



Models of Mind That Are Implied by Cognitive Science

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ABSTRACT

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Three models of mind were proposed during the history of cognitive science: functionalist, psychological, and neural model. The functionalist model of mind is based on symbol manipulation (computation). This model has two versions: the conception of mind as an innate information processor and problem solver, and mind as innate cognitive and visual system. A psychological model of mind is the extension by "common sense". The alternative is mind as a cognitive and visual system that is based mostly on manipulation of internal mental data. The neural model is the only model of embodied mind. It has two versions: non-pragmatic and pragmatic (autopoietic, distributed, and social mind).

1. Internalist Models of the Mind

1.1. General Features

Internalist models of mind are functionalist and psychological models. The mind is conceived of being separate from the body and its surrounding world. Sensations and perceptions are thus understood as an input only, a sort of raw data that enters the mind unconceptualized by pragmatic factors, and by phenomenological factors. For this reason, both models share the idea that either the whole mind or at least one of its dimensions is an input-output system that processes information. The mind is mostly unconscious. There is no agreement, however, in terms of the origin (whether the mind is entirely innate or whether it is a system that is derived from experiences), in terms of the nature of the mechanism of the mind (whether it is purely formal – functional – or whether rather psychological), in terms of the purpose (whether the mind is a problem solver or not).

1.2. Functionalist Model

1.2.1. General Features

This model of mind is known as the Computational theory of mind. The major implication of this theory is the biological innateness which means that the mind runs on a system that developed in the brain from its resources, i.e. that the whole mental mechanism had not been derived from experiences. Two competing models developed that differ in the conception of the nature of such innate system. Human thought is based on symbolic logic, i.e. that thought is formal, that it uses only empty meaningless symbols that are representations of some kind. The mechanism is believed to produce the base of human thought and actions. The purely formal procedure is based on the function of the mind to execute specific tasks following rules that are biologically innate.

Two competing versions of the same theory developed that differ only in the conception of those representations. They offer the different explanation of what symbols represent, and of what the purpose of such representations is. Otherwise, they both suggest that symbols are manipulated by computational operations that follow some rules (symbolic logic).

1.2.2. The Mind is One-Dimensional System that is Not Autonomous since it Needs Information to Run. It is an Input-Output System, Information Processor, and Problem Solver. The Mind is the Computer.

This theory is suggested in the older stream of cognitive science, called "cognitivism" or "classic theory" within the research in the field of the Artificial Intelligence (Turin, Newell, Simon and related work). The mind is the one-dimensional system because perception is not supposed to be separated from cognition. It is an input-output system since the mind needs some data to work with (input) to produce an idea or action (output). It is an information processor, since its only function is to solve problems, and that can be done only by processing of the input. The mind is thus almost like the computer.

This theoretical proposal was based on the results of the simulation of thought on computers, according to which the mind can be reduced to operations that were discovered in the behavior of a computer program when the computer got the task to solve a problem. Such operations were reported to be purely computational, comprising examples of adding, deleting, replacing and remembering. All information was translated into a formal language of meaningless forms (symbols) so that the program solves problems only by symbolic logic. The human mind was supposed

to think the same way: only in symbols representing data from the world (i.e., without any meaning) and only by manipulating the symbols through the computational operations. The mind was proposed to be a general problem solver.

1.2.3. The Mind is Two-Dimensional System (Cognitive and Visual). The Cognitive System is Entirely Autonomous, which Works Without any Input, does not Process any Information, and does not Solve Problems. Only The Visual System Processes Information.

This model has been proposed by Noam Chomsky and led to the foundation of generative linguistics, but it's also implied by cognitive neuroscientists like Marr, Gallistel, and King, for whose views Chomsky advocates.

Mind as a computational system based on functions that have properties proposed by Turing, and by which symbols are manipulated, are also presupposed in this paradigm. The capabilities (or functions) of the computer program designed by Turing (known as "Turing machine") to solve problems are taken to be the basis of cognition. The thought is therefore believed to be a kind of a computational system, the properties of which are solely grounded in the brain of men and animals. This suggestion is targeted against the view advocated within the neural model of mind, according to which cognition consists of connections and associations between either input from the environment or experiences, and not on functions.

But the view of mind as an information processor and problem solver is rejected since this paradigm differs from the problem-solving model in the following respect:

- The visual system is independent of cognitive system;
- The visual system is not a simple perception of external data but an autonomous computational system itself, so that information from the environment cannot be a simple datum (as is supposed to be for a computer and a human cognition accordingly). David Marr calls such a description a "computational theory", a theoretical prerequisite to the descriptions of processing (algorithmic theory) and neurological implementation. According to Marr's theory, information transduced by the retinas must be translated successively into three distinct forms before object recognition can be achieved.

Another difference is in the conception of the cognitive system that is not an input-output system at all. Even if there are computations as symbol manipulations – there is no processing of external data, but the only manipulation of symbols that represent strictly only internal data of the innate system of knowledge. You can talk about the computational level – in theory, though we don't know how, you can talk about the neurophysiological level, nobody knows how, but there's no real algorithmic level. Because there's no calculation of knowledge, it's just a system of knowledge. To find out the nature of the system of knowledge, there is no algorithm, because there is no process. Using the system of knowledge, that will have a process, but that's something different.

Chomsky explains language (taken as syntax) from such a point of view when he takes language to be based on computation (that might have properties of symbolic logic): „The operation Merge is as simple as possible – it involves minimal computation. That means when you form something new from X and Y, you don't change X, Y, and you don't impose order on them, so the output of Merge of X, Y is set containing X and Y, {X, Y}. That's the best case, and it makes sense". When he at the same time stresses that symbol manipulation is not about the world – implying, that computation is not processing of external data, but of data

of the system of knowledge: "There has, of course, been work on meaning in recent years, quite a lot, and highly illuminating. But I think we should understand it as syntax; that is, it has to do with symbol manipulation. It doesn't matter what the world is – these are studies of syntax, symbol manipulation."

1.3. Psychological model

This model comes from cognitive neuroscience: „There's a fairly recent book by a very good cognitive neuroscientist, Randy Gallistel, and King, arguing – in my view, plausibly – that neuroscience developed kind of enthralled to associationism and related views of the way humans and animals work. And as a result, they've been looking for things that have the properties of "associationist psychology". It is a critical revision of the functionalist account of the mind suggesting that the input from the world (which is a particular feature of the world that is) is not processed in the form of symbols but processed in the original content of the input (in the meaning of the feature of the world). Whereby such meanings in mind are associated (or connected) with each other according to their similarities. A theory attributed to Donald Hebb that "associations between an environmental stimulus and response to the stimulus can be encoded by strengthening of synaptic connections between neurons". The mind is thus a neural network of stored meaningful and organized features that are connected in synapses (this theory is called "connectionism" for this reason) so that any input from the world activates all synaptic connections across the whole network (the theory uses the term: massive parallel distributed processing) to leave only the ones that are relevant to the input. The input is then interpreted by all of those relevant connections of features that have something in common (that are similar). This thesis from cognitive neuroscience provided a theoretical framework for one of the branches of cognitive psychology (associationist psychology) that has been looking into the nature of the organization and structure of networks to discover new units of connections, such as fields and clusters of features (e.g., the research by Wolfgang Marx). However, cognitive psychology remains settled within the internalist paradigm of the mind: "The separation of man and environment in modern psychological theories, particularly in cognitive psychology, is a consequence of viewing humans as input-output systems when mental activity is based on linear processing of information from the environment: sensations, perceptions, and mental activity in general, are regarded as something related to the inner processing of environmental information by the senses and by the brain. The senses receive the stimuli which then run along the nerve paths to the centers analyzing the incoming information and creating interpretations of the events occurring outside the brain and body. This is the internalist account of mind, according to which mind and world are considered separate".

1.4. The Combination of Functional and Psychological Model: The Mind is Society

This model that has been proposed by Marvin Minsky within his Artificial Intelligence research as the result of the application of the psychological model of networks on the functionalist model of the cognitivist version. The functionalist implications of the cognitivism that the mind is problem solver and the computer remained unchallenged, but by the influence of the associationist psychology – or through the application of it – a new proposal was made according to which the mind has both dimensions: the functional (it is the computer), and the psychological (it is also a network of connected meanings). Minsky describes this two-dimensional mind as "society of mind". The result of such implications is Minsky's thesis that the mind as the computer solves problems not only by symbolic logic but mostly on psychological grounds using the input from the world and storing it in meaningful networks of features. Moreover, Minsky extends

the theory of network (that the mind organizes the input by related elements of the perceived features) by the suggestion that perceptions and sensations are taken by the mind and stored not only by features of the world but also by types of situations (which he calls "frames"). The mind is thus a network of not only interrelated features of the world but also of frames of situations. Minsky extends both the functionalist and psychological models by postulating a biologically innate mechanism "common sense" that replaces the procedure of symbolic logic. It allows the mind to solve problems through "new ways to think" (e.g., models of Self, thinking by analogy, creative thought, etc.). Minsky, in his book "The emotion machine. Common Sense Thinking, Artificial Intelligence and The Future of the Human Mind" indicates the shift established a new branch of cognitive psychology that is related to the Artificial Intelligence (contrary to the associationist psychology). Sperber and Wilson: "an input (a sight, a sound, an utterance, a memory) is relevant to an individual when it connects with background information he has available to yield conclusions that matter to him: say, by answering a question he had in mind, improving his knowledge on a certain topic, settling a doubt, confirming a suspicion, or correcting a mistaken impression. In relevance theoretic terms, an input is relevant to an individual when it is processing in a context of available assumptions yields a positive cognitive effect. A positive cognitive effect is a worthwhile difference to the individual's representation of the world – a true conclusion, for example".

2. Externalist Models of Mind

2.1. General Features

All following models are based on following assumptions. The mind and the world are not separated. The mind is thus distributed/extended. The particular extension is the source of consciousness, cognition/thought/meaning. The differences between the following models lie in different conceptions of the nature of distribution, and thus in accepting different extensions as relevant sources of consciousness, cognition/thought/meaning. Another difference is the attitude towards the neurobiological dimension of mind, the brain: whether the brain is or is not a relevant source of consciousness, cognition, thought, perception and thus meaning in general.

Thus embodied in the body and though it in the world. The connection of organisms with their environments has consequences for the nature of thought. The sensations and perceptions are not raw data that are additionally processed through the thought/reason, but perceptions and reason are connected actions of interpretation that are simultaneously reflected in the brain in the form of neural structures because the brain, body and the world are interconnected, not separated as the internalist models suggest. The mind is for this reason only the brain itself, the neural structures themselves. This approach to cognition is thus called Neural theory of mind.

In proposing what the specific source of interpretations is, each of the models takes the proposal of its preceding externalist models for granted; it does not challenge it. It only extends the proposal of the preceding (older) model by the proposal of an additional source of interpretations, leaving the sources that have been proposed already, unchallenged. All externalist models are thus not competing with each other; they are only extensions of each other. Also in terms of the nature of neural structures, there is a consensus across all the models. Again, the difference between them lies rather in the fact that some features of the neural mechanism are extended by new features, but the previous assumptions were not refuted, and remain unchallenged.

2.2. Non-pragmatic model of the mind: the mind is metaphorical

According to this externalist non-pragmatic account of the mind, the source of the interpretations that shape the nature of sensations, perceptions, and reason is sensorimotor experience gained during all interactions of embodied organisms with their environments.

This thesis is based on the presumption that experience is embodied. The way in which anything is sensed, perceived or reasoned is, unconsciously determined by the perception that is conducted from the perspective of the organism having the body, and interacting within the body and with the world. This sensorimotor experience shapes the way humans perceive and sense. In other words: humans interpret the world from the perspective of having bodies and moving them in the world.

The thesis that the mind is essentially metaphorical means that sensorimotor experience shapes not only perception but also reason in general. On this account, the sensorimotor experience is the essential ingredient of any concept or thought produced by the mind, since everything mental is interpreted through it. The proposed argument is that sensorimotor experience is transferred on everything mental (perception, subjective experience, reason) to create a concept or an idea. This transfer is called a metaphor.

This account is based on the presumption that experience is the outcome of the contact of organisms with their environments, during which subjects reflect their bodies, and use such experience in building their concepts and meanings by projecting this embodied experience unconsciously into perception and finally into reason. The brain is supposed to be embodied in the sense that it reflects all experiences by neural mechanisms (brain regions, circuitry, synapses) that enable to link experiences that happened often and simultaneously. The links between such experiences form a metaphor, from which other concepts are inferred during life. This model is not pragmatic though since the definition of experience is

2.3. Pragmatic models of the mind

2.3.1. General features

All pragmatic models of mind share the basic presumption that the source of thought (including perception) is not only sensorimotor experience but also interactions of subjects with the environment during their lives. The mind is thus distributed or extended ("distributed/extended theory of mind"): „Empirical studies of human cognition show that cognitive processes are distributed across brains, bodies and our social and physical worlds (Cowley 2007). For this reason, all pragmatic models disagree with the cognitive model of the externalist account of the mind that all cognitive processes are determined by the brain itself. "The mind is not contained in the body, and mental states are not solely determined by states of the brain", - as Clark and Chalmers (1998: 9) claimed this, - "cognitive processes are not (all) in the head!".

The cognitive domain of orientational interactions. This domain is established by interactions of the orienting organism and the organism to be oriented with representations as states of relative neuronal activity". Another source of thought is subjective experiences collected during all interactions with the world because subjective experiences with interactions are used to interpret all interactions. Thus, all phenomenological properties, from the perspective of which subjective experience is built during life (self-awareness, feelings/emotions, willing, interests, etc.) belong the relevant sources of thought. A mind is life; cognition is life (The branch of cognitive science that is currently active in the research of self-awareness is neurophenomenology). Within this

paradigm, two different proposals were made to explain the nature of interactions and how those interactions play a role in the interpretations of the world.

This model of the mind dominates the current scientific discourse. However, there are two different versions offering a different account of the determination of the environment.

2.3.2. The Mind is Orientational and Consensual Since It is an *Apriori* (Necessarily/Essentially) Coupled with Its Environment

According to this account of the mind, interactions are the source of thought, since they are orientational and consensual. They are orientational by being directed to the world intentionally, naturally. The consensuality means that there are negotiations, the outcome of which is a consensus between interacting subjects.

The authenticity and the consensus are explained by the nature of the relation between subject and the world. The premise of this account is that the relation is *apriori* based on a principle (i.e. that the relation is necessary/essential), and that this principle is a relation of the nature of coupling or interconnection meaning that the relation is reciprocal and causal. Humberto Maturana, the author of this thesis, named this principle *autopoiesis*: “*Autopoiesis*” is the principle of the essential interconnection (coupling) between human and animal organisms and their environment through interactions oriented towards the physical and social world”. The source of thought is thus the environment, and the mind is thus distributed/extended that way. In this sense, mind/cognition/thought/meaning are distributed. The environment is the source of thought also regarding interactions with the physical world. And also these interactions are causal, because they are necessary, essential – they cannot be otherwise:

Besides these interactions, subjective experience gained from such orienting interactions during the life of subjects is another source of thought (meaning).

Within this paradigm of the mind as an organism-environment system, two competing versions emerged that differ in their attitude towards another possible source of thought, which is an experience. Experience is recognized as a relevant source of thought only in the version of *autopoiesis* that is represented by the original authors Maturana and Varela, and currently by the authors within the “*biocognitive theory*” (e.g. Kravchenko), and by Evan Thompson (“*neuropsychology*”). This direction of the *autopoietic* approach is based on the acknowledgment of the cognitive (non-pragmatic) account only in terms of the acceptance of experience as a source of thought/meaning.

2.3.3. The Mind is Determined Only by The Environment

This conception of the mind was formulated outside of cognitive science since its authors are/were philosophers (Hilary Putnam, Andy Clark, and David Chalmers). According to this philosophical thesis, consciousness (and thus all its content – called “*narrow content*”, i.e., meaning: thought and perception) is not generated either by the brain or by self-reflection. The only source is the environment, whereby the bond between organisms and environments is supposed to be coupled, i.e., natural in the senses of *autopoiesis*: “In everyday talk, we mistakenly overlook how external resources especially artifacts extend our mental powers. External factors play a significant role in determining mental states as the result of coupling between the environment and the organism; this coupled system is one in which brain, body, and world move in and out of reciprocal causal relations (Clark1997)”.

2.3.4. The relation is determined by praxis

The *autopoietic* conception of the relation between organisms and their worlds is rejected, but the environment along with the brain and self-reflection are accepted as relevant sources. However, the relation between organisms and the world is not supposed to be necessarily, essentially, *apriori* reciprocal and causal, since there are interactions, such as interactions between subjects and the power (the state, the law, science, traditions), the content of which – its meaning – is not a consensus. It is not a consensus on the content (the meaning) is not being negotiated between acting agents. It is not being negotiated, since only one of the agents (e.g., state, power, institution, science, tradition, etc.) dictates the content, and thus causes something: it causes or rather influences the thought of the other agent (whatever or whoever the agent is). The organisms whose thought (meaning) is caused/influenced by the interactions with the power (whatever the power is), do not feel that such interactions are orientational, i.e., that they are naturally directed towards the world, as the principle of *autopoiesis* implies. *Biocognitive theory* claims that cognitive processes are embodied (and environmentally coupled) but within the impersonal organism-system framework. This cannot account for meaning and content. The *biocognitive theory* is more about living systems than meaning-making persons. The organism-environment system underrates the role of others and the distinction between these other meaning-making agents and artifacts (and other external objects) that cannot make meaning on their own”. Theoretical projects that are based on this model of mind are, e.g., “*dialogism*” (Per Linell). The collective mind is termed “*integrated distributed cognitive network*” in cognitive neuroscience: “Human cultures can be regarded as massive distributed cognitive networks, involving the linking of minds, often with large institutional structures that guide the flow of ideas, memories, and, knowledge through the cultural-cognitive network. Artists work within various subsystems of those broader networks; they are situated in space and time, defining themselves as members of a specific tribe and generation. They may influence the cognitive activity of their tribe, by influencing and modifying its symbols, images, and other expressive forms. Thus, they are workers within the network, highly placed within the distributed cognitive system.”.

References

- Simon H. A., Newell A., Human Problem Solving: The State of the Theory in 1970. *American psychologist*: 145-159
- Newell A., Shaw J. S., Simon H. A., (1959). Report on General Problem Solving. Carnegie Institute of Technology.
- Chomsky N., Poverty of Stimulus. (2012). *Studies in Chinese Linguistics*, Volume 33, Number 1, 2012, 3-16
- Jackendoff R., (1987) On Beyond Zebra: The relation of linguistic and visual information. Elsevier Science Publishers B.V. *Cognition*, 26, 89-114 [Crossref](#)
- Katz Y., (2012) Noam Chomsky on Where Artificial Intelligence Went Wrong. An Extended Conversation with the Legendary Linguist.
- Kravchenko A., Language and Mind: a biocognitive view. p. 106
- Full list of proposed operations can be found in Minsky, M., *The Emotion Machine*, New York, Simon & Schuster Paperbacks, 2006, p. 226
- Wilson D., Sperber D., (2002) *Relevance Theory*.
- George Lakoffs internet article: <http://www.americanscientist.org/bookshelf/pub/the-functionalists-dilemma>
- Maturana, H. And Varela, F., *Autopoiesis and Cognition*, Boston, D. Reidel Publishing Company, 1972

- Thompson E., Neurophenomenology and Contemplative Experience.
<http://www.wisebrain.org/papers/NeurophenomenologyMed.pdf>
- The connection of cognitive science with experience was proposed already in 1992 in: Thompson, E., Varela F. And Rosch E., Embodied Mind.
- Linell, P. 2009: Rethinking Language, Mind and World dialogically. Information Age Publishing. p. 148
- Linell, P. Cognition and Cognitive Science: Three Generations. In: Cognitive Dynamics in Linguistic Interactions. Ed. By Alexander Kravchenko; p. 109
- Turner M., (2005). The Artful Mind.
<http://cogweb.ucla.edu/crp/Papers/Donald-Steen-05-ArtfulMind.pdf>