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Abstract

Cognition is an important branch of study since the human cognitive capacity involves a person's experience with environment, determines his all-round development and helps in development of his system of thinking. The prominent disciplines in this field are Artificial Intelligence (AI), artificial life (A-life), psychology, linguistics, computational neuroscience, and philosophy- especially the philosophy of mind and language. Some relevant subfields include robotics, whether classical, situated or evolutionary; study of enactive vision, where the organism's own movements (of eyes and/or body) provide crucial information about his behaviour and response; the psychology of human-computer interaction, including various aspects of virtual reality such as *avatars*; and computational theories of literature, art, music, and scientific discoveries. Non-human minds are studied by computational ethology and neuroethology, and by A-life. Piaget, a well-known cognitive scientist has explored new avenues in the field. This paper seeks to describe different aspects of various theories of cognition.

Key Words: Cognition, biological equilibrium, consciousness, stimuli, psycho-neural phenomena.

1. Introduction

Cognition is the act of knowing or the process involved in knowing. When we 'know' something, it means that we are not only aware or conscious of it, but that we can, in a way, make some sort of judgment about it. Cognition is therefore a broad term that covers a complicated mental process involving such functions as perception, learning, memory, and problem solving.

The nature of cognition, or how we know, has been the subject of

investigation since the time of the ancient Greeks. It has been studied by philosophers as well as scientists. Around 1970, a new field of investigation called cognitive psychology began to emerge. Many of its practitioners study the brain and compare it to a computer in terms of its information storage and retrieval functions. However, most people who study cognition recognize that they are not focusing on how the brain, as an organ, works, but are more concerned with the way the mind works. While there are several competing theories, all try to explain how the mind works or how we know; one idea common to most of them is that the mind builds concepts- which are like large symbolic groupings, patterns, or categories- that represent actual things in the real world. When it encounters a new object or event, it compares them with the concepts it has already built and stored.

2. Development of Modern Theory

The theory of cognitive development proposed by Jean Piaget during 1930's through the 1970's explains how people's ability to understand the world grows and changes, and it is this changing cognitive capacity that creates some interesting circumstances. Piaget called the study of the way individuals learn to know as "genetic epistemology." The use of the word "genetic" simply refers to "origins" or "beginnings". Epistemology is the study of knowledge. Piaget studied the origins in an individual's ability to know by observing how infants, children, and adolescents understand the world. According to Piaget, children take an active part in their own development. The acquisition of understanding comes from interactions with the world around them. All experiences are understood according to the level of thinking that individuals use. The very act of acquiring new information, however, also changes the way one understand the world.

Information gathering process through experiences is called adaptation. Often, this process is little more than using what one already knows. For example, a toddler who knows how to use a cup, may be trying to drink from a slightly larger-than-normal cup. The child must adapt to the larger container. This is a relatively simple task and requires only the application of what the child already knows. Still, the behaviour is new and does cause the child to grow and change slightly. Such adaptation is called 'assimilation'. On the other hand, the same child may be attempting to eat with a spoon. Because toddlers usually eat with their fingers, the changes required now are significant and call for new abilities. More challenging the task, much greater is the growth. Such adaptation is called 'accommodation'.

Piaget believed that such changes occur because of an innate drive to maintain equilibrium. Biologically speaking, human bodies maintain relatively constant temperature, weight, oxygen, hydration levels and so on. This type of equilibrium is called homeostasis and is described as a dynamic balance. The input of food, energy, and air matches the output and maintains the status quo. If a person gets out of balance (for example, if one holds his breath too long or has not eaten for a long time) he or she is in disequilibrium and is motivated to re-establish the balance. Similarly, Piaget believed that the human cognitive capacity maintains a balance between a person's experience with the environment and his system of thinking. If the experience requires only application of the knowledge one already possesses, such as drinking from a glass, one does not need to change significantly; one adapts with little cognitive growth because one's abilities can handle the challenge. If a person does not have the necessary skills (as when trying to eat with unfamiliar gadgets such as chopsticks) he or she is in disequilibrium; abilities and experiences do not balance. In order to regain their balance, one must change the way one views the world.

Piaget called the ways we view the world 'cognitive structures'. He believed that we all follow the same general pattern in acquisition of new and advanced structures. He described the pattern of growth as a series of stages throughout life. Cognitive growth within a stage is slow. Generally, it involves application of the understood concepts to new situations (assimilation). Piaget described these types of changes as quantitative in nature. That is, the number of things an individual can do or understand using a particular concept, will grow, but the concept itself does not change significantly. The change from one stage to another is qualitative. It involves new concepts and ways of viewing the world (accommodation). This period of change is relatively rapid. Once the new stage is reached, however, change will be fairly slow while the new concepts are applied to various aspects of life.

Piaget believed that this process of growth and change was attributable to both nature and nurture. The child's drive to experience the world in an active fashion and to maintain equilibrium is biological (nature), whereas the impact and changes caused by the experiences provided by the world is environmental (nurture).

3. Cognition as Awareness

When we seek the simplest possible cognitive position, we are not seeking

the origin of knowledge. It is generally accepted that inquiry into origins is beyond the business of science. But we may ask, what are the facts about knowledge which involves the latter in its most elementary form? We obtain knowledge in its simplest form when we go back to the most elementary description of consciousness which we possess. It is simply that of awareness, or of simple apprehension. We may neglect for the moment the fact that awareness has in it a voluntary and a feeling element, and concentrate our attention on the fact that it has a cognitive element. Both Locke and Kant agree that all knowledge begins with experience, and from this there is no dissent on the part of any philosopher. What then is the simplest form of experience, or the ultimate datum from which knowledge starts? Do we have any state of mind which may, for this purpose, be regarded as 'ultimate', which, though itself unexplained, may afford the explanation of everything else?

Here, if anywhere, we have an act of knowledge seemingly concerned with the present reality, and with that alone. It is to be remarked again, by way of caution, that we isolate, for the purpose of study, the act of knowledge from the other elements in the complex state of consciousness which we call awareness. When we speak of knowing, of willing, or of doing, we abstract these from the normal state of consciousness which usually involves all three. Pure thought, pure feeling, pure will, are abstractions and not names of any concrete reality. Awareness is a state of consciousness which possesses all the elements of experience. Here we concentrate attention on the cognitive aspect of awareness. We may, from this point of view, name it apprehension, which is the simplest and the most ultimate of all cognitive acts. At the same time, it is contended that even the simplest state of consciousness has a cognitive aspect. The consciousness of the present is itself an act of knowledge. If, at this stage we may use language more applicable to a subsequent stage of the argument, a state of consciousness is the state of any conscious subject, and it has an object. But, one may ask, can every conscious state be described as knowledge? Would not this be a contradiction of the statement that knowledge, feeling, and volition are not to be derived from each other, that they are primary and underivable? It may be granted that each of these aspects of intelligence has peculiarities inseparable from its very existence, which must be described from attributes peculiar to itself. On the other hand, it may be justly contended that every state of feeling has its cognitive aspect, every state of knowledge has its feeling tone, and that volition has its emotional and cognitive aspect. Still we may focus our attention on the cognitive aspect which is present in every mental state. Awareness

is mainly cognitive, even if it also be volitional and emotional. This awareness, at its simplest, implies the consciousness of a content present to us, and an assurance that we are so far in possession of knowledge of it. It seems to be the simplest of all the acts of knowledge, and cannot be derived from anything simpler.

We are aware that the last statement is deeply contentious, and one which is attacked fiercely and from different standpoints. Idealism contends that the simplest act of knowledge is constituted by thought-relation, and we cannot have an act of knowledge which does not involve relations constituted by thought. Empiricists, on the other hand, tend to isolate sensations, and to make these the sole foundation of possible knowledge. We do not have space here to fully argue this question, but it may be said that even Idealism must have some data from which to start. Something must be given if thought is ever to make a start. And the common starting point of all the subsequent explanations of experience is just this position of awareness. Awareness may be so interpreted as to involve the whole outcome of completed experience. It may, indeed, be truly said of it that it is the awareness of a subject, and this is sufficient to justify all the claims of idealism. On the other hand, empiricism may contend that the first thing is the sensation, and that the awareness is second and that is the effect of the sensation. But it seems more consistent with the fact of experience, and with the whole analysis of the case, to take awareness as the first thing we meet with; it seems to be the ultimate fact beyond which we cannot go, itself unexplained, yet the explanation of everything else. From this primary and underived fact we may explain all the phenomena, whether these take the form of the ordered world of knowledge known as science, on the one hand, or all the facts which are formed into the ordered knowledge which we call by the name of Logic, Psychology, or Metaphysics, on the other. Awareness is the pre-condition of all the systems, and it is well to take it as the starting-point of any theory of knowledge.

Cognitive science is the interdisciplinary study of mind, in which the concepts and methods of artificial intelligence (AI) are central. The most prominent disciplines within the field are AI, artificial life (A-life), psychology, linguistics, computational neuroscience, and philosophy- especially the philosophy of mind and language. Cognitive anthropology is included too, though it often goes unseen under the label of evolutionary psychology. The many relevant subfields include robotics, whether classical, situated, or evolutionary; studies of enactive vision, where the organism's own movements (of eyes and/or body) provide crucial information for acting in the world; the psychology of human-computer

interaction, including various aspects of virtual reality such as avatars; and computational theories of literature, art, music, and scientific discovery. Nonhuman minds are studied by computational ethology and neuroethology, and by A-life.

4. Cognitive Science: A Modern Perspective

Cognitive science includes cognitive psychology and involves the study of language, memory, perception, problem solving, and creative thinking. What is more, most research has focused on individual human adult cognition. However, other aspects of mind are studied too: motivation, emotion, choice [1], development, psychopathology, interpersonal phenomena, motor control, and animal psychology. Consider emotion, for example. The role of emotion in problem solving, attitude formation, and neurosis were topics of research in AI and computational psychology in the early 1960s. But the problems were too difficult, and were largely dropped. Interest revived later, partly because of neuroscientific work on emotional intelligence and partly because of advances in the computational theory of scheduling in multi-goal systems [2]. Interdisciplinary conferences on the psychology, neuroscience, computer modelling, and philosophy of emotion blossomed at the turn of the century, when the topic became a prominent aspect of research. Whether the focus of attention is on development or psychopathology, emotion or motor control, the prime interest for cognitive science is in the abstractly defined computational functions that generate the concerned behaviour. But the neural mechanisms that implement them are also often studied. Despite the functionalist doctrine of multiple reliability, many cognitive scientists want to know how psychological functions are actually implemented in the brain. When functionalism began in the 1960s, little attention was paid to the nervous system by philosophers or AI scientists. Since the 1980s, that has been less true.

Indeed, neuroscience as such has become increasingly concerned with computational questions. On the one hand, there are theories of specific neural circuits doing closely specified things. For instance, cells in the retina and/or visual cortex that compute particular visual features, such as light gradients or surface textures; or cells in the female cricket's brain that enable her to discriminate the song of male crickets of the same species, and to move accordingly. On the other hand, there are broad-brush theories about the computational functions carried out by large areas of the brain, where the focus is less on specific individual cells than on

general neuroanatomy- different cell types, locations, and connections of the neurons.

4.1 Context of Cognitive Theory

Piaget's theory continues to have an immense impact on social science in general and on child development and education in particular. At the time his work was translated into English, the field of child psychology was mostly concerned with either Freudian concepts (Sigmund Freud's psychoanalytic theory) or behaviourism (mostly from B.F. Skinner and other learning theorists). Unlike the psychoanalytical methods or laboratory experiments used by proponents of those approaches, Piaget primarily used an observational strategy in collecting data. Occasionally he would ask questions or pose problems, but even then he allowed the child's behaviour to guide his explorations. This approach led to many new and startling conclusions about how children think. His theories resulted from this technique of gathering data and are remarkably useful.

4.2 Developmental Issues in Cognition Science

Most cognitive scientists study already established phenomena, although many include learning in their subject matter. And some do this because they believe that adult psychology cannot be properly understood without knowing how it developed. In short, they see the mind as an epigenetic system, deeply informed by its developmental history. Epigenesis was stressed long ago by Conrad Waddington in biology and Jean Piaget in psychology. It is self-organized development, grounded in innate predispositions in continual dialectic interaction with the internal and external environment. For example, there are inborn dispositions to attend to broadly face- like stimuli, or to human speech-sounds. Once the attention is caught, learning can help develop the infant's pattern recognition and discriminatory powers. In some cases, such as face recognition, the neural mechanisms relevant at different stages have been largely identified. An epigenetic view is not strictly environmentalist, or strictly nativist either. Rather, it stresses the dialectical interplay between the two. Late twentieth-century work in developmental neuroscience and developmental psychology has therefore led to a radical re-conceptualization of nativism [3]. Some philosophers of biology have defined new accounts of self-organization and dynamical development accordingly.

4.3 Cognitive Science is Computational

Cognitive science employs computational models of mind in two senses. First, the substantive concepts in its theories are computational. The mind is seen as some sort of computational system and mental structure and mental processes are described accordingly [4]. Whereas many psychologists use computers to express their theories, especially to analyse their experimental data, only cognitive scientists import computational ideas into their theories. Some work in cognitive science (in AI and psychology, not only in philosophy) employs computational concepts and insights, but with insufficient detail to allow programs to be written. When programming is possible, it provides several advantages. Even program failures can be scientifically illuminating, pointing out lacunae or mistakes in the theory, or fundamental limitations of the methodology used.

4.4 Cognition: Some Philosophical Problems

Many philosophical disputes arise within cognitive science. One dispute concerns the relative merits of the two AI approaches: classical (symbolic) AI and connectionism, or neural networks. The latter is broadly inspired by the basic structure of the brain. There are several types of neural networks, but the one most widely used within cognitive science- and the one of greatest interest to philosophers- is parallel distributed processing, or PDP. Some researchers champion only one of these AI approaches, whereas others admit both, because of their complementary strengths and weaknesses. Symbolic AI is better for modelling behaviours that involve hierarchical structure, advance planning, deliberation, and/or strict sequential order. The conscious, deliberative aspects of the mind are best suited to this approach. Connectionism, by contrast, is better for modelling the tacit learning and knowledge involved in pattern recognition, including the fuzzy family resemblances between instances of one and the same concept. It does not follow that all unconscious mental processes are best modelled by PDP systems. Some psycho - neural theories of action errors, including various clinical syndromes, employ hybrid (mixed) models in which the hierarchical aspects represent both conscious and unconscious processing.

4.5 Opposition to Orthodox Cognitive Science

A sixth controversy-or rather, batch of controversies- arises from the recent work that opposes orthodox (neo-Cartesian) cognitive science [5]. This involves both empirical theory/modelling and philosophical discussion. In general, it draws

on the traditions of phenomenological philosophy and/or autopoietic biology, rather than Cartesianism. It rejects both symbolic and connectionist AI, and the concept of representation. It highlights embodied systems (not abstract simulations), embedded in their environment and responding directly to it. Examples include situated robotics in AI, dynamical systems theory, ecological psychology, and A-life studies of evolution and co-evolution. Philosophies inspired by these empirical researches include the theory of extended mind [6]. This starts from the position that minds must necessarily be embodied and that memory storage lies largely outside the skull and goes on to argue that an individual person's mind is extended over the surrounding cultural artefacts: language, customs, and material objects- from palaces to pencils. The claim is that mind is not merely deeply influenced by these things, but it is largely constituted by them. Philosophical questions associated with A-life include whether evolution is a necessary characteristic of life, and whether the concept of autopoiesis captures the essence of life [7]. If living things are defined as autopoietic systems- whose physical unity, boundaries, and self-maintenance are attained by self-organized metabolic processes- then questions about the origins of life take on a different colour, as do questions about the possibility of strong A-life (life in computer memory)- so called by analogy to strong AI. Philosophers of A-life consider not only the nature of life as such, but how and why it is related to mind. Must all minds be evolved, for example? Autopoietic theorists define all life as involving cognition, while insisting that only linguistic life (i.e. adult humans) involves representations. But questions remain about whether, and if so why, life really is essential for mind ? By the same token, questions remain about whether the study of A-life is essentially unrelated to cognitive science or is fundamental to it ?

5. Cognitive Science and Culture

Culture directed research in cognitive science raises philosophical questions too. One concerns the nature of group mind, or as it is more commonly called, distributed cognition [8]. Can one identify aspects of cognition that cannot be attributed to any single individual, but only to a team of encultured persons acting in concert- and if so, can one model such phenomena in computers? Two more such questions concern the evolution of information-processing mechanisms that underlie important cultural phenomena- religion or aesthetic appreciation, for example-and the evolution of culture as such.

6. Perception and Cognition

For Piaget, learning played an important part not only in the elaboration of intellectual structures but also in the field of perception. It is this that distinguishes his view from that of the Gestalt psychologists. For the latter, the perceptual constancies of shape and size belong directly to the perceived objects and are independent of age and ability. For Piaget, however, perception of figures is built up as a result of a series of random eye and other muscular movements, which are gradually corrected. A young child does not attribute a constant size or even identity to the objects around him. Piaget believed that the logical forms of activity that emerge in child behaviour, namely classifying, relating, and so forth, arise as a result of his trial-and-error activities. Piaget's views on perception have certain philosophical implications. Previously, as he points out, philosophers have assumed a definite psychology of perception in their epistemologies. A good example of this is John Locke's sensationalism, in which it is assumed (1) that empirical facts are passively given in perception and (2) that they correspond to a certain range of linguistic expressions that designate them. For Piaget, however, even the notion of an object, one of the simplest forms of perceptual invariants, requires a definite learning process. Before the child is able to use linguistic expressions to refer unequivocally to definite objects, he must first have developed concrete classificatory and relational activities. Even the simple statement, "This is green," implies the acquisition of such skills and hence cannot be regarded as a reference to a simple perceptual datum. When we talk intelligently of green, this presupposes that we have learned to classify objects according to their colour and to differentiate one colour from another.

7. Conclusions

There is no doubt that cognition has become increasingly concerned with human behaviour. On one hand, there are theories of specific neural circuits doing closely specified things and on the other, there are broad-brush theories about the computational functions carried out by large areas of the brain, where the focus is less on specific individual cells than on general neuroanatomy.

The theories of cognition are pertinent and significant in mapping of the human behaviour and a lot can be done for better understanding of the human psyche through these theories. Cognition in Jainism assumes consciousness (chetana) and awareness (darshana) as inseparable entities that are inevitable and the most elementary forms in any given state of knowledge as discussed in this article.

Bibliography

1. Dennett, Daniel C. (1984) Elbow Room: The Varieties of Free Will Worth Wanting. Cambridge, USA: MIT Press.
2. Sloman, Aaron (1993) "The Mind as a Control System." In Philosophy and the Cognitive Sciences, edited by Christopher Hookway and Donald Peterson. Cambridge, U.K.: Cambridge University Press.
3. Elman, Jeffrey L., Elizabeth A. Bates, Mark H. Johnson, et al.(1996) Rethinking Innateness: A Connectionist Perspective on Development. Cambridge, USA: MIT Press.
4. Haugeland, John, ed, (1997) Mind Design II: Philosophy, Psychology, Artificial Intelligence. 2nd ed. Cambridge, USA.: MIT Press.
5. Cliff, David, Harvey, Inman and Husbands, Philip (1993). "Explorations in Evolutionary Robotics." Adaptive Behavior 2, 73-110. Wheeler, Michael W. Reconstructing the Cognitive World: The Next Step. Cambridge, MA: MIT Press, 2005.
6. Clark, Andy J. (1997) Being There: Putting Brain, Body, and World Together Again. Cambridge, USA: MIT Press.
7. Bedau, Mark, A. (1996). "The Nature of Life." In The Philosophy of Artificial Life, edited by Margaret A. Boden. Oxford University Press, Oxford.
8. Hutchins, Edwin, L. (1995) Cognition in the Wild. Cambridge, MA: MIT Press.