The Information-Processing Approach to the Human Mind: Basics and Beyond

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Cognitive psychology attempts to understand the nature of the human mind by using the information-processing approach. In this article, the fundamentals of the cognitive approach will be presented. It will be argued that the human mind can be described at three levels—computational, algorithmic–representational, and implementational—and that the cognitive approach has both important theoretical and practical/clinical implications. Finally, it will be suggested that the study of cognitive psychology can provide a foundation for other fields of social science, including the field of clinical psychology. © 2004 Wiley Periodicals, Inc. J Clin Psychol 60: 353–368, 2004.

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In Western civilization, interest in human cognition can be traced to the ancient Greeks. Socrates, Plato, and Aristotle speculated on the nature of memory and thoughts. This discussion about the nature of cognitions developed into a centuries-long debate between empiricists and rationalists. During this philosophical debate, sciences such as astronomy, physics, chemistry, and biology developed; however, interestingly, no concomitant attempt was made to apply the scientific method to the understanding of cognition (Anderson, 1990). However, this began to change with the work of Gustav Theodor Fechner (1801–1887). In his work, the formal beginning of experimental psychology, as well as

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the systematic study of cognitions, arguably can be found. Before Fechner, there was only psychological physiology and philosophical psychology. Fechner performed with scientific rigor what may be the first experiments that laid the foundations for the new psychology. By the end of the 19th century, psychology became even more scientifically respectable with Wilhelm Wundt's establishment of the first psychology laboratory in Germany. Despite this progress in the study of cognitions (including the contributions of Gestalt psychology), modern cognitive psychology as it is understood today has only been a serious area of research for approximately five decades. In the 1950s, a number of pioneers (e.g., Noan Chomsky, George Miller, Alan Newell, and Herbert Simon) broke with the behaviorist tradition, initiated a *cognitive revolution* in psychology, and thus laid the foundation/groundwork for the field of cognitive psychology. In 1967, Ulrich Neisser wrote his seminal book *Cognitive Psychology*, and in doing so named and defined that field. At the same time, in the clinical arena, Albert Ellis broke with the behavioral tradition (Ellis, 1958) and laid the foundation upon which cognitive therapies are based. Since that beginning, other famous pioneers (e.g., Albert Bandura, Aaron Beck, Arnold Lazarus, and Donald Meichenbaum) have made invaluable contributions to the development of cognitive therapies. Although other professionals had emphasized the importance of cognitions in clinical work (e.g., Alfred Adler, Karen Horney, and George Kelly), they did not promote the cognitive approach as an entity in and of itself (i.e., an independent status). The publication of Ellis' article, "Rational Psychotherapy" (Ellis, 1958), and seminal book *Reason and Emotion in Psychotherapy* (Ellis, 1962) added a good deal of legitimacy to the cognitive approach to the clinical work. However, despite some striking similarities (e.g., the focus on cognitions as potential *causes* of human behavior), the cognitive revolution in academic psychology (related to cognitive psychology) and in the clinical field (related to cognitive/rational therapies) showed little relation to each other. Only recently, as a result of the efforts of a few professionals (see David, 2003), have the two begun to converge under the umbrella of evidence-based psychology.

Cognitive psychology is concerned with the human mind, how it creates meaning, how it processes information it receives (input) to develop responses (output), and how those responses (output) in turn can influence subsequent input (Anderson, 2000). However, cognitive psychology is not only the science of human information processing per se, but it is an information-processing perspective that can be used in our attempts to understand all of the workings of the human mind, including cognitive processes, behaviors, and emotions (Anderson, 2000). As both a topic (i.e., the study of human information processing) and an approach (i.e., an information-processing perspective on any psychological phenomenon), cognitive psychology assumes that most complex human responses (e.g., behaviors) are cognitively penetrable. Cognitive penetrability means two things: (a) that a response (e.g., behavior) is an outcome of cognitive processing, be it conscious or unconscious, and (b) that a change in cognition will induce a change in the expressed response (e.g., behavior). It is important to note that the limits of cognitive penetrability are the limits of cognitive psychology. In other words, because some basic human responses are not cognitively penetrable (e.g., some basic behaviors are determined genetically), they typically are not considered within the realm of cognitive psychology.

The Basics of Cognitive Psychology

In essence, it is assumed that the human mind is a general-purpose system and that two important functions of the human mind are *representation* and *computation*. Representation can refer either to a *thing* that stands for something else (e.g., the word *dog* stands for the animal *dog*) or it can refer to the relationship between a representation in the sense just described and what it represents (e.g., the relationship between the word *dog* and the actual *dog*). Computation, both conscious and unconscious, refers to the transformation of representations into other representations in a rule-governed manner. To the question, "How do we know about the mind's functioning and about what takes place between observable input and output?", cognitive psychology answers, "By computational models supported by experimental evidence" (Eysenck & Keane, 2000).

A computational model tries to specify the relationship between input and output. Such models are similar to those used in other sciences. For example, in Newtonian mechanics, computational models are elaborated to explain the movement of a ball from point A to point B by inferring some unobservable constructs (i.e., forces) related by mathematical functions. Similarly, in cognitive psychology, computational models are elaborated to explain the relationship between input (stimuli) and output (human responses: subjective–emotional, cognitive, behavioral, and physiological) by inferring psychological constructs (e.g., schema, script) related by various rules. In this way, cognitive psychology is *functionalistic*, and it is quite neutral in the debate between realism (i.e., the cognitive constructs really exist) versus nominalism (i.e., the cognitive constructs are invented labels reducible to behavior or physiological phenomena) (O' Hara, 1995).

A function is three things bundled together. It is a set of inputs (domain), a set of outputs (codomain), and a rule for associating one of the outputs to each of the inputs. If the associations between input and output are rule governed, a computable function exists. In mathematics, functions can be defined in several ways: by formulas, tables, and graphs. For example, the following mathematical function, F: N (domain) $\rightarrow$ N (codomain), is defined by a formula: $F(x) = 2x$, where the domain N refers to all natural numbers, the codomain N also refers to all natural numbers, and $F(x)$ refers to the formula connecting domain and codomain. As can be seen, a mathematical function helps by:

1. explaining why a specific codomain value (e.g., 4) is given a specific domain value (e.g., 2);
2. predicting a specific codomain value (e.g., 6) being given a specific domain value (e.g., 3);
3. describing the entire range of domain–codomain relations (e.g., 0–0; 1–2; 2–4; 3–6; etc.); and
4. summarizing by a mathematical model/formula [$F(x) = 2x$] all the possible domain–codomain relationships (e.g., 0–0; 1–2; 2–4; 3–6; etc.).

Similarly, in cognitive psychology, a set of inputs (stimuli) is associated with a set of outputs (human responses: subjective, cognitive, behavioral, and biological) by several cognitive constructs. These cognitive constructs refer to both conscious information processing (e.g., explicit perception, explicit learning, explicit memory) and unconscious information processing (e.g., implicit perception, implicit learning, implicit memory) (David, 2000; Eysenk & Keanne, 2000). The cognitive constructs, like the mathematical formula described above, have several functions:

1. they explain why a certain input is associated with a certain output;
2. they predict the output given a certain input;
3. they describe the input–output relations; and
4. they organize and summarize various input–output relations.

In order to understand the cognitive constructs, one elaborates several computational models based on both the classic symbolic paradigm (e.g., schema, script, semantic, and prepositional networks) and a non-symbolic paradigm (e.g., connectionist networks).

Of course, there also are noncognitive mechanisms that could account for the relationship between observable input and output. Some people might argue that a neurophysiological description is desirable (Churchland, 1989). Others might argue for a behavioral description where cognitive processes are conceptualized as covert behaviors (Skinner, 1984). However, both neurophysiological and radical behavioral descriptions are too complex and too detailed to describe the human mind efficiently (Anderson, 2000). For example, in order to describe a simple psychological phenomenon—the memory biases induced by schema type processing (i.e., remembering schema-consistent information better than schema-inconsistent information) (for details, see Brewer & Treyens, 1981)—we would have to either describe the behaviors of millions of neural cells or examine the special history of contingencies associated with the items on the memory test. This is similar to using a relativistic mechanics formula to predict the movement of a large object at low speed, or to list all domain–codomain relations (e.g., 0–0; 1–2; 2–4, etc.) in order to describe a single mathematical function. In principle, this is possible, but it is too complicated and adds nothing to the prediction offered by a simpler Newtonian mechanics formula or by a mathematical formula [e.g., $F(x) = 2x$]. Similarly, in psychology, a level of analysis is needed that is more abstract and yet simpler then a neurophysiological and/or radical behavioral approach, yet one that still leads to accurate explanations and predictions. The cognitive approach fulfills these criteria and thus far has proved to be the most productive paradigm in studying the human mind. An empirical analysis of trends in psychology (Robins, Gosling, & Craik, 1999) showed that cognitive psychology has become the most popular model in use today, whereas the popularity of behaviorism has declined and neuroscience has shown only a modest increase in prominence in mainstream psychology. It is important to note that cognitive, neurophysiological, and behavioral approaches are not simply different languages used to describe the same phenomenon; sometimes they may refer to different phenomena. For example, as has been mentioned before, the domain of cognitive psychology is constrained by cognitive penetrability. In other words, a wariness should be maintained that although some cognitive models can be translated into neural or behavioral models and vice-versa, it is sometimes merely an artifact of the formalisms involved, not necessarily of the inner structure of the phenomenon under study.

Cognitive psychology is a part of the larger field of cognitive sciences. The aim of cognitive science is broader than that of cognitive psychology. Cognitive science is the study of the human mind and brain, focusing on how the mind represents and manipulates information and how information processing is realized in the brain. Cognitive science has emerged at the crossroads of several disciplines including: cognitive psychology, cognitive neuroscience, artificial intelligence, linguistic and cultural anthropology, and philosophy. Cognitive psychology benefits from this rich diversity by assimilating constructs from all these fields with their associated heuristic values, experimental paradigms, and research tools. In return, cognitive psychology has enriched the field of cognitive science by catalyzing research in several areas (e.g., cognitive neuroscience, artificial intelligence) through the new insights it offers into the components of the human mind. For example, *the marriage* between cognitive psychology and evolutionary biology has created evolutionary psychology, which tries to understand the human mind and its information processing from an evolutionary point of view. In addition, cognitive psychology can enrich a variety of other social sciences through its study of the basic mechanisms governing the human mind. These basic mechanisms are important in understanding the types of behavior studied by other social sciences, and in this sense, cognitive psychology studies the foundation on which all of the other social sciences stand (Anderson, 1990). Therefore, it makes sense to analyze the clinical field's development in the context of cognitive psychology.

To understand the cognitive psychological approach, it is helpful to distinguish between the terms paradigm/framework, theory, and model (also, it is useful to acknowledge that some cognitive psychologists often use these terms interchangeably). A *paradigm* is a general pool of constructs for understanding a domain, but it is not organized tightly enough to constitute a predictive theory (Anderson, 1983). Fundamental constructs of cognitive psychology are information processing, cognitive structures, and cognitive architecture. *Information processing*, both conscious and unconscious, refers to the rule-governed transformation of mental representations (e.g., using semantic rules to transform semantic representations). When the products of this information processing are combined into a homogenous organization, this usually is referred to as a *cognitive structure*. *Cognitive architecture* refers to the design and the general organization of cognitive structures from which a model of an individual's cognition in a specific situation could be created. Although the first models of cognitive psychology worked from the hypothesis that human cognitive architecture is homogenous (Anderson, 1983), accumulated evidence suggests that, in fact, it might be heterogeneous (Eysenck & Keane, 2000). Human cognitive architecture involves different cognitive structures (e.g., different memory systems), which use different kinds of representations (e.g., pictorial, semantic, verbal), a large number of different basic algorithms (e.g., semantic vs nonsemantic rules), and different neurobiological substrates. In consequence, today, most cognitive scientists prefer to see the cognitive architecture as heterogeneous rather than homogenous, and they use a variety of different tools to understand it (i.e., different computational models) (Eysenck & Keane, 2000). If an attempt is made to tie all these paradigmatic constructs together with additional details, a *predictive theory* might develop. While a paradigm cannot be evaluated according to standard verification logic, such logic can be used for the evaluation of the theory. A paradigm is judged in terms of the successful theories it generates. If a predictive theory leads to many correct accounts of phenomena, then the paradigm is considered successful. A *model* is the application of a theory to a specific phenomenon. A successful theory leads to many models, which account for a variety specific phenomena.

In the theoretical foundation of cognitive psychology, it has become commonplace to analyze the cognitive structures of the mind on three different levels: computational, algorithmic–representational, and implementational (Marr, 1982; Newell, 1990). These different levels of analysis generate different-level theories of the human mind. Different-level theories are necessary due to the widespread acknowledgment that complex systems have multiple levels of organization (McClamrock, 1991).

Computational/knowledge-level theory describes the goal of a given computation, as well as the logic of the strategy by which this computation can be carried out. Basic questions that research at this level addresses are: "What is the goal of the computation?", "Is it appropriate?", "What is the input and what is the output?", "What knowledge do we need to transform the input into output?", "How is the general strategy carried out?", and "What is the interaction between the goal and our knowledge?" Suppose someone is observed playing chess. A computational theory about what is happening in the mind of the player will reveal (1) his/her input (e.g., the basic starting position in the chess game), output (e.g., his/her chess-board move), and goals (e.g., to play chess and to win); (2) his/her knowledge (e.g., the rules of chess); and (3) the general strategy the player uses to transform the input into output (e.g., organizing the chess rules in such a way as to help him/her win). One of the fundamental assumptions of cognitive psychology is that to understand and explain a behavior, a prior description of the task involving that behavior is required. Consequently, the main requirements of a task (problem) are at the core of any computational analysis. The more accurate and comprehensive a task analysis is, the easier it is to identify the function transforming input to output. Therefore, computational analysis is the royal road to understanding human information processing. Cognitive psychology dedicates most of its energies toward constructing specific (experimental) tasks to understand specific information processing.

Algorithmic–representational-level theory specifies in detail the representations and the algorithms that govern them. At this level, some questions that are faced are: "How are input and output represented?" and "What is the algorithm for the transformation of input into output?" In the case of the chess game, a theory may exist about how the player represents the pieces of the board game (e.g., each piece represented individually vs one representation for a combination of pieces) and about the specific sequence of rules he/she follows during the game. To approach this level of analysis, detailed computational models are needed. Currently, two types of computational models are used by cognitive psychology: symbolic and nonsymbolic. *Symbolic models* assume that representations are symbols (e.g., pictorial, verbal) and that computation involves the manipulation of these symbols by rules (e.g., semantic rules). Some well-known symbolic computational models are schema, semantic networks, propositional representations and networks, and scripts (for details, see Eysenck & Keane, 2000). For example, a schema is a computational model that defines the structure of an object/situation/event according to a slot structure, where slots specify values that the object/situation/event has on various attributes. The schema model specifies in detail information such as: the type of representations (i.e., propositional, spatial imagines, and linear orderings), their organization (i.e., according to a slot structure), and how the schema mediates the input/output relationship (e.g., by generating a memory bias). All symbolic models are semantic transparent, meaning that each symbol has a discrete meaning. *Nonsymbolic models* (i.e., connectionist models, see McClelland & Rumelhart, 1986) assume that a representation is due to the activation of cognitive units organized in networks (similar to neural networks), and that computation occurs when the activation of these cognitive units is modified according to some rules (e.g., generalized Delta). Nonsymbolic models are semantic opaque, which means that the activation values or the weight of the connections have no specific meaning. Nonsymbolic models may bridge a gap between cognitive and neuroscience research because they simultaneously can mimic cognitive processes and neural circuits. Some authors prefer to say that nonsymbolic models go through transformations that can conform to rules, but are not caused by the rules. In their opinion, rules should refer to the transformation of symbols rather than to the transformation of activation level in a connectionist network. Regardless, symbolic and nonsymbolic models are complementary, and together they can account for the heterogeneity of the human mind (Eysenck & Keane, 2000). There are important differences between theories at the computational level versus at the algorithmic–representational level. First, computational theories are more general than algorithmic–representational-level theories. Computational theories only tell you what the problem is and what kind of function connects input to output. Such theories do not describe how the system represents the problem and how output is computed from input. Second, there is a well-known theorem (see Anderson, 2000) that states that any computable function can have, in principle, an infinity of algorithms that realize that function. Moreover, according to computational theory, a goal (e.g., to play chess and to win) and its associated knowledge (e.g., rules of playing chess) may be sufficient to predict a perfect game. However, an algorithmic–representational theory tells us that our cognitive system cannot search the *game tree* (all possibilities) in finite human time, that representations might not be comprehensive, that the algorithm used might not be the best choice, and that in consequence, the game might not be perfect. Algorithmic–representational-level theory, by using detailed computational models, not only allows us to have a clear description and understanding of human information processing (including both performance and errors), but also extends the scope of psychology by influencing artificial-intelligence projects. For example, a computational model of human information processing, once realized, might be programmed into a computer, which then would work like an artificial-intelligence system. Therefore, algorithmic–representational-level theories allow us to have a more detailed understanding of human information processing, including diverse aspects of performance and errors.

Implementational-level theory answers the question of how representations and algorithms can be realized physically. For example, what happens in the human brain during a chess game? How are the different strategies used by the player instantiated/realized/represented in the brain? The answers to these questions are studied by a fascinating interdisciplinary field called cognitive neuroscience. This field recognizes that even the implementational level is organized hierarchically; it consists of neural systems, neural networks, neuronal cells, synapses, and molecules, each of a different size, ranging from centimeters to Angstroms. This means that the very same problem can be studied at different levels of organization at the implementational level. For example, the problem: "What is a long-term memory?" can be approached at the level of the neural system (what is happening in the hippocampus?), the neural network (how long-term memory creates distributed networks), neural cells (the role of lateral inhibition in long-term memory), synapses (the formation of long-term potentiation), or molecules (the involvement of calcium ion pumps). An interesting approach at the implementational level is that of Hyland (1985). According to him (see also the connectionist approach), physiological constructs and psychological constructs often may refer to the same underlying event, just as Muhammad Ali and Cassius Clay are different names for the same person. According to this principle of complementarity, psychological variables can be related causally to other psychological variables and physiological variables can be related causally to other physiological variables (Kirsch, 1990). Furthermore, while each psychological phenomenon is computational and has a neural correspondence, not every neural phenomenon has a psychological correspondence. That is why some people insist that cognitive neuroscience is different than neuroscience. Hyland's (1985) concept of mind–brain complementarity is not an assertion about the real nature of the mind–brain, nor is it related specifically to any particular mind–brain philosophy (monism–dualism). Rather, it is a heuristic convention for using mental and physiological constructs in our theory (Kirsch, 1990). Brain analysis affect our psychological theories by constraining our computational and algorithmic representational theories, and we as psychologists and/or psychotherapists should choose those computational and representational–algorithmic theories that can be implemented by the brain. Yet, at the same time, our computational and algorithmic–representational theories impact upon brain analysis by offering a detailed description of information processing, which is the starting point for the analysis of the neurobiological substrate of that processing.

The relationships among these levels of analysis of the human mind are complex. In general, it might be said that there is a multiple realizability of a higher-level structure by various lower-level structures (McClamrock, 1991). For a specific computational theory, there is a large spectrum of representations, and for each type of representation, there are several possible algorithms to carry out the same process. Along the same lines, the same algorithmic–representational theory may be implemented in different physical systems (e.g., biological, hardware). Therefore, the same computation may be addressed differently by different implementational levels using different algorithms. For one computation, there might be several different representational/algorithmic levels, as well as several implementational levels.

In general, this multilevel analysis has proven to be fruitful in cognitive psychology. Higher-level theories allow us to generalize and to approach class things with different underlying implementational theories. Such higher-level explanations allow for reasonable explanations and predictions in the basis of less detailed information about the system (McClamrock, 1991). Among the higher-level explanations, the algorithmic–representational theory typically is seen as the central goal of cognitive psychology because it can predict and explain human behavior in its ecological conditions and can accommodate human errors. In psychology, the other levels are of interest primarily to the extent that they contribute to the clarification of this level. For example, a computational analysis can contribute to the understanding of the nature of a problem, and in this way makes the algorithmic–representational level more understandable. The implementational-level analysis constrains the algorithmic–representational theory. In the case of human beings, the brain research forces us to elaborate algorithmic–representational theories that fit the neurophysiological data. Yet there are disciplines for which other levels of analysis are more relevant. For example, for artificial intelligence, a computational theory could be more informative, and for cognitive neuroscience, the focus would be the implementational theory. A clear understanding of a psychological phenomenon involves all three levels of analysis. However, often the three levels of analysis and the corresponding theories are not developed equally. For example, we have well-developed computational and implementational theories of human perception, but less is known about it at the algorithmic–representational level. On the other hand, in the case of problem solving, the algorithmic–representational theory is developed better than the implementational theory. In order to develop a comprehensive picture of psychological phenomena, one must consider computational-, algorithmic–representational-, and implementational-level theories, which in turn requires an interdisciplinary effort.

To summarize, cognitive psychology seems to have achieved prominence in current mainstream psychology due in part to its argument that the human mind should be described in terms of information processing, to its use of experimental and modeling tools to understand this information processing, and to its use of multilevel analyses. In the following sections, it will be argued briefly that clinical theory and practice would benefit from an injection of the knowledge gained by cognitive psychology (the reverse is also true; for such a discussion, please see David, 2003).

The Potential Impact of Cognitive Psychology on the Development of Clinical Psychology

This section will focus on ways in which cognitive psychology may enhance clinical theory and practice. This presentation (for details, see David, 2003, and the other articles of this special issue) is a general, as well as introductory one, and is focused on a well-known cognitive approach in clinical psychology, namely, cognitive–behavioral therapy/rational–emotive behavior therapy (CBT/REBT) (Ellis, 1962, 1994).

First, it seems that cognitive clinical theories have been developed mainly at the computational level. For example, while much is known about the kinds of cognitions/beliefs that interact with our goals to impact on our responses (for details, see Ellis & Dryden, 1997), less is known about how beliefs are represented (e.g., schema or propositional networks?) and about the exact algorithms by which beliefs impact on our emotions.

Therefore, Ellis' (1962, 1994) theory (computational theory) that cognition, emotions, and behaviors are inseparable and organized together as a *whole* could be tested and detailed by elaborating specific computational models [e.g., semantic networks (Bowers, 1981) and/or connectionist models (McClelland & Rumelhart, 1986)], where beliefs and emotions are represented as connected nodes. In addition, little is known about the implementational level of beliefs. Ellis (1962, 1994) has argued that irrational beliefs have a strong genetic component, but there is virtually no research attempting to determine the neurophysiological counterparts of irrational beliefs or how the process of changing irrational beliefs during CBT/REBT is accompanied by changes in the brain. Such research is needed not only to test CBT/REBTs hypothesis about irrational beliefs and their genetic predisposition, but also to connect CBT/REBT to research in cognitive neuroscience and biological psychiatry. Among CBIs schools of thought, REBT is most in line with current biological research in psychopathology because of its ideas about the biological basis of irrational and rational beliefs (Ellis, 1994). However, this advantage has not yet been exploited. If psychotherapy in and of itself influences the structure and function of the brain (Brockman, 1998; Gabbard, 2000), then it follows that the monitoring of brain changes during REBT would be informative in terms of developing a theory of psychopathology based on both psychological and biological components. Congruent with this idea, current research supports the idea that a combination of CBT/REBT and medication is more effective than either CBT/REBT or medication alone in the case of various mental disorders (e.g., dysthymic disorder, unipolar depression) (Macaskill & Macaskill, 1996; Wang, Jia, Fang, Zhu, & Huang, 1999). This suggests that CBT/REBT interventions somehow may interact with medication in the brain. By exploring CBT/REBT at an implementational level, we might come to understand better how to maximize this interactive effect. In addition, a description of CBT/REBT theory in terms of connectionist models (McClelland & Rumelhart, 1986) might bridge the gap between CBT/REBT and neuroscientific research because some connectionist models are designed as analogues of biological systems and can mimic known neural circuits. In conclusion, it is believed that one of the next steps in CBT/REBT research should be the development of CBT/REBT theory at the algorithmic–representational and implementational levels.

Second, it might prove fruitful for CBT/REBT theory to assimilate experimental paradigms from cognitive psychology to test some of its hypotheses. Many basic aspects of CBT/REBT theory have not yet been tested rigorously (Bond & Dryden, 1996; DiGiuseppe, 1996). For example, the primacy of demandingness (*must*) among the irrational beliefs and the idea that irrational beliefs mediate emotion formation still has poor experimental support (for details, see Bond & Dryden, 1996; Solomon & Haaga, 1995). This difficulty of research can be related to the fact that CBT/REBT seems to lack powerful experimental paradigms to test its basic theory and hypotheses. By its experimental tasks, cognitive psychology could not only offer CBT/REBT a rigorous framework for testing some of its hypotheses, but also could extend and revigorate CBT/REBT theory and research by offering new constructs and research tools [e.g., experimental tasks related to: knowledge representation (Eysenck & Keane, 2000), the cognition–emotion relationship (Lazarus, 1991), and unconscious information processing (Jacoby, 1991; Schacter, 1987)]. Cognitive psychology already has contributed to new research in the areas of psychological assessment, and thus has reinvigorated the field of intelligence research (Sternberg, 1996). CBT/REBT may benefit from a similar enterprise. For example, Ellis always has argued that demandingness is a core element in depression (a sadly neglected one; Ellis, 1987). Upon analyzing the models of depression hypothesized by leading cognitive–behavioral theorists (e.g., Aaron Beck, Martin Seligman), Ellis (1987) commented that they probably explain how people make themselves appropriately sad, regretful, disappointed, and annoyed when they suffer major losses and inconveniences. However, Ellis (1987) argued that these models do not explain why people with similar losses and inconveniences may make themselves inappropriately depressed and self-hating. He hypothesized that the CBT/REBT model of depression has a crucial and unique cognitive and philosophical element that differentiates people's appropriate feelings of sadness from their inappropriate feelings of depression, and that appreciably adds to our understanding of the causative factors in depression. This element is CBT/REBTs concept of absolutistic and dogmatic shoulds, oughts, and musts (i.e., demandingness). For these ideas, Ellis was criticized seriously (Brown & Beck, 1989; Marzillier, 1987) and even was advised to be "more open minded and realize the values of all useful therapeutic approaches" (Marzillier, 1987). Because at that time CBT/REBT lacked a powerful task by which to investigate empirically CBT/REBTs theory of depression, Ellis could not prove empirically his theoretical point. However, although he was criticized by many of his colleagues in the CBT field, he kept pushing the idea that demandingness is a core factor in depression. Interestingly, recently, Solomon, Arnow, Gotlib, and Wind (2003) used individualized cognitive measures of irrational beliefs and found that demandingness indeed does seem to be the core factor involved in depression. This is a good example of how following cognitive psychology's efforts to construct specific tasks for specific cognitive processes could prove important theoretical points, which would otherwise be debatable.

Third, clinical psychologists should be aware that human cognitive architecture is heterogeneous; consequently, it is unlikely that the causes of our responses can be explained by using only a few cognitive constructs. Unfortunately, in psychotherapy, people often force the variety of human emotions, cognitions, and behaviors to fit a few constructs, in part, because these constructs, even if less productive and rigorous from a scientific point of view, still offer a homogenous and easily understandable perspective that supports a system/school of psychotherapy. For example, in CBT/REBT, the whole cognitive theory seems to be organized around the concept of irrational beliefs (or schema in Aaron Beck's cognitive therapy). While rational and irrational beliefs (or schema) are important components of human functioning (Ellis, 1962, 1994), they are not the only factors involved. For example, recent research in the neurobiology of memory has identified the role of unconscious information processing in human emotion independent of the effect of beliefs or cognitive appraisal (LeDoux, 2000). It is thought that it would be prudent for CBT/REBT theory to be extended by assimilating new constructs from cognitive psychology (e.g., unconscious information processing) to account for the heterogeneity of human cognitive architecture. Doing this might allow CBT/REBT to attain an even more comprehensive understanding of human beings.

Fourth, any analysis of cognitions should take into account a fundamental distinction between *knowing* and *appraising* (Wessler, 1982). Abelson and Rosenberg (1958) used the terms *hot* and *cold* cognitions to speak about the distinction between appraising (hot) and knowing (cold). According to Lazarus and Smith (1988), cold cognitions refer to how people develop representations of relevant circumstances (i.e., of activating events). Such circumstances often are analyzed in terms of surface cognitions (which are easy to access consciously) and deep cognitions (which, although consciously accessible, are more difficult to access consciously). *Surface cognitions* refer, for example, to inferences and attributions, whereas *deep cognitions* refer to schemas and other meaning-based representations (for details, see Eysenck & Keane, 2000). *Hot cognitions*, which also are called appraisals or evaluative cognitions, refer to how cold cognitions are processed in terms of their relevance for personal well being (for details, see Ellis, 1994; Lazarus, 1991). Consequently, during a specific activating event, there seem to be four different possibilities for how cold and hot cognitions about the activating event are related:

i. distorted representations of the event/negatively appraised;

ii. nondistorted representation/negatively appraised;

iii. distorted representations/non-negatively appraised; and

iv. nondistorted representations/non-negatively appraised.

According to Lazarus (1991) and to the appraisal theory of emotion, although cold cognitions contribute to appraisal, only appraisal itself results directly in emotions. The effect of cold cognitions (understood as distal causes: description, inferences, attributions, and schemas) on emotions seems to be mediated by hot cognitions (understood as proximal causes: cognitive appraisal). Although past research had suggested that cold cognitions are related strongly to emotions (e.g., Schachter & Singer, 1962; Weiner, 1985), it now is generally accepted that as long as cold cognitions remain unevaluated, they are insufficient to produce emotion (Lazarus, 1991; Lazarus & Smith, 1988; Smith, Haynes, Lazarus, & Pope, 1993). Different schools of CBT differ in the emphasis they place on various levels of cognitions (for details, see David, 2003; Wessler, 1982). Fortunately for CBT/REBT, because its theory (Ellis, 1962, 1994; Wessler, 1982) always has been focused on a special type of evaluative/hot cognitions as proximal causes of emotion (i.e., irrational beliefs) rather than on cold cognitions (e.g., descriptions, inferences, attributions, and schemas), it is congruent with more recent developments in cognitive psychology.

However, based on the clear distinction that has been established between hot and cold cognitions, a more detailed research program could be initiated in the field of CBT/REBT (for details, see David, 2003; David & McMahon, 2001). Some directions for such a research program will be detailed in brief. First, according to the appraisal theory of emotion (Lazarus, 1991), emotional problems will emerge only in cases of (1) distorted representation/negative appraisal and (2) nondistorted representation/negative appraisal). In Case 1, if one changes a distorted representation (e.g., "He hates me") into an accurate one (e.g., "He does not hate me"), then one may change the negative emotion (e.g., anxiety) into a positive one (e.g., happiness). However, the individual still may be prone to emotional problems because the tendency to make negative appraisals (e.g., "It is awful that he hates me") still is present. If, instead, one changes a negative appraisal (e.g., "It is awful that he hates me") into a less irrational one (e.g., "It is bad that he hates me, but I can stand it"), one likely will change dysfunctional emotions (e.g., anxiety) into more functional, but still negative ones (e.g., concern). Some people may argue that by changing the negative appraisal, one indirectly changes the distorted representations as well (Ellis, 1994). This is possible, but the experimental evidence for this hypothesis is mixed (Bond & Dryden, 2000; Dryden, Ferguson, & Clark, 1989). Supposing that distorted cognitions are influenced initially by negative appraisal, by practice they may get latter functional autonomy from appraisal (for details about the concept of *functional autonomy*, see Allport, 1937). A better choice seems to be a strategy that would change both distorted representations and negative appraisals. In Case 2, it seems that if one changes the negative appraisal, one would generate a positive (e.g., happiness) or a negative (e.g., concern) functional emotion. However, another possibility could be to change the nondistorted representation into a positively distorted one (e.g., "His negative comments about me are a way to communicate that he considers me strong enough to withstand his criticism"). Positive psychology may offer ways to help people make this kind of change (Seligman & Csikszentmihaly, 2000). In conclusion, although CBT/REBT theorists make the distinction between cold and hot cognitions (Ellis & Dryden, 1997), the distinction has not been explored thoroughly. By incorporating a clearer distinction between hot and cold cognitions into their research programs, CBT/REBT researchers could enrich their fund of knowledge. For example, they could study how different CBT/REBT strategies impact on cold versus hot cognitions to generate functional versus dysfunctional emotions, cognitions, and behaviors. It is believed that this could be a very influential and productive research program.

Fifth, just as the more applied science of genetic engineering is based upon the basic concepts and theories of fundamental genetics, the applied field of clinical psychology and CBT/REBT should be based on the basic principles of cognitive psychology. Borrowing its rigorous concepts and model, one could avoid many pseudoproblems that appear in the more applied sciences. Let us look at an example of how a debate in the clinical field could be solved by applying the theoretical model of cognitive psychology. Recently, an interesting scientific debate took place on the professional discussions list of the Academy of Cognitive Therapy about how to define schema in cognitive therapies. Some colleagues who follow Aaron Beck's original model defined schema primarily in terms of cold cognitions (e.g., hypothetical structures containing the stored representation of meaning), whereas the proponents of schema-focused therapy suggested that schema also include emotional components; yet, the question arose, if this is the case, how could this be a schema? Such a debate could be solved if one embraced the viewpoint of cognitive psychology. Schema is one of the structural components of the architecture of the human mind. As has been mentioned earlier, a schema is a computational model that refers to the structure of an object/situation/event according to a slot structure, where slots specify values that the object/situation/event has on various attributes (as related to schema, automatic thoughts refer to the specific values on various attributes schema has in specific situations). The schema model specifies in detail the type of representations (i.e., propositional, spatial imagines, and linear orderings), their organization (i.e., according to a slot structure), and how the schema mediates the input/output relationship (e.g., memory biases). Therefore, a schema is simultaneously content and process! A schema is not a physical structure, but rather a computational model that helps us explain, predict, summarize, and organize the present input–output connections. This type of computational model is shaped during our developmental stages and based on our life (including early) experiences. If schema is conceptualized as a computational model, then one could see how one schema could be a part of a larger schema, and so on. In addition, it is important to note that there are different types of schemas. If the slot structure refers only to cold cognitions, then we have a cold (conceptual) schema. If the slot structure also refers to emotions and hot cognitions, then we have an evaluative schema. Therefore, the type of the schema depends on the structure of the slots it contains! Core beliefs refer to the slot structure of the schema (therefore, while core beliefs refer to the content, the term schema refers to the organization of this content). Some people might think it odd to talk about core beliefs in the case of an evaluative schema because it has slots referring to both cognitions and emotions. However, core beliefs can include both cold and hot (evaluative/appraisal) cognitions. Since cognitive psychology (see also Ellis, 1994) has no difficulty conceptualizing hot cognitions, why should cognitive therapies? However, in the entire story of this debate, it should not be forgotten that schema is only one of many cognitive structures, and the other cognitive structures could have relevance to clinical issues. Moreover, this debate should teach us to be more careful when introducing a new construct. In physics, if a scientist used the term electron (an already well-established concept) to denote a new phenomenon, it is doubtful that the professional community would take him/her seriously. How is it then that in psychology people can assign freely a variety of meanings to a given construct (e.g., schema) without any negative repercussions for his/her scientific status? To summarize, although the schema construct has been well defined in cognitive psychology, its use in clinical psychology and cognitive therapies is far from rigorous largely because its meaning has been changed so many times (e.g., in cognitive therapy, in schema-focused therapy etc.).

The Potential Drawback of the Impact of Cognitive Psychology on the Development of Clinical Psychology

Of course, incorporating cognitive science into clinical psychology also could have drawbacks in that in the process of mixing the two, the unique identity of a particular clinical theory might be lost. Let me again exemplify this point by using CBT/REBT. CBT/REBT is a scientifically oriented psychotherapy, but at the same time it is an independent and idiosyncratic system of psychotherapy. A psychotherapeutic system can be described at a paradigmatic level (i.e., its assumptions), at a theoretical level (i.e., its empirically testable hypotheses), and by referring to its models and intervention procedures. Mainstream (cognitive) psychology also can be be described at the level of assumptions, theories, and models. However, as Lakatosh (1970) stated, the mainstream only exposes the public to its theories/models and tries to construct a protective belt (shield) around its core assumptions. This is a useful strategy, which keeps debates focused on theory and driven by empirical evidence. In this way, debates contribute to the progression and the development of theory. In contrast, assumptions are neither verifiable nor falsifiable. They often are assumed simply because an influential founder of the paradigm stated them. Assumptions also are masked and protected because sometimes they differ widely, even within an apparently homogenous theoretical enterprise. For example, cognitive neuroscience seems to be a fairly cohesive scientific enterprise. However, a *bloody war* would start if people were to debate the fundamental assumptions about the relationship between brain and mind. Some people would have a dualistic position whereas others would defend a monistic one. However, this does not happen because this problem remains well protected and unanswered. This strategy of not looking deeply into assumptions permits many people with different assumptions to work together in order to develop a theory with practical implications. Because there is no room for debate about assumptions in the mainstream, there is no place for *spiritual leaders* to guide such debates. In other words, mainstream (cognitive) psychology is theory driven rather than leader driven. Great founders create paradigms in which many others develop theories and models. The founder himself may develop a theory, which may or may not survive in its own paradigm. The originators of the paradigms are not forgotten, but their direct influence at the theoretical level might be less important (Still, 2001). However, his/her influence is tacit and is expressed by the basic constructs of the paradigm he/she founded, which are used in the theories and models developed in that paradigm.

Many of CBT/REBTs ideas have penetrated the mainstream of psychology, but CBT/REBT as a system remains less visible in the mainstream (Still, 2001). Because CBT/REBT as a system proudly exposes its philosophical assumptions about life and human beings, it feels uncomfortable to the more defensive mainstream. Furthermore, Albert Ellis seems to be one of the last psychotherapists of the old tradition of spiritual leaders (e.g., Sigmund Freud, Frederick Perls, Carl Rogers) (Smith, 1982). Albert Ellis is a fervent supporter of CBT/REBTs philosophical and cultural component. Thus, CBT/REBT, as with most of the traditional psychotherapeutic systems, seems to be both philosophical–cultural and leader driven. Because of these two factors, CBT/REBT as a system is incompatible with the way mainstream (cognitive) psychology works, and this may be why it has not been able to enter fully the mainstream psychology.

Other CBT schools have had a different fate. For example, both Aaron Beck and Donald Meichenbaum's approaches have been assimilated better into the mainstream

(David, 2002). However, both Aaron Beck and Donald Meichenbaum have focused on developing theories and have created specific models, which are well supported empirically. Although Albert Ellis is arguably the original founder of the cognitive paradigm in modern psychotherapy, his own theories are less influential and have been less thoroughly investigated empirically. It was easier for other forms of CBT to be assimilated into the mainstream because they, like other mainstream approaches, protected their philosophical assumptions and focused on their empirical theories. With CBT/REBT, this is more difficult because CBT/REBT proudly exposes its philosophical assumptions. Although many of CBT/REBTs ideas have been assimilated into the mainstream (Still, 2001), sometimes the source of these ideas is not cited in order to avoid the debates about their philosophical tinge. Ellis (Popa, 2001) has remarked that this has happened many times. In light of all these facts, one wonders what the role of CBT/REBT will be in relation to cognitive psychology.

One possibility is that CBT/REBT will remain an independent system of psychotherapy, which is scientifically oriented, but whose theory and research will continue to have a philosophical flavor. In this form, CBT/REBT will retain its identity, but will likely only be brought to the attention of mainstream (cognitive) psychologists through empirically validated treatment packages or specific techniques used in a more integrated therapy. In addition, its theory will continue to inspire researchers frequently, but it often will be presented under different names to avoid the philosophical connotations. This is the price to pay for preserving the current identity of CBT/REBT. It allows the mainstream to incorporate some of CBT/REBTs developments, but to continue to neglect CBT/REBT as a whole system. On the other hand, CBT/REBT could change its approach and begin to expose primarily its theory and models, rather than its philosophical assumptions. In addition, it could begin to assimilate constructs from cognitive psychology, which might attract more mainstream researchers and attention to CBT/REBT, and, by doing so, might make it more visible and influential in the mainstream. This assimilation of CBT/REBT into the mainstream, in turn, could contribute to the development of CBT/REBTs theory and practice. However, the price to pay in this case might be some loss of CBT/REBTs unique identity.

Conclusions

Cognitive psychology attempts to understand the basic mechanisms of the human mind. Thus, cognitive psychology studies the foundation on which all other social sciences, including clinical psychology, are based. It is certainly true that clinical psychology has developed without grounding in cognitive psychology. Researchers and practitioners in clinical psychology have managed to find higher-order principles unrelated to cognitive mechanisms to explain the phenomena in which they are interested. However, much is unknown and poorly understood in the clinical domain. If clinicians and clinical researchers could come to understand better how these higher-order principles could be explained in terms of cognitive mechanisms, and how to apply cognitive mechanisms directly to higher-order phenomena, they might have a firmer grasp on the phenomena in question (Anderson, 1990). The development of clinical psychology incorporating cutting-edge research findings from cognitive psychology would be a change compared with a move from traditional treatments (e.g., herbal treatments) to pharmacotherapy, or from selective breeding to genetic engineering.

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