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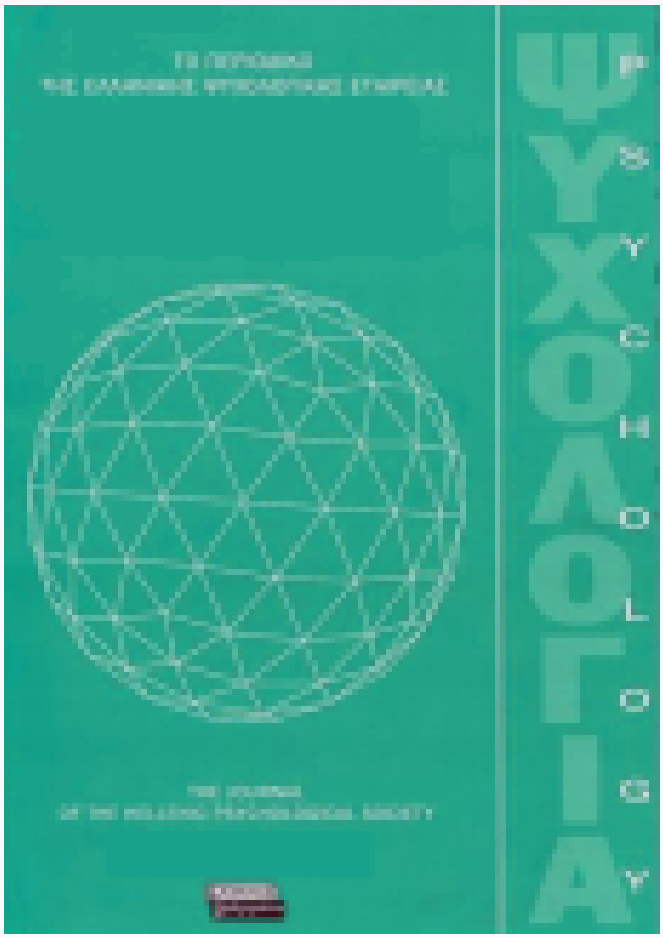

Constructing the world visually: The mind as physicist, physiologist and psychologist?

Theoni Velli

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Constructing the world visually: The mind as physicist, physiologist and psychologist (in alphabetical order?)

THEONI P. VELLI

University of Crete

ABSTRACT The article builds on the cognitive approach to the study of visual perception as it has been presented by Richard Gregory and Irvin Rock, to make the point that the interactionist constructivist nature of cognitive theory provides the required flexibility needed to create a variety of paradigms for the study of complex phenomena. It attempts to show that the eclectic nature of cognitive theory can incorporate both the Gestalt and James Gibson's ideas about perception, benefiting from them rather than rejecting them. It provides a creative new way to deal with the sterile arguments of epiphenomenalism and parallelism and all the 'dualisms' that come with them. However, although the cognitive theory model seems to have had an impact on biological and physical science, it has not affected many psychologists who continue to view disciplines such as Neuroscience and Computer Science as real threats to the future of Psychology.

Key words: Brain, mind, visual perception

Introduction

The title of this article sounds very ambitious, raises expectations and most of all raises the question of how this task can be completed in a few pages. It will not be completed! However, as a psychologist with special interest in the study of cognitive processes, I found it challenging to attempt to formulate and put forth a problematique regarding the possibilities that an interdisciplinary, multi-aspect, holistic, cognitive theory approach to the study of Mind has to offer.

The idea is by no means new; attempts of this sort are considered to be productive at different points in time, and this seems to be the right time for at least two reasons: The first is a historical one, an end-of-the-century type of theme and it has to do with the task assigned to the new science of Psychology (for some, to the science of experimental psychology, Wertheimer, 1987) by physicists and physiologists during the last part of the 19th century, namely, the task of studying *sensory experience* and *subjective reality*. The question is: does the world of science and the contemporary interdisciplinary trends of the study of mind still need Psychology today, or advances in other sciences such as, say, neurophysiology provide or are at the verge of providing sufficient evidence and knowledge to describe, interpret and infer the structure and function of mental processes? In this respect, is there a place for Psychology in the next century?

The second reason is a «practical» one also related to the end-of-the-century themes and it has to do with the much shared concern regarding the responsibility of Science for the survival of Planet Earth. It seems that Psychology was invited to join the world of Science at the eve of the century when the target of Science was to conquer the world. The question is: does the

Address: Theoni P. Velli, 15 Irinis Athineas St., 114 73 Athens. Tel.: *30-1-3300074 Fax: *30-1-3222740

world of Science still need Psychology today in pursuing the goal of saving the Planet, through new ways of knowing and applying knowledge, or do other sciences such as, say, computer science provide or are at the verge of providing sufficient alternatives and corrective supplements to the current course of technology, where needed? In this respect is there a place for Psychology in the next century?

Let it be stated from the start that it seems to me that the answer to both questions is *Yes*. With all due respect to other views (expressed by psychologists or other scientists) I believe they are not quite right. This is so because they seem to take into consideration only selected segments of psychological theory and data base as it has developed (not accumulated) over the past 150 some years. What they usually leave out is the cognitive theory approach, the interactionist model as it grew out of aspects of Gestalt theory (Murray, 1995) and revolutionarized Psychology by providing a way out of traditional dualistic thinking over the last 50 some years. Let it also be stated that the goal here is neither to ... defend experimental psychology nor to attempt to convince anyone but to partake in the, for a long time, ongoing debates and attempts to build bridges among the sciences.

The logical statement supporting the view that experimental psychology has a very important role to play in the course of Science in the 21st century will be developed here in the following fashion. First there will be a brief account of current views expressed by psychologists and other scientists on this issue either directly or indirectly. This part will bear the title *The State of the Art*. Second, reference will be made to the knowledge developed by 20th century experimental psychologists in the area of visual perception as an example of theoretical and methodological pluralism and rigorous and creative search for appropriate paradigms (inside and outside the laboratory) rather than hunting for variables on a trial-and-error basis . This part will bear the title *Why Things Look as they Do?*, taken from Kurt Koffka (1935). Why the field of visual perception, you may ask. The field of visual perception (for some, the Science of Perception, Rock, 1984) from the point of view of experimental cognitive psychology gives us a good opportunity to come to grips with and even go beyond the centuries old tyranny of the Brain-Mind (and vice versa) dualism and the other dualisms that come along with it. The field of visual perception and its interactionist models offer a good opportunity to understand why the popural concept of *context* and *things being relative to*.. is a basic factor not only for understanding human behavior (in the broad sense of the term) but also systems and operations that are of interest to other sciences.

The State of the Art

The information included in this section comes primarily from two sources: one book and four video-cassettes of a ten-hour television program broadcasted in New York. The book is called *The Science of the Mind-2001 and Beyond*. It was published by Oxford University Press in 1995 and edited by american psychologists Robert Solso and Dominic Massaro; it is already on its way to the third edition! It has already been read by many and it looks that it will be read by many more. So, in this sense, it is a valuable source.

Since this is a rather recent publication and since I will not review the book, I think that it will be to the benefit of the reader of this article to know at least who the contributors are and where they come from, in academic terms. I will do the same for the television program since it is rather unlikely that the readers of this article saw it. The intention here is to communicate and not to imply lack of information on the part of the readers.

With one exception, the book is a collection of papers written specifically for this publication. Also with one exception, the authors come from traditional experimental psychology and with one more exception they all come from cognitive experimental psychology (not to be confused with cognitive theory). The book was reviewed by Ulric Neisser (1996) under the title «Part Sourcebook, Part Crystal Ball».

The television program with the title *The Glorious Accident* was produced by the Educational Television Station of New York City, Channel 13, WNET, in the last part of May and the early part of June, 1994 and was broadcasted over parts of the USA, Canada and Europe. It consists of one-hour interviews with each of six men known for their contributions to Philosophy and the Sciences and one four-hour round table discussion among the six participants, some of whom had not met personally before. The interviews and the coordination of the round table was conducted by the Dutch filmaker and journalist Wim Kayzer. Before listing the participants, a word about the title of the program, *The Glorious Accident*, is in order, so that its relevance to this article becomes obvious. The question put to the participants by Wim Kayzer in the letter of invitation was: *What are the concepts that our apparently unique consciousness has so far developed out of our curious appearance in space and time?* Although oddly put, the question shows that *The Glorious Accident* is a metaphor referring to the limitations of theories of evolution to fully account for homo sapiens' characteristics such as consciousness and implying that the existence of homo sapiens is another «glorious accident». The six men, in order of appearance on television are: Oliver Sacks, Neurology/Psychiatry; Rupert Sheldrake, Biochemistry; Daniel Dennett, Mathematics/Philosophy; Stephen Toulmin, Humanities/Philosophy of Science; Freeman Dyson, Nuclear Physics; Stephen Jay Gould, Paleontology.

Both of the above mentioned references are examples of what scientists in all fields are busy doing as the end of the 20th. century is around the corner. They are busy conducting *inventories* as to where they were at the beginning of the century, how far they have gone and what the future looks like. Psychology, as a young science, has been very productive over the past 150 some years in terms of theory, research paradigms, methodology, and applications in a variety of societaly relevant areas of concern (Leahy, 1994). But most of all it has been productive in terms of very intense, one could even say, heated debates regarding its very subject matter and the appropriate variables to be studied, not to mention the methods and research tools to be used. Proponents of Behavior Theory, Gestalt Theory, Cognitive Theory (named Cognitive Psychology by Ulric Neisser in 1967) and to a lesser extent Psychoanalytic Theory, on both sides of the Atlantic Ocean, have left a very rich heritage of knowledge and ideology promising an even brighter future.

It is interesting and, in a sense surprising, that, even today, a number of psychologists share B.F. Skinner's expressed concern {as reported by Roger Sperry (1995) in reference to a communication that the two men had during the 1980's, the last decade of Skinner's life}: *Can the American Psychological Association, or any other organization count on another hundred years? ...The more we know about human behavior, the less promising appear the prospects.* By and large, the book *The Science of the Mind-2001 and Beyond* seems to share Skinner's pessimism. Written in creative, speculative, humorous and, at times, cynical manner, Solso & Massaro's book, for the most part, seems to convey the message that Psychology cannot afford to continue to exist as an independent scientific discipline, at least not in the form that we know it today.

Between *pulls* and *pushes* (Hunt, 1995) from disciplines such as computer science, telecommunications, neurocognition, neuroscience (Gardner, 1995), genetic engineering (Bower, 1995) and the natural science, psychologists will find themselves divided as they join the different *camps* with little or no communication among them. As an example, in the tradition of G. Fechner, contributors Hunt (1995), Solso (1995), Sommer (1995) and Kosslyn (1995) view the mental world either as an epiphenomenon or they view mental processes to exist and operate parallel to brain processes. Furthermore, they place great faith in the potential of brain measures to explain psychological functioning. Although in gist, Solso (1995) & Massaro (1995) consider the issue of consciousness to be an issue for Physics,

Biology, Mathematics and Computer Science.

Although the majority of contributors seem to think along the lines of epiphenomena and parallel functions of Brain and Mind, there are a few, 6 out of 20 to be exact, who focus, expand and reflect on the possibilities that Cognitive Theory has and will continue to offer, not only for Psychology but for other sciences as well. In one way or another, this is the message that seems to be conveyed by the contributions of Mandler (1995), Gregory (1995), Sternberg (1995), Massaro (1995), Murdock (1995) and most of all Roger Sperry. What these authors have in common is that in the tradition of Cognitive Theory, in the tradition of the interaction model, they have escaped from the type of trap, the dead end that the Mind-Brain dualism leads to. They also view technology as a tool and a means for further refining the methods of observation and experimentation, and in this sense, as aids to the study of Mind rather than «replacements» of it. For example, Murdock (1995) and Mandler (1995) point out that neuroscientists and psychologists cannot replace each other because, although they study the same phenomena, they ask different questions about that which they study. Murdock also points out that brain scientists will benefit from the guidance cognitive experimental psychologists can offer, in regards to cognitive phenomena, that would assist them (brain scientists) in what to look for in the brain.

Roger Sperry's contribution goes beyond the points made above. He actually claims that cognitive psychology is leading the way to the 21st century world of science in both theory and methods. The reader will agree that such a claim deserves more space and a more detailed summary of Sperry's contribution. Sperry views the cognitive revolution in Psychology as the first movement, among all other sciences, to assert that *«reductive physicalism or microdeterminism, the traditional explanatory model of science (including behaviorism), has serious shortcomings and is no longer tenable»*. He lists the sciences that have followed the example of cognitive psychology in adopting the antireductive, emergent insights model and forsees that, in the long run, the history of science will give credit to the cognitive, mentalist, consciousness revolution as the most revisionary and transformative of all scientific revolutions of the 20th century. For Sperry, psychology was actually the first to overthrow its traditional mainstream doctrine in favor of the emerging new paradigm. Computer science, neuroscience, biology, anthropology, evolutionary and hierarchy theory, systems theory and quantum theory have followed.

Before I bring this part to a close, two points need to be made. The first one is that during the time when *windows to the brain* were opened by magnetic resonance imaging (MRI) and positron emission tomography (PET), as well as other techniques, some related issues in human cognition were better understood in the works of Posner (Posner, M. I., Inhoff, A. W., Friedrich, F. J., & Cohen, A. 1987), Petersen (Petersen, S. E., Fox, P. T., Posner, M. I., Mintum, M., & Raichle, M. E., 1988), and Tulving & Schacter (1990) to mention only a few. Yet, the much celebrated issue by *Scientific American* on Brain and Mind, in September, 1992, seems to be oblivious to knowledge produced by cognitive psychology. The second point is that the thesis put forth by cognitive theory is not an «anti-thesis» but a new synthesis in which old practices, methodologies, and scientific gains were practically not lost or totally changed, but preserved to play their role in the «new ways of knowing».

We now turn to the second source of information, the television broadcast on the *Glorious Accident.* Here, the statements made by the participating scientists confirm Sperry' s views. The interactionist model seems to be guiding the participants' thoughts as they attempt to «answer» questions about *consciousness.*

It seems that the views expressed by Gregory (1995), Mandler (1995), Murdock (1995) and Sternberg (1995) in regards to the role that Psychology, as a scientific discipline, will play in the 21st century are also supported by the views expressed by scientists in other fields. What seems to be peculiar, at least on the surface, is that the role of Psychology in terms of

perspective, theoretical models, paradigms and methodologies is doubted (if not rejected) from within the field itself. Special attention to this issue was given by both Murdock (1995) and Sternberg (1995). For those of us who have been trained in the Gestalt - Cognitive Theory milieu, the following thought is very tempting! Simply put, the argument that *Psychology goes where the natural sciences go,* has been the argument of Behaviorism ever since the beginning of the 20th century; this argument, by and large, failed to provide for productive and innovating paradigms for Psychology. We, then, wonder whether the *learned habit* of following *others* has indeed proven to be so strong as to make new learning very difficult, much like according to a proactive inhibition type of mechanism! Maybe, this is what Skinner meant when he said that «*..the more we learn about human behavior, the less and less promising appear the prospects*», namely, the prospects of Behaviorism (my interpretation). But this is only a very simple thought on my part.

Why do things look as they do?

As I stated in the beginning, I have chosen the field of *Perception* and more specifically the area of visual perception to put forth an example of the *constructivist-interactionist* model based on cognitive theory premises. First, perception incorporates the domains of the *biological, mental* and *physical* to explain *sensory experience* and *subjective reality* without ever relying exclusively on any of the three to reach understanding and explanation of the phenomena under study.

Second, perceptual processes seem to be at the «*mid-point*» of the continuum of *physiological processes* on one side and *cognitive processes* on the other. Although perception cannot be thought of as a cognitive process (it is a very fast and spontaneous process to be compared with other types of cognitive processes plus the fact that knowledge of what is really out there does not change the perception of it) is not a physiological process either. This is so, because the same stimulation may give rise to more than one percepts (e.g., reversible figures) and different stimulations may give rise to the same percept (e.g., lightness perception). As such, it is a good example of how an interactionist model may provide for a good paradigm to study perceptual phenomena.

Third, in spite of the fact that perception is not a clearcut case of a cognitive process, the perceptual system seems to be making some type of *inference* regardless of whether it interprets a retinal image on the basis of additional information (according to the inference explanation), *organizes* the stimulation out there (according to the Gestalt explanation) or makes a decision on *affordances* based on *optic flow* and *texture gradients* information (according to the stimulus explanation).

Fourth, the complexities of the perceptual process and the variety of perceptual phenomena do not allow for one theory of perception to explain it all. It seems to me that if we insist on having one theory of perception, then the nature of that theory will have to be eclectic. Evidence for this is the fact that the leading scientists of perception in 20th century psychology, all have their favorite phenomena. With all due admiration and respect for them, it seems to me that they, like Hollywood stars, are remembered for only a few of the roles they interpreted.

Fifth, in the case of perception and specifically in the case of visual perception the same principle or principles seem to operate both in phenomena where «things are they way they look» as in the case of constancies, as well as in phenomena where «things are not the way they look», as in the case of illusions. In the words of William James (Wertheimer, 1987) «*illusions are logical fallacies if true perceptions are valid syllogisms*». Furthermore, illusions are informative «logical « perceptual errors that contribute to the survival of the human organism as much as the constancies do.

Finally, choosing the case of visual perception provides for an opportunity for a demonstration of the possibilities that the interactionist model has, including the notion of

construction of the world by an active human organism instead of a passive one either because of genetic type of programming or because of a tabula rasa type of situation. Perception is a good case for supporting a very popular notion in all areas of psychology, the notion of *context* and *things being relative to...* not only on the basis of phenomenological evidence but on the basis of very fast and non-conscious operations as well.

The chapters on *Perception* in introductory psychology books usually list a number of theories of perception, or explanations of perceptual phenomena as if any one of the theories or theorists have ever claimed to explain it all. Leading 20th century psychologists in the area of perception, Kurt Koffka, James Gibson, Richard Gregory and Irvin Rock, never claimed, at least not in their published works (as far as I know), that what they claimed as explanations of perceptual phenomena was anything more than a series of working hypotheses.Thus, if one is compelled to have a single theory of perception, its nature has to be eclectic for there are perceptual phenomena that fall under the category of exceptions in terms of one or another theory but can be accounted for in terms of an eclectic model which gives more productive explanations and leads to further research.

Furthermore, chapters on visual perception, more than in any other area of psychology, include information about scientific advancements made in the study and understanding of the structure and operations of the visual cortex, without making a reference to the different levels of explanation (or different types of explanation, to avoid any implications of hierarchy) involved. So, our students (and possibly our colleagues who are not interested in the area of perception per se) are left with the impression that they have to choose, to take sides, so to speak, between one or the other explanation. It seems that there is no end to this attractive magnet called dualism! I find no better way to give an example of another way of thinking about the types of explanation, mentioned above, than a long quotation from page 8 of Irvin Rock's 1984 book *Perception: «Suppose we want to know why a picture of a crater looks like a mount when it is inverted. In the absence of any understaning of the process of perception, we would have no idea what to look for in the brain. Suppose, however, that through experimentation we discover that, when people are shown pictures of an enclosed region with a shadow on the top, they perceive it as a hole or indentation, whereas when they are shown the same picture with the shadow at the bottom, they perceive a mount or elevation. Now at least we know a general principle about the perception. We can try to penetrate the problem further by asking about the origin of the principle. Since light in our environment almost always comes from above, a hole will tend to be shadowed at its top. Thus (as in this particular case) the principle might be one that is learned. If we discover that the principle is learned, we will know that the kind of brain event we should expect to find to explain the shadow effect will be one encompassing the storage of a learned principle. If we finally do find the neural correlate of this effect, we would still retain the principle as part of the explanation. If we discarded the principle, the brain event, couched solely in the language of the neural discharge, would have little meaning».* Again, given this line of thought, it seems to me that psychologists who forsee that the workings of the Mind will *one day* be totally accounted for by observations on brain structure and functioning prefer, in the words of Stephen Toulmin (Kayzer, 1994), 17th century type of thinking about these issues, and are unwilling to take on the challenge that cognitive theory offers in notions such as many levels of explanation and emergent insights. By the way, the reader is advised not to rush to label Irvin Rock (1984) an *empiricist,* because of the specific example he used, for, as it will be shown later on, previous knowledge is only one of the possibilities that he offers in his cognitive theory of perception.

As to theories of perception, introductory texts usually list them in three categories or perspectives: a) the inference/empiricist perspective; b) the Gestalt perspective; c) the stimulus perspective. These perspectives are differentiated along the basic assumption that they make about a) a *passive*

organism who perceives directly on the basis of stimulus information, while moving around in ambient light; b) an *active* organism who perceives indirectly, that is through mediating processes which take the following forms: i) the form of *spontaneous interactions in the brain* around a number of principles of perceptual organization of the stimuli; ii) the form of *hypotheses* made by the perceptual system in a problem-solving type of model. The *direct perception* hypothesis is associated with James Gibson (1966); *the perceptual organization of the stimulus* hypothesis is associated with Kurt Koffka (1935) and the *perceptual hypotheses* hypothesis is associated with Richard Gregory (1970) and Irvin Rock (1984).

A bit of history of Psychology may be useful at this point. The students of the history of theory in psychology, who are sensitive to the issue of continuity and change, will recognize that Gibson's thesis has its roots in the psychophysical tradition of correlating subjective sensations with physical stimuli. His notions of the sensitivity of organisms to *pick up* information signaled by *higher order patterns of stimulation,* by *higher order stimulus relationships* that remain invariant over changes in the environment (Gibson, 1950, 1966), coupled with his creative study of freely moving organism, not only brought the psychophysical argument out of its deadlock but developed new ways of thinking and knowing. As for the Gestalt perspective (Koffka, 1935) the notion of *spontaneous interactions* (leaving out, for a moment, the «brain» part of it) but especially the notion of the qualitative difference between the whole and its parts was the forerunner to contemporary notions in Physics and Biology.

Daniel Dennett's (1991) notion of the *dance* of the cells reminds of Koffka's example that a melody is not simply the sum of separate notes, since one can alter all the notes in octave or key and still preserve the melody. As for Richard Gregory and Irvin Rock (despite of their differences, especially in the area concerning the perception of the third dimension) their notion of *perceptual hypotheses* (Gregory, 1970, 1980, 1994 & Rock, 1970, 1984), has its roots in the Helmholtzian idea of *unconscious inferences* and past experience. However, they have developed these ideas to create a *cognitive/interactionist/ constructivist paradigm* for the study of perceptual phenomena; a paradigm tested in ingeniously designed experiments offering working hypotheses that can afford exceptions and even make the revolutionary idea of the *intelligence* of the perceptual system as the necessary precursor of all intelligence (Gregory, 1970; Rock, 1984) seem quite plausible.

Given the above stated starting and finishing lines among the leading scientists of perception in 20th century psychology, how can one claim, as it is claimed here, that Psychology is passing the threshold into the 21st century with, at least, one eclectic theory, the *Eclectic Theory of Perception?* An eclectic approach is more obvious in Gregory and Rock but it seems to me that this became possible because the Gibson and Koffka hypotheses were available. The Gestalt perspective has not been given due credit in psychology in general and in perception in particular (Murray, 1995). Contemporary terms such as *top-down* analysis are rarely traced to the Gestalt idea of the relation of the whole to its parts or to the idea of spontaneous interactions. As for Gibson, it seems to me that he is probably the most misunderstood theorist (although not as much as Freud and Piaget!) especially in regard to the issue of *internal representations,* a central issue for his critics and an issue for his *defenders* who seem to go as far as claiming that Gibson's message was that internal representations were not important, as Turvey & Shaw (1995) seem to be saying.

Without claiming to be an expert on Gibson (having read only two of his books and four of his journal articles) I would like to draw the reader's attention to: a) what Gibson himself considered to be at the heart of his approach, namely, *«a pragmatic ordering of research priorities»* (Gibson, 1950) and b) Ken Nakayama's, at the Vision Sciences Laboratory, Harvard University, 1994 journal article on the contribution of Gibson to the study of Perception; Nakayama writes on page 334: (Gibson's contribution) *«is apparent as soon as researchers realize that the search for internal representation cannot proceed in*

isolation, divorced from behavior or from an analysis of what is to be represented». In contemporary terms, Gibson's *bottom-up* analysis seems to be the basis for work being done in computer vision. The perceptual hypotheses approach proposed by Gregory and Rock is a better example of the eclectic theory model. This line of thought is more productive because it is not constrained by either the *top-down* or the *bottom-up* processing and concentrates on the dynamic interplay of the two. The logic is something like this: the perceptual system starts out with a stimulus and a hypothesis; the perceptual hypothesis is the *top-down* part of the process and it is tested as the system analyzes the stimulus which is the *bottom-up* part of the process; the hypothesis is either accepted and further checked or rejected, a new hypothesis is formulated analyzing other stimulus features and so on and so forth.

In a nutshell, the *cognitive/interactionist/constructivist* approach to the study of perceptual phenomena would answer Koffka's question *Why things look as they do*, in the following way: «*because of the cognitive operations performed on the information contained in the stimulus*» (Rock, 1984).

Concluding Quotations

I would like to close with two quotations and leave the conclusions (if there are any) to the reader.

Quotation 1. Irvin Rock, 1984, page 234: «As far as perception is concerned, then, the mind is hardly a tabula rasa upon which experience writes. It imposes organization on the incoming stimulation, exhibits certain rules of preference, and is particularly sensitive to stimulus relations. It infers and computes, predicating such inference on certain 'assumptions', taking account of one kind of sensory information in assessing the significance of another kind. Yet perception is affected by past experience - although the relevant experience that is effective in vision is not derived from touch.»

Quotation 2. Earl Hunt, 1995, page 272: «If I am correct, both scientific advances and changes in social needs are about to have profound influences on cognitive psychology. As these changes snow down upon us, a few of our species are going to die out. (Would 'Go the way of the behaviorists' be appropriate?) But will the genus survive? Looking about at the latest meetings of the Psychonomic Society, one certainly sees dinosaurs. And yet, there are probably enough furry creatures underfoot to ensure against a total extinction».

A last thought to be shared

I wrote this article in the company of my teacher, the late Irvin Rock who provided me with the opportunity to learn to appreciate our perceptual world; in the company of Ulric Neisser whose cognitive psychology (..assigned to me at the New School for Social Research by Mary Henle!) provided me with the opportunity to appreciate psychology and has been my constant *thinking* companion ever since graduate school; in the company of Anastasia Efklides who provided me with the opportunity and ..continuously encouraged me to write this article; and in the company of my past student Zoe Kourtzi, now a doctoral candidate at the Institute of Cognitive Studies at Rutgers University, who sent me the videotapes of the television program «The Glorious Accident». Zoe presented her work at the last meeting of the Psychonomic Society and I am sure that she was one of the «*furry creatures*» that Earl Hunt saw there.

As for my..emotions & cognitions (!) in preparing this article, I found the *either-or* types of perspectives clear but boring and the *multi...* types of perspectives confusing but very exciting.

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