INFORMATION AND INFERENCE AS COMBINED COGNITIVE PROCESSES (*)

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Abstract:

The concept of *inference* is complex and slippery, specially when linked with that of *information processing.*Cognitively, inferences are a medium to access related categories and draw new categorizations. Inferences also facilitate comprehension of discourse. A key role of inferences is then to fill gaps in available information to complete meanings and contextual senses for the missing ones. So rational use of information rests on further implications of exclusive inferential resources. An inferential background for information search and processing is then postulated upon interacting dynamics between implicit and explicit inferences that may render unforeseeable determinants of innovation and creativity.

Information processing has been usually referred to as *"automatic processing", "cascade processing",* and *"conceptually data driven processing"*. Nevertheless, the inferential structures involved in information processing have not been sufficiently studied.

Firstly, in the case of *"automatic processing"* the issue has been defined as any mental operation occurring without the need for conscious initiation nor conscious control, in a way that many times have been recalled as preconscious or preattentive processes. And this is really the way they happen, however automatic processes are not simply random nor hazardous processes, actually they are inferentially pre-coded crystallized processes structured to work automatically. One well known automatic phenomenon is the "Stroop Effect" (first reported by J. Ridley Stroop in 1935) by which people are much slower to say "green" for the incongruent word RED in green ink than for the control stimulus XXX in green ink. The incongruity between the color of the meaning and the color of the writing ink of the word breaks or suspend the automaticity of the process for a while, causing a kind of retardation deserving analysis and explanation. Automatic processing seems to be a step-by-step process of in which necessary and sufficient inferences to thoroughly solving the problem were thought at one time and immediately encoded as algorithms in order not to be slowly thought about again but to be quickly unthinkingly acted. So, we consider automatic processing of data information as product of compacted inferences to be simply acted. Automatic processing is an inferentially expected process, that when incongruity appears it is because that something unexpected or not foreseen in the inferential sequence has appeared. The set of inferences made automated to reach this effect stands occult and compacted as an implicit inference behind this kind of information processing. Alternative interference and facilitation effects may occur since later studies demonstrated a small facilitation effect when ink color naming time was faster for congruent stimuli such as the word RED in red ink than for the XXX control word. This means that contrarily when the implicit inference is confirmed by data, the automatic processing is accelerated, thus showing a facilitation effect. This way, interference effect seems to correspond to implicit contradiction, and facilitation effect to implicit confirmation as behind inferential effects on the automated inference. This provides an alternative explanation to the problem of the intricate relationship between information and inference at this automatic level of information processing.

Secondly, in the case of *"cascade processing"*. This term refers to the notion that "later" stages of processing can be set into operation prior to the completion of processing of earlier stages (Mc Clelland, 1979, and Humphreys, 1991 in Blackwell Dictionary of Cognitive Psychology, Ed. Eysenck, Michael W. 1991). A complex task can be broken down into a number of distinct stages, which, put together, enable the complete task to be performed. In addition, many of these stages can be sequentially ordered, in the sense that "early" stages must begin before "later stages". Information processing models of cognitive performance typically assume that processing is based on a series of such component stages. A *discrete processing model* is one in which information is passed from one stage to another only after processing at the earlier stage is completed (Sternberg, 1969).

A system operating in cascade can be thought of as entertaining sets of hypotheses about stimuli, that are confirmed or disconfirmed as more stimulus information is gathered. The way in which different variables affect a system operating in cascade is considerably more complex than the way in which variables affect a discrete processing system. Cascade models of performance have gained in popularity since the advent of "connectionist" models of information processing, many of which operate in a cascade manner. Cascade operations are also important for the way in which such models can learn relations between stimuli and responses (Rumelhart, Hinton & Williams, 1986). Tests of whether human information processing is best conceptualized in terms of a discrete or a cascade processing model have to date produced mixed results.

Thirdly, in the case when comparing *"data driven processing"* to "*conceptually driven processing"* the connection between information and inference becomes more evident. The distinction between these two types of informational models refers to the corresponding flow of control in information processing. *Data driven processing* is a bottom-up information processing that is initiated, guided and determined by stimulus information coming in from the outside world and currently being received by the sense organs. *Conceptually driven processing* is a top-down information processing guided by information already stored in memory; that is, guided by the prior knowledge and concepts acquired from previous experience. The distinction between bottom-up and top-down processing comes from computer science (Norman & Rumelhart, 1975). Bottom-up processing is an informational sequence that starts with a low-level analysis of the sensory inputs coming from the physical features of external stimuli and ends by building upwards toward a final high-level interpretation or categorization. Top-down processing begins with higher level processes generating expectations and hypotheses from immediate interpretation and categorical evaluations of the sensorial input. Many cognitive activities, such as memory, perception, and language understanding, can involve both data-driven and concept-driven processing, but their role is different and controversial. Data-driven processing is the basic approach emphasized by Gibson's (1979) theory of direct perception, while top-down processing is the basic approach for constructivist or inferential theories of perception. For Gibson, dynamic changes in visual patterns, for example, provide enough stimulus information from environmental objects to be directly recognize in a way that is sufficiently rich to adopt proper actions and applications in reply. On the opposite side, the constructivist or inferencial approach see perception as a-priori influenced by expectations that derive from the perceiver's past experience as well as from the current context. Recognition is the product of inferences based on knowledge about how the world is organized, that works as a supplement of the sense data. The contribution of top-down processing varies with the availability of contextual information and with the quality of the stimulus information. Top-down processing offers short cuts so that a message can be understood without having to be completely analyzed.

Summarily, data-driven processes are characterized as parallel, automatic, effortless, unconscious, and relatively unaffected by capacity limitations; while concept-driven processing, by contrast, are characterized as serial, requiring conscious control, and drawing on limited capacity resources.

However, an intermediate approach between the two antagonistic above is represented by Neisser’s (1967) *analysis-by-synthesis model*, which incorporates both data-driven and conceptually driven processing working interactively and altogether. Within this view, the relative contribution of each type of processing is flexibly determined by the quality of the stimulus information and the availability of contextual information. In the analysis-by-synthesis model (Cohen, 1991, pg. 89) "the initial stage of data-driven analysis is followed by a stage in which an internal representation is synthesized. The synthesis is based on the information derived from the initial analysis together with conceptually driven hypotheses derived from prior knowledge. This representation is then matched against the input. If there is a match, the stimulus is recognized; if a mismatch occurs, the cycle is repeated and alternative representations are synthesized until a match is found". Interactive models of this general kind have been developed to account for language processing. Language understanding involves several levels of analysis, both low-level processes of physical analysis and higher level processes carrying out syntactic and semantic analysis. In speech and reading perception data-driven and concept-driven processes interact permanently.

A fourth example could be represented by the *chunking phenomenon*. The concept of *chunking* refers to the notion that some of the limitations of short-term memory can be overcome by grouping or chunking of information into larger units. This reconstruction process was forwarded by George Miller (1956) in his influential article entitled "The magical number seven, plus and minus two". Miller termed "chunk" each recoded pack of information, and proposed that the immediate memory span, measured in chunks, is relatively constant (for seven plus or minus two) for different types of material.

And a fifth example could rest on *categorization*, here the inference is a visible part of the process.

What is inference and what is creativity with respect to information and information processing.

An inference is made whenever a reasoner, either human or machine, goes beyond the evidence given by information. Inferences occur in every kind of understanding and reasoning processes. But inferences may be valid or not valid from a formal logical standpoint. However, inferences are mostly made in cases in which are only likely to be the case, rather than in cases in which are necessarily the case. Inferences usually allude to different relations to be stated between meaningful terms, but these relations can be stated in terms of formal and propositional logic, class and relation logic, set theory, modal expressions and heuristically.

From a logical standpoint basic inferences are deductive or inductive. A number of aspects of inferences are of interest to the psychologists: First, there is the question of how efficiently human beings draw conclusions which are licensed (or enabled) by the logic of a situation. Second, the same question can be asked of specified kinds of pragmatic reasoning, where the conclusion may be about the likelihood of something, rather than something necessarily being the case. But above all, and as Sanford (1991) states "inferences occur everywhere in perception, reasoning, understanding, and language comprehension. This raises the third and perhaps most important issue, that of what it is that controls and contains the inferences which one makes in a given situation, a particularly interesting issue, since in theory, most premises will allow an indeterminately large set of inferences to be made (Sanford, 1991, pp. 187)".

What is then creativity? "Creativity" refers to the ability to produce unusual, high-quality solutions to problems. It has often been argued that there are significant aspects of human intelligence which are not adequately assessed by intelligence tests. Guilford (1961), for example, drew a distinction between convergent thinking, which is required by most intelligence tests, and divergent thinking, which is not. However, creativity seems to be more firmly related to divergent rather than to convergent thinking. As Eysenck (1991, pp. 86) states it: "Convergent thinking refers to thinking of a deductive kind in which there is a single appropriate answer, whereas divergent thinking involves non-logical processes and novel situations in which there may be several relevant answers". "Divergent thinking, or the ability to think of diverse valuable alternatives to a novel situation, forms a major part of which is often known as creativity".

Creativity has been a notoriously evasive and difficult phenomenon to study in laboratory. Many test of divergent thinking or creativity are basically measuring originality rather than creativity. That is to say, they assess the tendency to produce unusual solutions to a problem, but do no evaluate satisfactorily the quality and usefulness of those solutions. This is a criterion conducive to think that a creative genius is the same as a mad man insofar as he does not deviate into a socially and culturally successful path of discovery and invention.

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