Some thoughts on logic, language, mind and reality

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This discussion will be predicated upon the notion that adult human cognition includes an internalized system of logical relationships and principles, in other words, that logic has some psychological reality in that at least a fragment of it is included in human competence.

To avoid some likely misconstruals, it seems a good idea to state here what this discussion is not. It does not examine whether standard logic, as a complete system, adequately represents human reasoning - a question that has preoccupied psychologists and some philosophers for some time (e.g. Cohen, in press) - nor does it attempt to determine whether an alternative logical system would be more suitable for this purpose as some psychologists have proposed. Nor does it take a stance in the debate regarding the adequate logical system in terms of logicians' and philosophers' criteria (ostensibly distinct from those of the psychologist). Rather it is assumed that some logic, possibly incomplete, is part of human knowledge; which form it has does not matter for the sake of the present discussion.

Given this premise, the aims of this paper are (i) to provide a first step towards integration of some issues in philosophy of logic with analogous issues concerning human logical cognition, in particular to examine the relationships between logic and language and logic and reality from those two vantage points; (ii) to address some general questions concerning the development of logical cognition within that perspective. In relation to this second aim, I will argue, more generally, for the necessity of articulating the epistemological and developmental foundations of the cognitive functions or knowledge structures that we are investigating in cognitive science, if our account of those functions and structures is to have any genuine substance.

The relationships between logic, language, and reality are notoriously controversial among philosophers and linguists. This paper cannot begin to give an adequate account of the debate and of its philosophical and conceptual ramifications, but as an oversimplified approximation, the issues that will concern us here, have to do with the nature of propositions as, alternatively, empirical linguistic, or subjective entities, and, correspondingly, whether logic is more properly ssen as formalizing necessary relations in the empirical world, or analytic relations within natural language. What follows is a schematic survey of a few alternative positions, limited to highlighting the relevant contrasts. Thus, for example, Carnap (1951) and Katz (1972), on different grounds, put forth a view of logical relations as linguistic relations, and characterize logical truths in terms of linguistic structures, taking sentences rather than abstract propositions as primitives. Putnam (1971), on the other hand "finds something ridiculous in the theory that logic is about sentences" (ibid, p.6) and, in this article and others, defends a realist position with respect to the entities subsumed within logic (classes, properties, etc...), and, presumably, with respect to logical truths. Frege (1918/1956) similarly "assigns to logic the task of discovering the laws of truth, not of assertion or thought" (ibid p.289), thereby excluding both language and mind from the foundations of logic. Quine, on the other hand, argues against the distinction between analytic and synthetic truths (Quine, 1953) and, relatedly, sees logic as one part of a "whole interlocked scientific system", an integral part of any scientific prediction, and therefore ultimately revisable on the basis of empirical evidence (Quine, 1970); the close relations between logic and language are acknowledged but the foundations of logic are nonlinguistic (and, additionally, empirical). Interestingly, a somewhat analogous relationship between logic and other forms of knowledge, is present in Wittgenstein (1922/1961), despite the radical divergence of those two philosophers on most other matters: starting with the premise that the world is the totality of facts, the early Wittgenstein's thesis is that we picture facts to ourselves, that a picture is a model of reality, and has in common with it its pictorial form. A logical picture of reality is one which only has logical form in common with the reality it depicts; therefore, every picture is at the same time a logical picture. Thus, on this account logical relations do not have a status distinct from that of other modes of representing reality: they are grounded directly in the structure of events, as other modes of representation are, although they are more basic and of wider applicability.

Analogous questions arise with respect to logical cognition and will be discussed here. They articulate with the general context of the philosophical issues just mentioned in two ways. First, examining human logical cognition entails assumptions about the nature of logical knowledge. Second, examining logical development entails assumptions about the sources from which logical knowledge is derived.

Regarding the former question, the specific issue is whether logical knowledge primarily consists of knowledge about the structure of language or of knowledge about the structure of events in the empirical world. The psychological angle on this issue highlights considerations of a somewhat different kind than those of the philosopher. The concern is not so much about the foundations of logic but rather about the way in which logical knowledge articulates with the other components of an individual's knowledge structure. In an important sense, logical knowledge is knowledge about both language and the empirical world to the extent that language itself is semantically grounded in the empirical world to which parts of it refer. However, cognitively in terms of the organization of the mind - logical knowledge may or may not hinge on linguistic knowledge. Thus, for example, regardless of the fate of the philosophical debate about whether the notion of analytic truth is well-founded, (e.g. Quine, 1953; Putnam, 1962), one may ask whether, cognitively, people can discover new logical truths via linguistic structures exclusively - a cognitive analogue of the "analytic" situation. This question is seen most clearly when put in a developmental light, as will be done presently.

The second question raised previously concerned the epistemology and development of logical cognition. It will be assumed here that logical knowledge is derived constructively both from linguistic and nonlinguistic sources.

Regarding the linguistic foundation first, the assumption is that logical knowledge is derived both from awareness of the structure of language itself and from the correspondences between linguistically expressed propositions and empirical states of affairs, with the latter source of knowledge ensuring that the resulting logical system remains semantically sound and internally consistent (though not necessarily complete).

More specifically, the initial comprehension of "logical" relations is certainly semantically based and contextually restricted, as has been shown in the language development literature for other kinds of relations. However, it seems compelling to assume that further elaboration of these logical relations involves a process of abstraction from their initial content-bound meaning and an elaboration of their linguistic properties. The development of negation may be a paradigm example of this microdevelopmental process. Negation in the early stages of language development appears to signify disappearance or nonexistence, and it only subsequently emerges as a propositional operator in children of 2-3 years of age (Pea, 1980). However, by age 5 or 6, it seems hardly questionable that the logical properties of negation are mastered by the child at a fairly abstract level, in the sense that the child knows that if a statement p is true, its negation is false across a wide range of contents and presumably on inferential grounds. Thus, negation initially appears to refer directly to the events or objects themselves, and its meaning is grounded in direct verification of the presence or absence of these objects. Further developments, however, are of a more "syntactic" kind, though presumably retaining the initial meaning as their semantic foundation. With regard to this later development, it is useful to remember that logic and syntax as formal systems, have a highly similar status with respect to natural language. Although the details of the parallel, its limitations, and the resulting issues are beyond the scope of this paper, it is enough to note that the two systems are alternative formalizations of natural language and that both logic and syntax interface with semantics, in ways that are partly similar. If one recognizes this parallel, it is then natural to look at both syntactic and logical development as a process of gradual structuring of the linguistic environment. Furthermore, it is natural to speculate that, in a way somewhat similar to the way in which the child learns to structure her/his linguistic environment syntactically (presumably by exploiting the interconnections between the syntactic, semantic and contextual aspects of language) s(he) may also be assumed to structure the linguistic environment in terms of what statements can be legitimately derived from what other statements, and under what conditions. Thus, what is suggested here is a process of abstraction of logical forms from content specific instances embodying this form. If, in addition, as some have proposed, logical and grammatical structures are in close correspondence, the acquisition of grammar and of logical forms would proceed concurrently in part.

Turning now to the nonlinguistic sources of logical development, two positions are possible. Piaget takes the most radical option in locating the foundations of logical structures in the systems of actions of the child upon the world and in positing that logical relations are constructed by reflective abstraction on the properties of the world as apprehended by the child's actions (e.g. Piaget and Inhelder, 1969). This is a radically nonlinguistic account. A different account can be given, based on the notion that, except for the very initial period of cognitive development, the events in the world and the relationships between these events can be represented mentally in terms of propositions, so that e.g., valid patterns of inference can be abstracted from the structure of events in the world via propositional encoding. An example will help concretize this notion: in observing the functioning of an electrical circuit possessing implicative properties (turning on either one of two switches, S_1 or S_2, causes the same light to go on), a person may observe that, when the light is on, one does not know which switch has been used - a typical indeterminate conditional inference. Coming back to the earlier part of this discussion, if logic is seen as formalizing necessary relations in the empirical world, observations of the kind just sketched may provide a direct, (ostensibly) nonlinguistic foundation for such logical knowledge.

So far, abstraction of logical knowledge from linguistic and nonlinguistic sources, has been discussed in general terms. A mechanism implementing this conception will be outlined, extending notions discussed in Falmagne (1980), in which various modes of representation of linguistic and nonlinguistic information are assumed to be possible (the formal mode being one of them, and mental models as proposed by Johnson-Laird (1980) being another) and in which functional and developmental relationships between those modes of representation are described. This conception is somewhat parallel, in a mentalistic way, to the early Wittgensteinian notions discussed earlier, and the way in which perhaps logical forms are abstracted from the structure of mental models together with the operations carried out on them, will be discussed.

The preceding discussion should not be mistaken as reflecting an empiricist epistemology. It seems clear to me that a strictly empiricist account of logical development and a strictly rationalist account are equally untenable and, furthermore, intellectually unappealing. An assumption that seems more apt, both on empirical and philosophical grounds, is that natural logic is both constrained and made possible by fundamental properties of the mind - minimally by fundamental cognitive ways of processing experience. What should be invoked on the "constraint" side is far from being clear at this point. Some proposals whose relevance to the present issue needs to be examined or developed are notions of natural connectives, (Osherson, 1977) notions of conceptual naturalness, and, with some qualifications, some linguists' quest for linguistic universals.

On the "positive" side, regarding those properties of the mind that make natural logic possible, one of these basic cognitive functions is the human capacity for abstraction, which provides the mechanism for emergent discontinuities in modes of thinking and of processing language in the course of development or of learning (those discontinuities which radical empiricism is poorly equipped to account for). In the same way as this capacity permits the child to acquire a linguistic medium which stands in a symbolic relation to the referent world, and, later on, to undergo the formal structuring underlying advanced syntactic development, perhaps it permits for logical forms and logical truths themselves, to be abstracted from language (and nonlinguistic experience), as

has been proposed here. Thus, the program as I see it is to understand the interplay between learning mechanisms, and the cognitive constraints and possible a priori dispositions within which learning operates.

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