opportunity for new approaches to the testing process that are dependent on having powerful computational facilities in operation during the test. In particular, it has become possible to obtain test results speedily and in a manner that aids both expert interpretation and self-interpretation.

Many researchers have developed computer techniques for the elicitation and analysis of personal construct psychological data, some of which are reported in the following chapters. Many of these are interactive programs that allow a greater degree of autonomy and more control to be given to the user. It would be easy to assume that such interactive programs are merely more convenient ways of eliciting construct systems through extensions of Kelly's repertory grid and do not themselves add anything qualitatively new to the process. However, such an assumption would be missing certain crucial psychological factors in the person–computer situation and its differences from the person–person situation. For example, we have observed informally, in making the grid elicitation program PEGASUS (see Chapter 3) available to a wide range of people in a variety of situations, that those coming to it for the first time often seem to find it a very dramatic experience. They react to it intensely and become gripped by the interactive process of construct elicitation. They also feel that they are learning something new from the process and are prepared to use this in determining their behavior.

Probably such involvement is also significant in the elicitation of construct systems by a person rather than by computer interaction. However, we believe there are certain quite fundamental differences when the elicitation is done in such a way that interpersonal interaction is clearly absent. In particular, when a person is feeding back comments and guidance, it is a natural and ready assumption that the constructs are being injected rather than elicited. It is easy for the subject to believe that the elicited constructs do not come from him/herself, but that a tutorial or debating situation with another person is taking place. It is necessary to persuade him/her that this is not so, and the persuasion has to be stronger the more striking and significant the constructs elicited. However, when a computer is the tool by which his/her construct structure is being reflected or laid bare, then such an assumption of outside injection and interference is far less tenable.

When constructs are being elicited by a computer program, then it is more likely to be accepted that it is precisely and only oneself that is being portrayed. We trust a computer program to be doing just what it appears to be doing without deeper motivations and without attempting to persuade us to its point of view. No one is telling the user anything. One is seeing, in interacting with PEGASUS, possibly for the first time, the basis for one's own thought processes. Very often extreme surprise is the first reaction. If another person were eliciting the construct structure, then the surprise would be taken as an indication that he or she was incorrect, and one would ignore or argue with him/her. With computer elicitation, it is more likely that one will accept the reflected
structures as self-generated, and the surprise will act as a motivation to know more.

That this knowledge can be totally private is another important feature of interaction with the computer. We do not like to be caught, as Kelly put it, with our constructs down. When another person is involved, we are more reluctant to expose and explore our constructs the more surprising they are, perhaps because the surprise is often the result of a conflict between our ostensive value judgments and the basis of our behavior. Or it may just be sloppy verbal behavior that we are naming two distinct constructs with the same label. For example, in using PEGASUS, a scientist found that he was using the word time to label several different elements and was generating confusion in his arguments because of this.

Another reason that we are reluctant to explore construct structures freely in interacting with another person, particularly a professional, is that we are acutely aware of the possible waste of their time. This phenomenon has been noted (Card et al. 1974) as a major reason for the preference expressed by patients to be interviewed through an interactive computer program rather than by their doctors. There are many pressures and artifacts of interpersonal relationships that can totally obscure and undermine such reflective processes that we require in the elicitation of personal constructs.

It is interesting to note that this argument has been put in reverse. Adams (1979) notes that children learn quickly to play games on a personal computer and conjectures that this is because of the lack of interpersonal complications. She suggests, however, that “one of the benefits of game-playing is that a child learns how to behave with and towards others, how to cope with success and failure, and what effect it has on others. In the human-computer relationship the child does not learn these valuable social skills” (p. 29). We are arguing conversely that the need to deploy such “social skills” is a burden that can seriously detract from the exploration of the self.

**SIGNIFICANT APPLICATION AREAS**

These cognitive modeling techniques have been used widely in many areas of work. The ones covered in this book are clinical psychology, education, management, and computer science. Commenting on clinical psychology, Shepherd and Watson (1982) state, “Personal meanings arise from events and relationships which a person interprets within his most basic frame of reference — his awareness of being an individual, conscious of personal agency and personal biography” (p. 1). Fransella (1982) explains, “To construe is to impose meaning or interpretations upon something or some things” (p. 47). Many clinical psychologists have used personal construct psychology to explore a patient’s personal meaning system, and to make explicit the implicitly held models of the world that lead to behavior, that is, prediction or action.

In education and learning, many groups are using personal construct psychology techniques. Phillips (1981) has studied the development of research skills and the styles of supervision of doctoral students. She elicited information from the viewpoint of the students at stages during the progress of their research over three or four years, and from the viewpoint of their supervisors. Valuable insights were acquired by both parties about this process, and some interesting results were obtained. Pope and Shaw (1981) and Pope and Keen (1981) have related personal construct psychology to various philosophies or ideologies of education mainly as they applied to school learning, and they extended this to areas of educational research and to some of the current issues in education.

Personal construct psychology has been found to apply equally well in helping an expert articulate her skill, as it has been in more traditional uses, such as in helping a person referred for psychotherapy to articulate her problems, or a student her needs for learning. The initial success of expert system developments (Michie 1979; Gevarter 1983; Reitman 1984) and the development of a number of reasonably domain-independent software support systems for the encoding and application of knowledge (Hayes-Roth, Waterman, and Lenat 1983) has opened up the possibility of widespread usage of expert systems. In particular, the Japanese Fifth Generation Computing System development program (Moto-oka 1982; Gaines 1984) assumes this will happen and is concerned with knowledge processing rather than information processing. However, what Feigenbaum (1980) terms knowledge engineering (the reduction of a large body of knowledge to a precise set of facts and rules) has already become a major bottleneck impeding the application of expert systems in new domains. We need to understand more about the nature of expertise in itself (Hawkins 1983) and to be able to apply this knowledge to the elicitation of expertise in specific domains.

Shaw (1983) and Boone (1984) have used personal construct psychology techniques to elicit and structure expert knowledge, and to analyze and refine this knowledge into production rules. (An example of a production rule so obtained is: If a database is inverted, then it will not
run on a Vax computer.) These rules can then be assembled into an expert system building tool or shell for immediate refinement and debugging. Boose (1985a) has developed over 200 expert systems, using personal construct psychology as a base.

PERSONAL CONSTRUCT PSYCHOLOGY IN THE ERA OF MENTAL MODELS AND THE PERSONAL COMPUTER

These are exciting times for psychologists. The constructivist paradigm, the development of cognitive science, the legitimation of mental models, and the availability of the personal computer together offer the vehicles to explore new territories. The remaining chapters in this book are by those who have constructed those vehicles and have begun to use them. All those who have participated in generating this book hope that the wider dissemination of these tools, techniques, and experience will encourage others to join in the exploration. Many different disciplines of psychology have much to gain from the constructivist paradigm and its operationalization through the personal computer. The following chapters should promote this symbiotic relationship.