This target article has been accepted for publication in

PSYCOLOQUY

psycoloquy.92.consciousness.1.bridgeman Monday May 4 1992

ISSN 1055-0143

ON THE EVOLUTION OF CONSCIOUSNESS AND LANGUAGE

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ABSTRACT: Psychology can be based on plans, internally held images of achievement that organize the stimulus-response links of traditional psychology. The hierarchical structure of plans must be produced, held, assigned priorities, and monitored. Consciousness is the operation of the plan-executing mechanism, enabling behavior to be driven by plans rather than immediate environmental contingencies. The mechanism unpacks a single internally held idea into a series of actions. New in this paper is the proposal that language uses this mechanism for communication, unpacking an idea into a series of articulatory acts. Language comprehension uses the plan-monitoring mechanism to pack a series of linguistic events into an idea. Recursive processing results from monitoring one's own speech. Neurophysiologically, the planning mechanism is identified with higher-order motor control.

KEYWORDS: consciousness, language, plans, motivation, evolution, motor system

1.0 INTRODUCTION

1.1. Consciousness is one of the central problems that led to the founding of modern psychology in the 19th century. The method for studying it was originally introspection, a technique that failed to deliver what was needed because the data of introspection were internal experiences rather than objectifiable events. Since data could not be verified, the method was defective and was abandoned.

1.2. By rejecting consciousness as a legitimate object of study, psychology made great advances in the study of perceptual, motor and control processes but lost sight of the issue of the role of consciousness in mental life. Recently, the issue has re-emerged with more objective methods, such as probes of memory by priming and

reaction time, and with the recognition that many mental functions are unconscious. A new psychology of plans promises to include consciousness by organizing and synthesizing the many subdisciplines that have grown within psychology and the cognitive neurosciences.

2.0 PLANS AS THE CENTER OF PSYCHOLOGY

2.1. Bringing consciousness back into the mainstream of cognitive psychology requires a reorienting of psychology itself. Throughout this century the dominant metatheory in psychology has been the stimulus-response link, the connection between environment and behavior. The job of psychology was to explain what happened between a stimulus and a response, and not much else. In behaviorism this orientation was obvious. Modern cognitive psychology retains a similar orientation, however -- the innovation is that additional boxes, representing internal processes, are interposed between stimulus and response. But the diagrams always have a stimulus at one end and a response at the other. The approach of the "new connectionism" is the same at a more microscopic level of neural modeling, with hidden units allowed.

2.2. This kind of psychology has been extremely productive in describing and explaining the information flows that occur in many tasks and it is a necessary part of a plan-oriented psychology. But it is incomplete in that the motivation for activating a particular block-diagram mode of information flow is not specified. That is, we may understand how visual information from an object is filtered, processed, and compared with remembered information about objects, but the theory does not address why the subject was looking at the object in the first place.
The act of looking was motivated by a plan, an internally held image of an intended achievement (Miller, Galanter & Pribram, 1960). The image is an internal representation, not necessarily a graphic visualizable entity. The plan is defined more broadly here than in its everyday sense, to mean a scheme that can control a sequence of actions to achieve a goal.

2.3. It is plans that motivate behavior. Thus the block diagram of cognitive psychology usually describes a method for executing a low-level plan, for example, a plan to examine an object. If most of the minitheories of modern cognitive psychology concern fragments of plans and they are generally organized by plans, then the plans become the prime movers, the keys to understanding how behavior is controlled (Shallice, 1978). Current models of pattern recognition, recall, attention, etc. become the means to an end.

2.4. If the centrality of plans in human mental life is a reality, then it is important to understand more about how and why plans are established and executed and why the control of behavior by plans rather than direct control by the environment should have evolved.

2.5. The power of plans is that they allow an organism to escape from the contingencies of its immediate surroundings, to be controlled instead by its own needs in the longer term. A simple animal responds to its environment and to its internal states in a machine-like way and has no need for plans. The fly does not make a decision to feed: When food is at hand in the environment and internal receptors are in the right states, feeding simply happens. More complex organisms can store several plans simultaneously, executing one while holding others in abeyance. Humans typically have hundreds of plans, from small, immediate ones such as eating the next bite of dinner to large ones such as earning a college degree. Large-scale plans in turn contain a hierarchy of smaller-scale plans.

2.6. As a plan is executed, a single goal state or idea is unpacked into a series of actions. The plan must be held in an active, working memory while this occurs. Plans can also be discussed in terms of the psychology of motivation; modern conceptions of motivation include the pathway from motivating influences such as instinctive needs or selective attention, through plans, to action (Heckhausen, 1991). The plan becomes the path from motivation to action.

2.7. Organization of behavior by plans requires neurological machinery to support the planning function and its various ancillary needs. There must be neurological devices to (1) make plans, (2) store them, (3) execute them, and (4) monitor them (Bridgeman, 1986; 1988). In order to control behavior, the currently active plan must have access to memory and attention. It must link these functions with perception in order to guide action according to a combination of the internally held plan and the external realities of the perceptual world.

2.8. Here is where a natural explanation for the phenomenon of consciousness emerges: In this scheme it appears in the plan currently being executed. Consciousness of events, actions and ideas is nothing more or less than a result of the operation of this mechanism, along with its requisite memory functions. In the process it has access to episodic memory, bringing episodes from the past into working memory, and it lays down new episodic memories. The reportability of experiences, thoughts and actions, then, is based on an intimate interaction between behavioral control and memory. Though consciousness in this conception emerges from the planning process, not everything that is experienced consciously is related to plans. Perceptions, to

the degree that they enter the episodic memory, also have the ability to affect behavior and to engage the mechanisms that generate consciousness.

2.9. Thus consciousness becomes not a separate neural module, but a result of the operation of the planning process. It is an active process, not a passive state (Freeman, 1990): the result of the planning process taking control of behavior and gaining access to memory and sensory input. In this context it is meaningless to look for a box labelled "consciousness" in a brain model, or to try to localize it in the brain's anatomy. The operations that make us conscious occur in the context of controlling behavior from a plan, and consciousness has no separate existence of its own. Because it is an effect, not a cause, there is no sense in looking for its functions.

2.10. Planning seems necessary to evoke consciousness, but it is not sufficient. Some very routine plans, even quite complex ones such as driving home along an accustomed route, seem to take place without awareness, or at least without a subsequent episodic memory of the events. The episodic memory seems so confounded with earlier experiences of the same activity that it fails to be recorded as a separate experience. The activity fails to pass the memory test of awareness: we ask whether someone was aware of an event or action by asking whether they can describe it from memory. In defining tasks that require "deliberate attentional resources", Norman and Shallice (1980) indicated that they (a) involve planning or decision-making, (b) involve components of trouble shooting, (c) are ill-learned or contain novel sequences of actions, (d) are judged to be dangerous or technically difficult, or (e) require overcoming a strong habitual response or resisting temptation. Executing a very routine plan that does not meet these criteria seems to leave the planning mechanism free to engage in other activities, frequently activities involving language.

3.0 RELATIONSHIP OF CONSCIOUSNESS TO THE EVOLUTION OF LANGUAGE

3.1. The plan-executing module has the job of taking a parallel, simultaneous idea and converting it into a sequence of serial behaviors or subplans. The mechanism is identifiable in all primates, perhaps in all mammals. The classic studies of Koehler (1925) showed that chimpanzees could plan a behavioral sequence with several steps, such as piling boxes to stand on and reach a banana suspended high overhead. Even dogs can solve detour problems that require them to move away from a reward in order to reach it eventually.

3.2. In the course of human evolution this plan-executing module became

more complex and loomed ever more important in mental life. At one point, I suggest, it began to be pressed into service for organizing communication as well as action. A single idea is unpacked into a series of words, and those in turn into phonemes, in the same way that any other plan (idea) is elaborated. In both the execution of actions on the world and the execution of communications, an ordered sequence of internally organized acts replaces the environmentally released behaviors of lower animals.

3.3. Analogously, speech understanding is handled by another existing module. It normally monitors the progress of plans, taking a sequence of events and packing it into an idea. Again, an immediate working memory is centrally involved in this process. Language could evolve quickly, on an evolutionary time scale, because it was made mostly out of old parts. The sequencing and comprehension mechanisms were already developed for the planning and monitoring of actions, respectively. Only the articulatory apparatus and perhaps a specialized grammatical ordering system (Bickerton, 1983; 1984) had to be added.

3.4. At this point a question arises whether planning and language share the same mechanism, or whether a new parallel planning mechanism evolved to specialize in language. There are many examples of the evolution of new functions by the doubling of genes, resulting in two copies of a morphological feature. Many cereal grains, for example, developed in this way. One of the copies is then free to evolve into something else. The open and flexible property of the planning mechanism, however, allows for language to be added to its functions with little or no change. The mechanism already had the capacity to handle many plans simultaneously, to organize each one, to put them into priority, and to handle plans for different kinds of actions.

3.5. Once the relationship between language and planning is articulated, a number of seemingly unrelated pieces fall into place. An otherwise puzzling aspect of speech, for example, becomes a consequence of this analysis: the peculiar relationship between consciousness and language.We are acutely aware of what we say and what is being said to us. This contrasts with nonlinguistic communications, such as human cries and laughs, which we produce without planning, as incidental concomitants of other activities or emotional states. We are capable of imitating these vocal outbursts, but we cannot deliberately produce them except in the proper context as part of other activities. Once the utterance occurs, whether linguistic or not, it is perceived like any other event. The essential difference is in the planning, not the perception. Perception of our nonlinguistic utterances puts us in touch with our emotions, while perception of our own language puts us in contact with our ideas.

3.6. This view is not without precedent. Indeed, even the word for consciousness in English, Russian and the romance languages translates as co-knowledge, those aspects of mental life that are communicated or are potentially communicable. Russian psychology has capitalized on this etymology, emphasizing the enhancement of conscious function that comes from social cooperation and communication (Luria, 1981). Many psychologists from Wundt onward have pointed out the privileged position of language in human awareness.

3.7. The appearance of language as a communicative act generated by the planning mechanism brought with it some immediate and very powerful advantages. Not the least of these is that one also hears one's own speech, so that the plan-monitoring mechanism has immediate access to the plan-executing mechanism's products. In the process of development the loop can become internal, as pointed out by Vygotskii (1962) in his analysis of the importance of internal speech in human thinking. The whole planning process is made recursive, and the enormous power of human thought becomes available with a relatively minor change in a mechanism that all primates share. Again, this process allows quick evolution of a seemingly complex addition to the human brain.

3.8. Needless to say, these advantages created a strong selective pressure in early humans or pre-humans to improve the language faculty. The categorical nature of the components of speech (phonemes and words) made it possible to transfer an idea from one human's brain to another's, under reasonably favorable conditions, without error. The task was accomplished with the communicative advantages of hierarchical digital coding, combining a small set of qualitatively different phonemes to make up distinct words. This does not apply to other animal communication systems.

3.9. Up to this point the operation of the plan-executing function has addressed only narrative consciousness, awareness of one's perceptions and actions. In the current analysis, this sort of consciousness would have to be admitted in animals as well, to the degree that they can separate behavior from environment with a planning mechanism. But language changes everything. If the currently executed plan is a linguistic one, a plan to perform a communicative act rather than a conventional action sequence, one can become aware of one's own ideas; an enhanced self-consciousness becomes possible.

3.10. An action plan becomes conscious only in the process of its execution. What is unique about the linguistic action plan is that whereas the processes that generate speech remain unconscious, the linguistic sequence can be fed back into the neurological system that

normally monitors external events connected with executing a plan. Essential to this capability is the parallel-serial-parallel route from a simultaneously held idea, through sequential plan-executing mechanisms, and back into a perceptual module that accepts sequences, all without overt behavior. If internally planned speech is fed back to a language-understanding process without leaving the brain, ideas from one's own internal language (thoughts) can be stored in the episodic memory that normally holds the perceptual results of the plan-monitoring process. The relationship between planning and consciousness, however, remains the same for linguistic acts as for other planned sequences that act on the environment in an instrumental way. Pribram (1990) traces the resulting reflective self-awareness or intentionality back through von Uexkull to Brentano. There are still other kinds of consciousness that I do not have the space to address (Baars, 1988).

4.0 THE NEUROLOGY OF CONSCIOUSNESS

4.1. In the above sketch, consciousness is associated with planning for action, and as such it results from the operation of the controller of motor activity. To see how the controller might be organized, a comparison of the neural organization of sensory and motor systems is useful.

4.2. The organization of sensory systems can be summarized with the example of vision, the best-examined of the sensory modalities. Cortical representation of vision begins at the striate cortex, area 17, located at the posterior pole of the neocortex. Striate cortex is concerned primarily with visual processing in a retinotopic mode, including such functions as binocular interaction and spatial frequency analysis, although the receptive fields of striate neurons are also influenced by the task an animal is performing (Artim & Bridgeman, 1989; Bridgeman, 1982). The organization is strictly topographic, with a dazzling degree of organization into stripes and blobs, columns and hypercolumns. As one moves anteriorly in the cortex, the visual field is represented again and again, in ever more abstract codes that progressively change from representing the form of the stimulus to presenting its meaning to the animal. Precision of localization is exchanged for sophistication of coding, and different functions are handled in different maps of the visual field. Finally, in inferotemporal and parietal areas, neurons are affected more by particular applications of the information than by the visual image itself.

4.3. The organization of the motor system is similar to that of vision, beginning with the primary motor cortex at the posterior edge of the

frontal lobe. This cortex codes motor acts organized in a topographic representation of the body's muscle groups but it does not code literal muscle movements; rather, one finds an image of intended achievement (Pribram, 1971); in other words, it holds the synthesis of a plan, probably one that is originated elsewhere. Analogously to visual organization, the motor field is represented many times on the cortex, and analogously to the more anterior cortex, it represents more abstract aspects of the motor organization process. Since plans are concerned with long-term organization of motor activity, the most anterior prefrontal regions are concerned with the processes of synthesizing plans. A few of the nonprimary motor areas in humans have evolved to specialize for language: Greenfield (1991) provides an example of how Broca's area, originally a more generalized control field in primates, split in the course of evolution to include a linguistic articulatory function for symbolic communication in the left hemisphere.

4.4. Information from the sensory systems and from limbic areas concerned with motivation and emotion is used in creating and executing the plans, tying anterior and posterior functions together. Orbital prefrontal cortex is a point of contact of planning with the motivational and emotional concerns.

4.6. Almost all of the processing is unconscious; what we perceive consciously is only the tip of a neuronal iceberg (Bridgeman, 1992). Everywhere the neurophysiologist looks, unconscious processing dominates brain function. The receptive fields, anatomical arrangements and biochemical processes of neurophysiology remain hidden from conscious experience, not by repression but by structural limitations on the planning mechanism itself. We become aware only of the plan currently being executed and of the perceptual and motor events surrounding it.

4.7. As this preliminary analysis shows, the reorganization of psychology around plans will also require a reinterpretation of neurological function. The organization of plans becomes the central business of much of the brain, other regions being concerned with their execution and with providing the sensory information needed to make them successful.

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