



Chapter V

Symbols: Integrated Cognition and Language

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Abstract

What is the nature of symbols? This word is used for traffic signs, mathematical notations, and motivationally loaded cultural objects that may inspire war and peace. This chapter explains relationships among symbols, cognition, and language. Symbols are explained as processes in the mind involving cognition and language. Relationships between cognition and language were a mystery until recently. Linguists often considered language as relationships among words and other linguistic entities, separately from its relationships to the world. Mechanisms of language in the mind and brain were considered separate and different from thinking and cognition. Neural mechanisms integrating language and cognition are unknown. Yet, language and cognition are intertwined in evolution, ontogenesis, learning, and everyday usage; therefore, a unified understanding of working of the mind is essential. A mathematical description of such unifying mechanisms is the subject of this chapter. We discuss relationships among computational intelligence, known mechanisms of the mind, semiotics, and computational linguistics, and describe a process integrating language and cognition. Mathematical mechanisms of concepts, emotions, and instincts are described as a part of information processing in the mind and related to perception and cognition processes in which an event is understood as a concept. Development of such mathematical theories in

the past often encountered difficulties of a fundamental nature manifested as combinatorial complexity. Here, combinatorial complexity is related to logic underlying algorithms, and a new type of logic is introduced—dynamic fuzzy logic—which overcomes past limitations. This new type of logic is related to emotional signals in the brain and combines mechanisms of emotions and concepts. The mathematical mechanism of dynamic logic is applicable to both language and cognition, unifying these two abilities and playing an important role in language acquisition as well as cognitive ontogenesis. The mathematical description of thought processes is related to semiotic notions of signs and symbols.

Symbols in Computational Intelligence and Linguistics

Symbol is the most misused word in our culture (Deacon, 1998). We use this word in trivial cases referring to traffic signs and in the most profound cases of cultural and religious symbols. Charles Peirce considered symbols to be a particular type of signs (CP 8.335). He concentrated on the process of sign interpretation, which he conceived as a triadic relationship of sign, object, and interpretant. Interpretant is similar to what we call today a representation of the object in the mind. However, this emphasis on interpretation was lost in the following generation of scientists.

In the development of scientific understanding of symbols and semiotics, the two functions—understanding language and understanding world—often have been perceived as identical. This tendency was strengthened by considering logic to be the mechanism of both language and cognition. According to Bertrand Russell (1919, p. 175), language is equivalent to axiomatic logic, a word-name “merely to indicate what we are speaking about; [it] is no part of the fact asserted ... it is merely part of the symbolism by which we express our thought.” David Hilbert (1928, p. 475) was sure that his logical theory also describes mechanisms of the mind: “The fundamental idea of my proof theory is none other than to describe the activity of our understanding, to make a protocol of the rules according to which our thinking actually proceeds.”

Logical positivism centered on “the elimination of metaphysics through the logical analysis of language,” according to Rudolf Carnap (1928) logic, was sufficient for the analysis of language. This belief in logic has deep psychological roots related to the functioning of the human mind. A major part of any perception and cognition process is not accessible to consciousness directly. We are conscious about the final states of these processes, which are perceived by our minds as concepts approximately obeying formal logic.

Similar understanding of relationships among symbol, language, logic, and mind can be traced in semiotics of Ferdinand De Saussure (1916) and in structuralism. A simplistic idea that words are labels for objects falls apart as soon as we consider words for abstract ideas, say, *rational*. Saussure (1916, p. 98) tried to resolve this problem by saying that “the linguistic sign does not unite a thing and a name, but a concept and a sound image.” Here, the real world is taking a back seat; both aspects of the sign exist in the mind. Structuralism was derived later from Saussurean linguistics. It emphasized “concept” as a part of language and

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