The Memory Mechanism

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The mechanism of thinking is still considered to be a great mystery, in spite of extensive research on mental processes during the past half century. This has even lead some scientists to daring conjectures about yet unknown physical phenomena which might underlie this mechanism. However, I believe that nothing of this kind is necessary. In my view, it is only necessary to accept as a fact, that meaning cannot be analyzed in elementary logical components, as long lasting research in cognitive psychology indicates. Many researchers have already reached this conclusion but they don't seem to see its consequences. These are obvious if we note that long-term memories can only be of two kinds: there are explicit (or declarative) memories expressible by linguistic components and implicit (or non-declarative) memories stored only as sensorimotor neural mechanisms for action or reaction. If the conceptual system cannot have a declarative form, then we must seriously consider the possibility that it can be built up by non-declarative, implicit mechanisms. Of course, in this case we must also explain how non-declarative knowledge can be used to build up declarative knowledge, that is, how implicit neural mechanisms result into concepts as we usually use them.

This is not as difficult as it may seem. We only have to take in account the fact that the conceptual system is an evolving mechanism. Young children acquire linguistic knowledge only gradually during a period of many years. Yet they are able to communicate in an imprecise, not always accurate form throughout this period. In fact, the meaning of concepts seems to develop in their mind gradually from a very hazy, unstable and imperfect form into a precise and concrete one. This reveals an important fact about the conceptual system. During its first stages of development it has a very imperfect and hazy form although it still can be used for the purposes of rudimentary communication of a young child. In fact, this is again an indication that the conceptual system is based on implicit neural mechanisms, since implicit knowledge builds up only gradually, while explicit one is almost instantly acquired.

Of what kind may this implicit memory mechanism be? Like all other implicit memory mechanisms it gradually develops a hierarchy of increasingly refined reaction schemata. But then, when does a concept acquire a concrete form? Here we must recognize the immense influence, which the necessity of communicating has on a child's mind. Young children often develop their own linguistic (vocal) symbols for certain objects, actions or situations. However, they soon abandon their own vocal signs and adopt the echoic symbolism, the words, used by the people in their environment. This is not merely an exchange of tagging. It also implies the necessity of "norming", i.e. standardizing the concepts in a child's mind. Like all implicit neural mechanisms, the implicit memory mechanisms that underlie some concept, are based on accumulated experience. Therefore, they can have various forms in different people, since different people cannot have exactly the same experiences. This means that the child must gradually adjust his experiences

to those of other people and learn to use the concepts based on them in a certain standardized way. That is why it takes ten or more years until these concepts are fully "understood", i.e. properly used, as the Developmental Psychology tells us. At first we learn how to interact with objects, but later we learn how to interact with the word-concepts used in our environment. This provides the logical content of these concepts, which is very different from their empirical content.

Note that a grave misconception, which hinders many people to recognize the mechanism of thinking is the belief that the concepts have a universal standard form, the same for all people. According to the view discussed here, since the concepts are formed empirically and evolve gradually they cannot have any common form in all people (although there should have extensive similarities due to the similarity of experiences that underlie them). The concepts develop a standard form only subsequently, when the child tries to communicate.

What kind of a system do these observations favor? We might consider the creation of some kind of network model for the conceptual system, since such a model explains one of the most prominent properties of memory: its associativity. The memories are stored in mind not independently, but so that the activation of one leads immediately to the remembrance of others, associated with it, on the basis of experience. However, if memory is based on implicit mechanisms the nodes which are interconnected to build up such a network cannot be discrete elementary components of meaning. They are empirical associations, i.e. empirical action and reaction schemata. We might call them 'empirical categories'.

There is a fundamental difference between empirical categories and logical ones. Logical categories codetermine each other. They are interdependent, building cycles of logical definitions. The concept "bird" is a determining element of the concept "wing", but the concept "wing" is also a determining element of the concept "bird". Each of these concepts is a part of the logical definition of the other one and can not precede it. We can not define what is an wing without mentioning that it is an anatomical part of a bird, but we can also not define what kind of animals the birds are without mentioning that they have wings. Thus, whole categories of concepts should be formed in the child's mind simultaneously, without any obvious indication of the kind of logical elements, by means of which they could be formed. This shows that the connections of properties that form a memory network can not be connections of logical properties. They must be 'empirical categories', i.e. empirical interaction schemata. Such categories are not based on logical definitions and they are functional, even if only primitively, from the first moment of life. The logical definition of the concept "bird" as "an animal, which has wings and feathers" is not functional until it is defined what is a "wing" and a "feather". But a wing or a feather is an anatomical part of a bird, which leads us to a vicious circle. In reality, what a young child initially understands as a "bird" is not based on any such definitions. A bird is simply perceived as a creature that flies. This means that the concept "bird" is initially determined kinesthetically or interactively, in the way that we empirically observe a flying object. The kinesthetic observation mechanism is

part of the empirical 'definition' of this concept. Later, of course, we find out that flying is performed by means of wings and can define a bird as an winged animal. However, we also note that certain winged animals, like chicken, do not fly, which causes the reasonable question whether they are "really" birds. Here we see that, although empirical definitions may be imprecise from a logical point of view, logical definitions can also lead us to confusion. This is not a matter of logical contradictions, but rather a contradiction to the initial determining experience.

But, if the initial "definition" of concepts is empirical, based on sensori-motor interactive mechanisms, then how do the logical categories appear and why? Obviously, this happens when the child seeks communication, i.e. when he/she attempts to achieve social interaction. The logical categories are the means of communication in society. The initial empirical categories are based on personal experiences and may exhibit great variations from one person to another. It is, therefore, necessary for them to be "standardized" so that communication between people becomes possible. This gradually leads to the creation of logical categories, logical concepts, or rather, a logical standardization of the concepts[1].

The most important nodes of this mixed, partially empirical and partially logical, network are marked from the age of two on by words. These are used as names, as tags which make these nodes discernible. The words allow us to move in this vast network without being lost. They are like the street names in a city or the marking of merchandise in a large storehouse. By means of them we can express complex meanings by placing them in a sequence, i.e. by constructing a sentence. Thus, they allow us to build up a "mental model" of any situation (in Johnson-Laird's terms), which often allows us to recognize various not immediately given interrelations between the factors involved in this situation. It is experimentally observed that people, in order to make simple syllogisms, compose mental models of the situation at hand, which they mentally process or manipulate[2]. Thus, they are lead to logical conclusions immediately, without the application of rules of Logic. In fact, the logical standardization of the concepts seems to be based exactly on such mental models. The gradual assimilation of ever more complex "mental models" related to some concept allows the ever better handling of various logical aspects of the concept.

The network of empirical categories is a tagged network of associative interconnections of various motor and sensory abilities of the body. These associations do not seem ever to vanish from our memory, even after the beginning of logical categorization. This is obvious, e.g. from the fact that adults as well as children use interactive schemata rather than logical

[1] According to Piaget, the complete logical handling of the basic concepts of space, time, quantity and number is accomplished around the age of 12 years, with last developing the concept of time.

[2] See experimental results due to P. C. Wason and P. N. Johnson-Laird, which are described in the second one's book: Mental Models, Cambridge U.P., 1983 or similar results due to C. A. Riley and T. Trabasso, which are described in the book: Geoffrey Brown – Charles Desforges: Piaget's Theory, Routledge & Kegan Paul, London, 1979, p. 59.

definitions in order to explain the meaning of some word. Explaining what an egg is, usually they will not say that an egg is an initially unicellular organism, which is the result of a reproductive process and gradually evolves into a multi-cellular organism similar to its parents. What they are likely to say is that an egg is something edible born by a hen, forgetting that eggs are laid also by fishes or insects. Similarly, when asked "What is salt?" they will not answer that it is a chemical compound of chlorine and sodium, but rather that it is a white crystalline substance with a characteristic spicy taste. Thus, in the mind there are two parallel and partially contradictory processes: the creation of empirical associations and logical categorization.

Based on the above hypothesis, that empirical associative connections remain permanently in the memory, we can now immediately understand why a great part of this network is unconscious. We should only note that the network of associative connections begins to acquire a notation by means of words from the second year of life on. The earliest associative connections have no names. What is more, they have increasing haziness, reduced specificity, as we go back in time. They are hazy mental schemata, which grasp some common features of wider sets of empirical data. Thus, while they are important for the formation of concepts, as we use them especially in internal (mental) dialog, they are not easily discernible and become ever less discernible as we go to earlier stages.

They also play another important role. They allow us to find common elements, common features, in concepts, which seem logically independent. These preliminary stages of concepts, which have been called by many psychologists "preconcepts", constitute non-specific recognition mechanisms for common empirical features of various concepts. These mechanisms are not easily discernible or totally indiscernible, because they are too hazy.

Note that various logically unconnected concepts may have some common early empirical content, since all associative connections are stages of concept formation, which reduce the initial very hazy and unspecific conceptual structures to more specific ones. For instance, the concepts "water glass" and "spoon" have the common preconceptual content [container]. The brackets denote here a common perceptual schema, a perceptual mechanism and not any logical definition of the concept "container". No matter how different a water glass and a spoon are, we know that they can be used to contain a quantity of liquid. Similarly, even a young child understands that he can use even a walnut shell as a container. But how does he know that? Does he make some sort of logical analysis like: "The shell of the walnut is something hollow and hollow objects can be used as containers of liquids"?

It is rather improbable that he makes such syllogisms e. g. at the age of 1,5 years, in which, according to Piaget, the stage of "symbolical thinking" begins. This is the stage, during which some objects begin to be used as symbols, as substitutes, of others. What is more, later developmental psychologists believe that this stage begins even much earlier.

What a young child does is rather that he uses the same unspecific perceptual mechanism for the recognition, the mental grasping, of all these objects. Thus, it is immediately obvious that a walnut shell can be used as a container, without any logical processing. The perceptual mechanism

[container] is simply a preconcept of all these objects, an unspecific perceptual mechanism, which grasps anything that can play the role of a container. I.e., it recognizes automatically a common content in concepts, which superficially are very different, like a thimble and the calyx of a flower.

Such a perceptual mechanism does not ever reach a final stage but is continuously developing. The concepts give the impression that they have a final form, because their use in discourse imposes a strict standardization of their 'social' meaning. However, this standardization is only one of their components. Their empirical – associative content continues developing as long as we live. For instance, a chair is for a young child a big object, on which he may climb with some risk. For a young adult it is simply a piece of furniture, on which he may rest for a while. For an old man it means restfulness or aching bones, depending on how comfortable it is. Similarly, abstract concepts like "love" and "freedom" have a different associative-empirical content in every period of life. For instance, to a three, or four years old child "freedom" roughly means "being unconstrained". To a twenty to forty years old citizen it means "having one's basic rights respected and being able to develop activities". It also means "being able to exercise political influence directly or indirectly by expressing openly one's political views and participating to elections". To a fifty to sixty years old it may primarily mean "being able to control the habits and passions of earlier years, being able to accept the nonfulfillment of some of one's initial goals and wishes (internal freedom)". To an over seventy years old it may primarily mean "being still able to be independent of help by other people" and finally "making peace with one's inescapable destiny, the death!", "being able to accept death in peace of mind". So "freedom" is not merely a lexical entry, but a concept whose various aspects or facets one has to internalize gradually as one grows older.

The existence of such a vast network of preconceptual associations allows us also to explain somehow the phenomenon called "inspiration" or "intuition" of a scientist. After a usually long lasting persistent and futile search for the solution of a problem many scientists have a sudden inspiration, which sheds light on the problem from a very different and unexpected point of view and leads to its solution. How does this happen?

Logically unconnected concepts may have common preconceptual content, common preconceptual aspects and possibilities. The realization, the recognition of this preconceptual content or of preconceptual possibilities is possibly what we often call "intuition" of a scientist or intuitive thought.

The existence of the two systems of empirical and logical categorization explains also the creativity of thought. The two systems are, by their own nature, incompatible. Empirical categories can partially be described by logical categories, but their content can never be exhausted in this way. I.e., they have a relationship similar to that of the diagonal and the side of a square, whose lengths have a ratio of $\sqrt{2}$. This number is irrational and can not be written as a fraction, i.e., as a quotient of two integers. However, it can be considered as a decimal number with infinite non-repetitive decimal digits: 1.414213562…. This allows its approximation by means of fractions, any truncated forms of this decimal representation, e.g. 1.414. In the same way,

empirical categories can have a logical description, but only approximately. Their content can not be logically exhausted. They are carriers of infinite logical information.

Finally, we should not ignore the fundamental role of the inborn drives, or instincts for the formation of this system. The instincts are both the moving power of the mechanism of thought, which make it operate, and its steering rod, which determines in which direction it will move. They are filters of the incoming information, which choose what will be attended to and further processed and what will be ignored.

This very short sketch of the mind mechanism shows, I think, that this system is not very complex in its structure. However, it has great plasticity, so that it is doubtful whether thinking machines can be built easily. In order to construct them, we must equip them with a great variety of "instincts" or "drives" and allow them to form empirical associations interacting with a physical and social environment rich in experiences. The result would be something like a primitive man with sentimental disorders and bad upbringing and education. Most important is, however, that such a structure will intrinsically have a free will and will not be fully controllable. It will not be an obedient machine.

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