The automatic processing of some basic grammatical rule

Jr-Wen Jou.

To my father

Sushow,

and in memory of my mother

Yinfang (1909-1990)

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THE AUTOMATIC PROCESSING OF SOME BASIC GRAMMATICAL RULES

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Introduction

Automatic Processing of Language by the Native Speakers

Automaticity in cognitive or motor skills is a property which enables an individual to perform the cognitive or motor skills quickly, accurately, and with little or no conscious attention required. Automatic processing in different task paradigms demonstrates different properties and characteristics (Logan, 1985a, 1988; Jonides, Naveh-Benjamin, 1985; Palmer & Jonides, 1988). These properties have been studied and known in domains of simple tasks such as perceptual detection of a target, memory search (Schneider & Shiffrin, 1977; Palmer & Jonides, 1988), and lexical decision (Neely, 1977; Logan, 1988). Its nature has hardly been studied and is relatively unknown, however, in more complex and continuous tasks such as language processing in the form of reading and comprehending a complete sentence. As Logan (1985a) properly pointed out, "First, automaticity should be studied in a broader range of paradigms in order to capture the variety of ways in which it is important in skilled performance; and second, research on automaticity should take into account the continuous cyclical nature of many skills, which is largely neglected in the current literature." (Logan, 1985a, p.

380). Language as a stimulus is continuous and its elements are highly predictable. The automaticity in such tasks may not be exactly the same as in simpler and discrete tasks, and it is worth the effort to find out how they are similar and dissimilar to the simpler and more artificial tasks.

It is a widely accepted fact that, to a linguistically mature native speaker of a language, using the language as a tool of communication is an automatic process, which does not require conscious effort, can be performed at a very fast speed, and does not impose a noticeable cognitive load on the processing of the information transmitted through the language (Bock, 1982; LaBerge & Samuels, 1974; Dornic, 1979, 1980; Krashen, 1977; Anderson, 1983; Johnson-Laird, 1983; Logan, 1985a; Carr, 1981; Fodor, 1983, 1985). These qualities of language performance are consistent with the concept of automatic processing proposed by many investigators (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977; Shiffrin, Dumais, & Schneider, 1981; Schneider, Dumais, & Shiffrin, 1984; LaBerge & Samuels, 1974; LaBerge, 1981; Logan, 1978, 1979, 1980, 1985; Jonides, 1981; Jonides, Naveh-Benjamin, & Palmer, 1985; Hoffman, Nelson, & Houck, 1983; Hasher & Zacks, 1979; MacLeod & Dunbar, 1988; Lewicki, Czyzewska, & Hoffman, 1987), and with the concept of modular nature of language processing and perception in general proposed by Fodor

(1983, 1985), and supported by others (Katz, Boyce, Goldstein, & Lukatela, 1987; Forster, 1981).

Johnson-Laird (1983) thinks that a child learns the native language in a natural way (i.e., without formal instruction) and that after the initial mastery of the skill, he or she can perform the skill without the least idea of the principles governing his construction of sentences. He further pointed out that an important property of unconscious mental processing is that it is carried out in parallel with many other mental processes, including other unconscious and conscious processes. According to Johnson-Laird, the lower the level of the processes, the more likely that they are inaccessible to conscious introspection. For instance, one can never consciously describe how he or she controls and manipulates one's muscles in the vocal tract when talking, but one knows very well what it is that he or she wants to talk about. Such unconscious mental processes, according to Johnson-Laird, can make the processing system operate more rapidly and efficiently by making possible many parallel processes to go on simultaneously.

Anderson (1983) called such an operation a proceduralized process based on procedural memory, as opposed to a slow conscious process based on declarative memory, which characterizes newly learned performance. He

equates automatization with a process by which a declarative knowledge has evolved into a procedural knowledge by the repeated activation of the long term memory (LTM) nodes involved. When such memory nodes have reached some threshold of strength, the operation no longer has to be carried out in conscious working memory. Rather, it is performed in the LTM itself. To Anderson, language use is mainly a proceduralized process. He also called the process of automatization compilation in the sense that a computer program can be compiled into low level machine language and be executed more quickly and readily, but that the compiled program is no longer accessible to meaningful interpretation or examination.

Fodor (1983) basically proposed the same view about language processing. The process which Johnson-Laird referred to as lower parallel processes inaccessible to consciousness, and Anderson referred to as proceduralized memory, is actually the same as Fodor's modular systems. And the higher level mental activity or the declarative memory is the equivalent to what Fodor called the central processes, as opposed to modular systems. Fodor (1983, 1985) argued that the processing of syntax and meaning of words is modular, which, according to him, means it is fast, mandatory, and opaque to introspection. Sternberg (1985), in commenting on Fodor's modularity concept,

suggested that the modularity was a result of overlearning and was essentially the same as automaticity. In reply, Fodor pointed out that an automatized central process such as solving a physics problem by a physicist is not the same as a modular process such as perceiving a phone. But he conceded that it is sometimes difficult to distinguish an inherently modular system from an automatized central process. However, he argued that perceiving language is different from the automatic solving of complex problems such as the physicist solving a physics problem. According to Fodor, one always processes a language in modular fashion, but a physicist can switch to a central processing mode (which is actually controlled processing) when he or she encounters a novel physics problem. In the present study, no attempt will be made to distinguish automaticity from modularity, and these two terms will be used interchangeably in the remainder of the paper.

Theories and Issues of Automaticity of Cognitive Processes

Many theories have been proposed to explain the nature and the mechanisms of automaticity. Some authors explain the phenomenon from the perspective of memory change (Anderson, 1983; Schneider & Shiffrin, 1977; Schneider & Fisk, 1984). Automaticity, according to them, is basically either the development of a process to directly access LTM,

or the lowering of activation thresholds (i.e., increasing the activation strength of these nodes). Other theorists base the explanation on the intervening construct of resources (Wickens, 1980; 1984a; Kahneman, 1973). From this point of view, automatization is a change in performance resource function (Wickens, 1984a), meaning that automatization is the diminishing demands by a performance for the underlying resources as training continues.

A different version of this view suggests that there are multiple types of resources (Wickens, 1980; Hirst & Kalmar, 1987). If two performances do not draw on the same type of resources, they can be concurrently performed effectively. A fourth position is a structural view. Under this view, as long as the performances are carried out in segregated subsystems of mental or cognitive structures, they can operate easily (For a summary, see Wickens, 1984a; Hirst, 1986). Such a structural view would imply that when automaticity takes place, there is some structural change in the system.

A fifth position holds that when automaticity develops, the control of the processing is transferred from a central general level to a specialized local level, or a local subsystem (see Wickens, 1984a for a summary; Hoffman, Nelson, & Houck, 1983) so that the performance no longer competes for the general central processing resources. This

view of automatic processing is in essence the same as Fodor's modular processing. The modular process is encapsulated (i.e., inaccessible to central cognitive processes), local or domain-specific, rapid, and mandatory. As it is encapsulated, it is not influenced by the goals, expectations, strategies, and contexts of a task. In contrast to such fast, unconscious modularized processes is the central process which operates slowly and consciously, and is fully under the control of one's free will and intention. Since the modular processes are not accessible to the central processes, they do not interfere with the higher conscious mental processes.

Lastly, Logan (1988) proposed that the development of automaticity is the change of the processor's knowledge base from an algorithm-based procedure of achieving a task goal to a direct memory retrieval of the solution. In essence, this proposed procedure is somewhat the same as Anderson's proceduralization process.

According to some investigators (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977; Schneider, Dumais, & Shiffrin, 1984), automatic processing and controlled processing are two qualitatively different processes. These two processes can be described by pairs of polar adjectives. For example, automatic processing is fast, parallel, effortless, work load independent, attention

free, involuntary or rigid, and immune to interference. In contrast, controlled processing is slow, serial, effortful, work load dependent, attention demanding, voluntarily controllable, and susceptible to interference. Such a concept of automatic processing vs. controlled processing has often been interpreted as indicating that these two modes of information processing are dichotomous mental states (Logan, 1985).

Recently, however, this dichotomous view of automaticity has been questioned (Cheng, 1985; Logan, 1985a; Kahneman & Treisman, 1984; Logan & Cowan, 1984; Ryan, 1983; Zbrodoff & Logan, 1986; MacLeod & Dunbar, 1988). In place of the two mutually exclusive states, a continuum or gradedness notion of automaticity is proposed (Logan, 1985a; Kahneman & Treisman, 1984; MacLeod & Dunbar, 1988; Gardner, 1985), in which the two kinds of states described by the binary adjectives are conceptualized as two extremes on the continuum. According to this view, automaticity is a property that can be quantified by infinite gradations (Logan, 1985a). Or, at least it can be differentiated into three orders, strongly automatic, partially automatic, and occasionally automatic (Kahneman & Treisman, 1984). These authors indicated that the dichotomous characteristics enumerated above are not truly dichotomous. For instance, as Logan (1985a) indicated, many

operations considered automatic are rarely attention-free, and load-independent. Attention-free or load-independence is an ideal situation that in actuality is hardly ever achieved.

Despite these questions raised about the theory, Schneider and Shiffrin (1977; Shiffrin & Schneider, 1977, 1985; Shiffrin & Schneider, 1984) argue that the concept of a qualitative distinction between two different types of information processing is a very useful one and accounts parsimoniously for a wide variety of data from many diverse sources of perceptual, memory, and cognitive domains. Without such a theoretical framework, these data would have required many different specific, ad hoc, and unrelated theories to explain.

They also argue that a skill is usually a combination of many subskills or components, and that some of the components may have been automatized while others are still in the controlled processing stages, hence the lack of dichotomy sometimes observed in the performance of a complex skill. The same view was held by other researchers in the area (LaBerge & Samuels, 1974; Jonides et al, 1985; Palmer & Jonides, 1988).

Recently, Schneider (1985) has proposed a four-stage model of the development of automatization through which a skill evolves from a completely controlled phase to a

completely automatic phase. These four stages are (a) controlled processing with memory preload (preloading the working memory with the semantic categories and stimulus-response mapping used in Schneider's semantic categorization tasks) (b) controlled and automatic processing (c) automatic processing with controlled assist and (d) automatic processing. This view of automaticity development seems to be able to accommodate the intermediate stages of skill development before a completely automatic level of performance is attained.

Another issue related to the continuum vs. dichotomy of processing is the question of internal consistency of the concept of automaticity (Logan, 1985a). In other words, for a mental operation to be defined as automatic, does it have to possess all the phenomena of automaticity such as those enumerated earlier? According to Logan (1985a, 1988), if automaticity is viewed as a continuum, there will be no such problem. Automaticity at a lower level will possess fewer of these phenomena than does one at a more advanced level. Logan indicated, for example, that the Stroop-type effect (inability to ignore the irrelevant stimulus dimension whose processing has been highly practiced and routinized) can be observed at an earlier stage of automatization, whereas diminishing of task-load effect can only be approximated after an infinite number of practices.

And since this ideal state is rarely attained in reality, further improvement and learning can continue without limit (Logan, 1985a, 1988).

Currently, a review (Logan, 1988; Palmer & Jonides, 1988) of the literature on the issue of the definition of automaticity has reached the following conclusions. There are no necessary and sufficient properties that define the phenomenon of automaticity. Different researchers used different lists of properties and disagreed on the necessity and sufficiency of the properties they listed. Logan (1988) indicated that the set of mechanisms that are possible in human cognitive systems is probably unbounded, and that no single property or set of properties can be common to all human mental activities. Similarly, Jonides et al (1985) suggested that a different model of automaticity should be formulated for different cognitive tasks because the structure of each task is often unique. This is perhaps why studying overpracticed human performance in different domains is very important. Only by so doing can we understand what the common, and what the unique mechanisms are across various domains and types of cognitive skills and activities.

As far as language processing is concerned, it would be interesting to find out to what extent a group of native speakers' processing of some language rules is automatized