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The Process Approach in Perception

Support from Studies of Brain Damage Patients

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Western science has been arguably very successful at constructing explanations for many physicochemical and organic systems. Accordingly, biology and neuroscience evidenced significant advances in the understanding of important basic processes, especially at the cellular and molecular level. But regarding the explanation for more global processes involved in common human experience, such as consciousness, abstract thinking, language and creativity, science in general, and the neurosciences in particular, have as yet to provide adequate explanation.

Is it possible that the basic approach of modern science to questions of brain functioning is in itself an obstacle to the answer? In other words, is it possible that the very attempt to fixate the object of inquiry (say the relations of brain functions to conscious experience) as an individuated entity, as opposed to conceiving it as a process, obscures the true nature of the phenomenon to be explained?

Perhaps the strong influence of atomism in Western science, for all its successes in technology, is obfuscating the true nature of processes in perception and action. In the study of brain and language, for example, we talk of individual phonemes, syllables, letters, words, sentences, and the like. In other words, we deal with individual units arranged hierarchically, yet each unit is treated as a well defined, individuated entity. As a consequence of this conceptualization, which reflects our concept of reality as well, populated as it is by distinct objects, investigations of language is centered around distinct 'centers', such as syntax, semantics, phonology, etc. In each domain, again, distinct units are utilized further in constructing tests and assessment tools. One of the consequences of this approach is that language has been regarded, ever since the Chomskian revolution, as constituting a module on its own, analogous to other bodily organs, which is genetically determined, uniquely human and independent of other cognitive processes[1].

But what if in the domain of brain functioning, with regard to language and every other cognitive process, what we take to be 'units'[2] are actually evolving processes? What if the role of our nervous system is not to analyze objects (as modern neuroscience would have us believe), but rather to construct seemingly stable objects out of a never ending flux in the environment and in our brain? Such a view, of course, would turn our view of the brain and perception upside down: perception would no longer begin with distinct objects to be analyzed by our senses, but actually reflect the end product of our perceptual system. Likewise, any

1 Grodzinsky, Yosef, The neurology of syntax. Language use without Broca's area, in: Behavioral and Brain Sciences 23 (In press 2000).

2 Words, letters, sentences.

observed action (linguistic or otherwise) would be regarded as the articulation and individuation of a more global intention.

The suggested view here is not new, and thinkers such as A. N. Whitehead already described objects in terms of process many years ago. There were other investigators who have already applied this approach in their studies. One of the most prominent investigators who applied the process approach to the study of perception was Heinz Werner.[3] In the 1920s and 1930s, Werner conducted studies showing that the perception of objects in adults traces momentarily the developmental history. That is, he showed that the perceptual act is one of brief evolution from holistic, poorly differentiated entity to an individuated object. This is very similar to the term Concrescence by Whitehead in his book *Process and Reality*[4], used to describe the process by which the universe of many things acquire an individual unity, or the shift from an undetermined stage to a concrete object. Thus Whitehead went on to state that concrescence is nothing other than the real constitution of an actual occasion, or an actual entity.

Today, both Werner and Whitehead are hardly ever mentioned or referred to in the neurosciences or neuropsychology. There are historical reasons for this almost total absence from today's research literature, for even in their own time they were fairly marginal to the mainstream of science and psychology. Whitehead was a philosopher, which most psychologists would find difficult to read. Werner's ideas did not fit well with the Zeitgeist of his days, when behaviorism was the only respectable theoretical framework within which to construct psychological theories. Following the rise of Chomskian linguistic, with its emphasis on the modularity of language[5] and its profound influence on theory and research in neuropsychology, the process approach of Werner and Whitehead was again marginalized, receiving little or no attention.

In the present paper, I will attempt to show that adopting a process approach to perception and action, and within this framework interpreting clinical findings, may result in a much more coherent picture of the brain-behavior relations, especially in the domain of language. The importance of utilizing clinical evidence to support a rather philosophical stance depends, of course, on one's view of the world. For some, philosophical coherence independent of empirical evidence suffices. But for the scientist, the ultimate test of validity of any theory is the evidence to which it can give coherent explanation.

Before embarking on the details of the empirical evidence, it may be worthwhile to consider briefly contemporary conception of brain functioning with respect to language and cognitive functions in general. Only a general, and therefore somewhat superficial exposition of this conception will be presented here, and the interested reader is invited to peruse any contemporary textbook in neuropsychology for more details.[6]

3 Werner, H., *Comparative Psychology* of Mental Development, New York 1948.
4 Whitehead, A. N., *Process and Reality*. Corrected edition New York 1978.
5 The 'language acquisition device'.
6 Cf. Kolb and Whishaw, Introduction to Human Neuropsychology, 3rd Edition, 1996.

In the modern conception of the brain, the massive neuronal organ we call 'the brain' is made up of discrete areas which specialize for a variety of different functions, such as different types of stimulation or information. Thus, for example, we have the visual or auditory pathways in the nervous system, each with its own nerve fibers, specific relay stations and specific cortical areas which specialize for the respective types of energies (i.e., light or sound). Similarly, specialized cortical areas of the brain were identified which are involve with processing of expressive language (mainly inferior frontal areas, of which Broca's area is the most well known and studied). Other areas of the brain are postulated to specialize for receptive language (especially the posterior aspect of the superior temporal gyrus known as Wernicke's area). Furthermore, specific components of language became a rich source of research regarding their respective specialized neuronal processors in the cortex. Thus areas in the brain are said to be specialized for reading, speaking, grammar, phonological analysis, speech production etc.

Within this framework of functional/anatomical localization in the brain, it is assumed that the unit of analysis is a discrete entity, say, a word, a sound or a letter. An initial identification of the entity is thus required, whether it arrives at the brain via the auditory, visual or tactile modality. The role of the brain is, then, to 'make sense,' as it were, of the units, by combining them into meaningful, larger units, and attach a relevant significance to them. How significance is acquired by the child is a complex question, and although very relevant here, it is outside the scope of this paper.

A good example of the thorny problems raised by this atomistic view can be seen in the following fact: research on acoustic analysis of word perception has demonstrated that there is nothing discrete in the stream of sounds reaching the human ear. That is, in a spectrogram of human speech, there is no obvious demarcation of phonemes, syllables, or even boundaries between one word and the next in a sentence. This means that it is the listener who imposes a perceptual, and in a real sense - imaginary, boundaries on the acoustic stream. According to the alternative approach adopted in this paper, the discrete units are not given to, but are constructed by, the brain.

I now turn to clinical findings, in part derived from the general neuropsychological literature, and in part from my own studies of patients with acquired reading disorders. Several well known clinical phenomena present difficulties to the traditional atomistic view, and these will be used as examples to support the process approach. The phenomena to be considered here, all taken from the domain of studies with brain damaged patients, have in common a strange feature: the brain damaged patient responds to objects in the environment without being conscious of them, or denying their presence altogether.

The first example are patients with the syndrome known as 'unilateral neglect' (the patient seems to ignore one half of the world, most commonly the left side). These patients do not simply fail to perceive their neglected side. On the contrary: they seem to respond to it by actively ignoring it, thus all the while taking it into consideration. Thus, they ignore the (usually) left side of wherever they

happen to look, always from the center of their fixation point. If asked to bisect a line at mid point, their bisection point would be shifted away from the neglected side. But given a new, shorter line to bisect, the patient will shift the midpoint again away from the neglected side. No matter what line the patient is asked to bisect, his performance will show an active shift away from the neglected side. This behavior indicates that the patient must 'respond' in some sense to the full length of the line. Can such a patient be said to 'see' the left side of the line which s/he ignores?

A similar case of seeing without perceiving was described in patients with the acquired reading disorder known as deep dyslexia.[7] These patients seem to have lost their ability to perform phonological analysis in reading. This can be demonstrated by asking the deep dyslexic patient to choose two words that rhyme with each other, out of an array of four words, or to read aloud pronounceable non-words[8]. The deep dyslexic patient cannot perform such tasks. More interesting is the fact that deep dyslexics will make many semantic errors while reading aloud. That is, while attempting to read the word 'CAT' aloud, the deep dyslexic may say 'DOG,' or while trying to read the word 'AMBULANCE,' the word 'EMERGENCY' is produced. These two pairs of words cannot be said to resemble each other visually. Nor do they share many letters or sounds. Obviously, the deep dyslexic grasped something about the word s/he was attempting to read. That something is the underlying meaning of the word, hence the reference to such 'errors' as semantic errors. Deep dyslexics also do better when reading words which denote concrete objects, and they are almost totally unable to read aloud prepositions[9] no matter how frequent these are in the language.

Perhaps a more detailed description of a patient I had the opportunity to study in some detail will help illuminate the present discussion. The patient in question was an educated widow with university education, who enjoyed reading a great deal until she sustained a cerebrovascular accident, which resulted in an infarct in the left hemisphere. On testing she exhibited word-finding difficulties, but could express herself quite well. Her comprehension was good and she continued to live independently. However, she complained bitterly that reading has become very difficult. Indeed, on testing it became clear the patient could not read even the most common words in English, such as 'YES' or 'NO' reliably. When asked to identify single letters she could not do so. Her ability to match spoken words or letters to their written version was severely impaired. Despite this devastating disability, she could readily identify strings of letters as constituting a real English word. That is, when asked if ,say, 'HORSE' and 'BLATE' were legitimate English words, she would respond without hesitation with 'yes' to the former and 'no' to the latter, all the while denying any knowledge of what the real words meant. This

7 Cf. Schweiger, A./Dobkin, B./Field, T./Zaidel, E., Right hemisphere dominance for lexical access in an aphasic with deep dyslexia, in: Brain and Language 37 (1989) 73-89.

8 A letter string such as 'SHATE,' which most children can readily pronounce by the third grade.

9 'IN,' or 'BECAUSE'.

indicates that her ability to perform lexical decision was intact. Here I ask the reader to reflect on whether or not the patient can be said to be 'reading.' Moreover, this patient could readily perform a task in which she was given a category (say, 'fruits' or 'kinds of dogs') and asked to circle the 12 words in an array of 24 words that belong in that category. Again, the patient performed quickly and accurately. Actually, the patient expressed surprise at being able to do these tasks, since her personal experience was one of inability to read at all. More about this later.

Two more tasks should be mentioned here, as they shed more light on the interpretation of the clinical evidence. When shown a target word (say, 'CENT') and asked to find in a list of 5 other words the one that has the same meaning, our patient responded with dismay at being asked to perform something she clearly cannot do, namely, read. With some cajoling, the patient was persuaded to try, whereupon she performed well above chance (around 70 percent). In fact, in the case of the task above, the patient was asked to match the word 'CENT' with the word that means the same thing among the following: 'NANNY,' 'DOLLAR,' 'PENNY,' 'MONEY,' 'PENCIL.' After scanning the words, the patient pointed to the three words related to the word cent (money, dollar, penny) and stated that these three are somehow related to the target, but she cannot decide which one has the same meaning. In another semantic task, our patient was presented with letter strings (the 'target'), flashed rapidly on a computer screen. She was asked to decide whether each string was a real word or not (this task is known as a 'lexical decision' task). Prior to each letter string, a word was flashed on the screen, which the patient was asked to ignore (the 'prime'). On one half of the trials, the 'primes' were semantically related to the letter strings which were real words[10]. We know from a large body of research, that in this situation, when the prime is semantically related to the target, both normal and brain damaged patients decide faster whether a string of letters is a real word. In fact, in a very instructive study, Anthony Marcel in England[11] demonstrated that this is the case for normal subjects, even if the primes are presented so fast that the subjects cannot report what they saw. Similarly, our patient showed the expected effect of faster and more accurate decisions when targets were preceded by related primes, all the while protesting that she could not 'read.'

It is perhaps clear by now why an atomistic approach, which postulates that the input to the brain is a discrete object to be analyzed and interpreted, is totally inadequate to explain the clinical evidence presented above. The patients are shown not to appreciate objects or perceived them as discrete items. In the 'neglect' patients, objects in the neglected side are treated as if they don't exist, yet the patients behave as if they exert 'invisible' influence on their behavior. In the case of deep dyslexic patients, the supposedly initial level of perception (of letters and phonology) does not help the patients in reading the words aloud. They exhi-

10 The prime word TABLE preceded the target word CHAIR.

11 Cf. Marcel, A. J., Conscious and unconscious perception. Experiments on visual masking and word recognition, in: Cognitive Psychology 15 (1983) 197-237.

bit, instead, access to the meaning of the words only, so that very often they produce a semantically related word instead of the one they read, although it may be very different in terms of its letters and sounds from the original printed word. When it comes to our patient described above, I have shown that this woman could not identify single letters, could not pronounce any written words correctly and strongly denied being able to read anything. Yet, when presented with tasks and examined in the right way, she could be shown to appreciate the meaning of words while at the same time denying she has 'read' them.

Now, if we reverse the atomistic process, and adopt the view that perceiving is the construction of discrete objects out of diffuse background meaning (of course, in the context of an interaction between sensory changes and past experience), the clinical material presented above takes on new meaning. Thus, we need to insist that in the process of normal reading, it is the meaning we absorb first and foremost, only later to arrive at the phonology. In fact, research has shown that readers have a very difficult time repeating sentences they have just read; they are good, however, at describing the meaning of what they read. The patients described above do what every reader does, except that as a consequence of the brain damage, their ability to construct the final, surface feature of words is impaired. Therefore, they can no longer have words that are specifically individuated. Our patient demonstrated that she is able to identify the categories to which words belong, and to decide that the word 'CENT' goes with the words 'DOLLAR,' 'PENNY,' and 'MONEY,' but she could not make the distinction between particular items in the same category, since that requires further individuation of the items. Similarly, the deep dyslexics, who cannot complete the perceptual process to the point of phonological specification of words, find the words 'CAT' and 'DOG' equivalent. The reader can now appreciate that patients with the 'neglect' syndrome will deny seeing anything in the neglected side, yet will respond behaviorally to the underlying meaning of objects on that side.

All the evidence described above is consistent with the view that perception does not begin with sensory analysis of discrete objects, but rather discrete objects are the end result of the perceptual process. Furthermore, the perceptual act is never static; it is an ongoing process of 'becoming,' of continuing articulation of objects and events perceived by our brain as existing 'out there' in the environment. In terms of language in the brain, the understanding or production of verbal material is no different. Speaking, reading and understanding language involves an ongoing process of articulating intentions and meaning into sentences, words and sounds. Damage to the brain does not produce new and different processes in perception and action. Instead, 'symptoms' seen in patients are incomplete, or derailed, normal processes, from which we can deduce the normal functioning of the brain-behavior system.

An intriguing speculation regarding consciousness is suggested by the clinical findings described above, and by many other clinical symptoms which have been described over the past 150 years. Recall that our patient demonstrated she could appreciate the meaning of words which she denied 'reading.' Recall also the

insistence of 'neglect' patients that nothing from the center of their focus to the neglected side exists. These and other symptoms are referred to in the literature as 'unconscious processing.' What do these clinical symptoms suggest about the nature of consciousness? Perhaps the subjective experience of consciousness is closely related to the constructive process of perception, and its later stages of individuation of objects unto the environment. In other words, we are conscious of objects, including material objects, words, letters, and even our own selves, only at the point where these entities have become articulated and specified[12]. Prior to this stage, our experience of the world and ourselves is 'intuitive,' 'inexpressible,' perhaps closer to the familiar 'emotional' responses which cannot always be articulated clearly.

To summarize, tremendous amount of research into brain-behavior relations to date has not produced adequate models of higher cognitive functioning, such as those related to language and consciousness. Neuroscientists keep looking for the location of grammar, words and sounds in the brain. Perhaps the reason for this shortcoming has to do with a preconception of the basic perceptual process as proceeding from discrete units, or objects, to meaning. In this paper, findings from neuropsychology were used to support an alternative approach, articulated many years ago by such thinkers and researchers as Whitehead[13] and Werner[14], among others. According to this approach, discrete objects and actions are the products of brain functioning, not its raw material. Clinical observations support this view and in turn become part of a coherent framework for the study of the brain.

12 Word meaning has become articulated into its phonological from.
13 Cf. A. N. Whitehead, Process and Reality.
14 Cf. H. Werner, Comparative Psychology.