

## **The process of language comprehension; an approach to examining issues in cognition and language**

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The fundamental concerns of the field of cognitive psychology—understanding the nature of the mental representation of information and the processes which operate on those representations—have received their most extensive examination in the past decade in the field of psycholinguistics. The reasons for this are obvious: language is a relatively accessible domain for study, and the systematic classification and observation brought by linguistics and philosophy to language provided a major initial stepping stone for the investigation of the psychological functions underlying human language production and comprehension. And, while there has been much growth in a number of other fields in the area of cognition, the now-expanded domain of psycholinguistics still represents one of the most promising and profitable areas for examining cognitive function. It appears likely that major breakthroughs in understanding the extent of (and constraints on) our ability to perceive, process, store, recall and comprehend information will come from gaining a detailed empirical understanding of the nature of language processing.

It is particularly important in this regard to underscore the point that language, like other cognitive functions, is a (dynamic) *process*. It is, in fact, precisely because it is a process that gaining an understanding of its nature has proved so intractable over the years; such an enterprise requires that we rely on more than just an examination of the end-state characteristics of the process (such as memory representations) or static models of its putative underlying structure. Rather, if we are to achieve any substantive understanding of language performance it is necessary that we examine the micro-structure of the entire process as it occurs in real time. It is only through the careful examination of the temporal course of mental operations involved in the various levels of analysis underlying speech that we can hope to discover its nature.

There are a number of critical questions underlying the examination of language as a process which must be answered in the coming years. The first, and in one sense most fundamental, concerns the basic nature of the integra-

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tion of information that occurs during the perceptual processing (or production) of language. This issue has evolved in the past few years into a hotly contested one, one that contrasts hypotheses that, on the one hand, view language processing as a maximally interactive system (in which any type of contextual information can affect the nature of processing of any other piece of information) and, on the other hand, view the system as a highly modular one comprised of autonomous subroutines (so that contextual information does not affect processing internal to any particular subroutine). Resolution of the issue of whether the system in general is a modular or an interactive one is perhaps the most important key to establishing a viable psychological model of perceptual processing. Certainly, it is clear that a system which supports the nearly infinite variability in processing that is inherent in any maximally interactive model requires a significantly more powerful underlying mechanism than one which consists of relatively autonomous, context free, internally consistent routines. Failure to provide clear definition of the nature of information integration almost guarantees that we will posit either far too powerful or far too weak an underlying mechanism as the basis for language behavior, a failure which may well be a critical one in our attempts to understand the process.

However, in addition to being important in and of itself, part of the importance of focusing on the nature of information integration is that it highlights several other key problems that must be faced in discovering the nature of language processing. One set of these issues concerns the nature of the informational types themselves. We do not have an account of the distinct types of information that are actually functional in speech processing. While systematic observation in linguistics has allowed for the characterization of a number of sources of information in language-phonetic, morphemic, syntactic, etc.-such descriptions are based on the rules and constraints of linguistic description and have yet to be shown to have anything but an indirect relationship to the types of information which are functional in the ongoing process of language comprehension. The development of the psychologically relevant characterization of the functional sources of information in language processing is a critical goal for psycholinguistics, and it is important to note that it is a problem that can only be resolved by empirical study.

A further, related, issue stems from the fact that the characterizations we give to both whatever relevant informational types exist and to the procedures by which these functions are intimately tied to assumptions we make about the techniques by which we examine these processes. There is simply no passive window which allows examination of mental processes without affecting those processes to some extent. Thus, it is absolutely essential at

this time that we begin to consider the modeling of our empirical tasks as being a critically important part of our attempt to model mental representations. It is encouraging to note that, from time to time, various experimental techniques have undergone critical examination (witness the study of phoneme monitoring over the past nine years). However, far too little is known of even the most basic characteristics of those tasks which have attracted such attention, not to mention those that have been ignored in this respect.

There are at least two corollary issues that are of importance here. The first relates to the critical need for discovering, testing, and using new experimental techniques. Given that the problems we face are to be best resolved by empirical *examination* of the real-time characteristics of language processing, we are in need of experimental techniques which are sufficiently flexible to examine such processing on-line and, simultaneously, which are as non-intrusive into the process under study as possible. Further, we are in great need of tasks which are differentially sensitive to various levels of analysis in language processing. It is important that *examination* of mental processes be seen to be a multi-leveled enterprise. We need to discover the nature of each of the several putative levels of processing as they occur (either serially or in parallel) during the on-going perceptual analysis of language; the relative speed, interactivity, and scope of each of these processes must be detailed. Thus, the relative temporal course of processing, the accumulation of detail, and the rate of integration of each process into the developing interpretation needs to be documented for (for example) phonetic, lexical and syntactic information during comprehension. To do this, it will be necessary to develop batteries of 'on-line' tasks, each of which has *known* properties that reflect different aspects of the process under study.

The second corollary issue concerns the need for determining the relationship that holds between conscious and unconscious processing and automaticity of processing. There is not sufficient space here to even begin to detail the degree to which these interrelated issues are critical to the enterprise of understanding language processing. However, because language is a highly overlearned, automatized system, until we understand the consequences of that fact and the way in which it affects our ability to interrupt, examine, introspect upon, have intuitions about, and manipulate language, we will have little idea of the true information contained in the data that we are gathering. Similarly, until we understand the cognitive operations underlying the ability to bring the results of *unconscious* processing (the level of most of language processing) to consciousness we will not have adequate knowledge of how our experimental tasks may be changing the basic operation of the language processing system. Further, gaining an understanding of consciousness and automaticity will provide a basis for examining the nature

of the relationship between putative language processes and more generalized, domain-universal, cognitive functions. The distinction between such processes is clearly a critical one in our development of cognitive processing theories.

### **Specific approaches**

The immediate goal of much of our work over the past six years has been to discover the nature of the processes that underlie language comprehension through the careful examination of the information available throughout the course of sentence/discourse understanding. We have taken the major testing ground for examination of this general theoretical issue to be the domain of lexical processing. This choice has been made for a number of reasons. First, words are likely candidates for being truly functional sources of information during language processing; word recognition is acknowledged to play a role in nearly every psychological account of language, just as words are taken to be important structures in most linguistic accounts. In addition, lexical representation and processing are commonly considered to be (the) major points of intersection of acoustic-phonetic, syntactic, semantic and discourse information in language. Thus it is a logical realm in which to examine the general nature of information interaction, the (relative) temporal characteristics of language processing, and theoretical issues of automaticity, unconscious inference, and the relationship of linguistic and psychological modeling.

An important phase of our work has involved the examination of the maximally interactive and autonomous module hypotheses of information integration as they apply to the access and processing of lexical material. We have studied the effects of a large range of 'higher order' contextual information sources (from local lexical semantic and structural relationships to more global sentential and discourse effects) upon the access and integration of lexical material in ongoing sentence/discourse comprehension.

In pursuit of this work, we have developed a relatively sensitive, non-intrusive, flexible, measure of the unconscious access of lexical information -the cross modal lexical priming task. The work using this task has been illuminating in many regards. We have, throughout a number of studies, found strong support for the hypothesis that (at least) lexical access is an autonomous, form-driven process, one that operates without regard to biasing input from higher order contextual information (e.g., Swinney, 1979; Swinney, Onifer, Prather, and Hirshkowitz, 1979; Onifer and Swinney, 1981; Swinney 1981a; 1981b). Through the examination of the temporal course of activation of lexical material we have also learned much about the nature of the post-access effects of frequency-of-meaning, type of contextual information, and speed of processing upon the choice of a relevant interpretation for

a word from among all of the information that is initially accessed. Some information about the roles that automaticity and consciousness play in the context-independent process of access and in the contextually incorporative post-access decision process have also begun to be determined through -the use of cross modal priming and other on-line procedures (Swinney, 1981b).

Some of the most exciting evidence, however, has come from our examination of these real-time processing issues in populations which have specific language disorders, disorders which provide theoretically dissociative test cases for study of the issues raised above, and in immature populations, populations in which the highly automatized routines which exist in adult language processors have yet to develop. The study of the on-line processing of words, structures, and suprasegmental information in young children and in populations with aphasics, schizophrenia, and dyslexics are providing critical diagnostic evidence for the validity of the modular (autonomy) theory of language processing as well as providing critical evidence about the primacy of certain types of these operations and about the nature of the automatization of such routines in language (see, e.g., Swinney, Zurif and Cutler, 1980; Swinney, 1981b). Work involving such a multidisciplinary approach seems to us to be absolutely necessary for the development of a firm understanding of mental operations, if only because it is often just in the *absence* of overlearned routines and fully functional systems that some of the micro-structure of mental events become apparent.

An additional, and we think important, focus for much of our recent effort has been in the relatively neglected area of non-literal language processing. While it is understandable that much of the early work in language focused solely on the processing of literal material, it is equally clear that an extremely large amount of the language that we deal with is non literal: idioms, similies, metaphors, and the like.. Our major efforts in the past two years have been on attempting to understand the on-line processing characteristics of nonliteral as well as literal processing-to determine whether the processor attempts such interpretations (particularly where multiple interpretations are possible) by use of a canonical order hypothesis, by reliance on surface cues, or by some other means. The evidence thus far (see, e.g., Swinney and Cutler, 1979) both supports the modular theory of perceptual information integration and adds much evidence to our general understanding of the role of learning in language perception.

Finally, much of our recent efforts have been aimed toward the examination of the underlying properties of semantic and syntactic priming, both in discourse contexts and in isolation. The results have suggested that much of what has been assumed to be an `automatic' spread of facilitation in priming may in fact be the result of a relatively elaborate decision process. Recent

work with Penny Prather has extended these findings into both the area of speech perception and the domain of visual processing, in an attempt to discover the degree to which much of the evidence supporting a processor comprised of independent subsystems applies to other domains of cognitive processing.

In all, the approach that we have taken in examining many of the questions raised above—the nature of information interaction, the types of information that are functionally available in processing, the temporal course of conscious and unconscious processes, and (overall) the nature of the representations involved in the perceptual analysis of language—has obviously merely scratched the surface of the complexity of both theory and fact that must be developed to provide a sufficient characterization of the cognitive system. However, we have found it particularly instructive to examine the form of the evidence that has emerged from an extensive examination of one small portion of the language system—lexical processing. Particularly because this evidence is in such agreement with that obtained from our broader, multidisciplinary examinations of language processing, we take it to be likely that it is representative of the nature of cognitive processing in general. Independent of the validity of this interpretation, it is important to re-emphasize that the issues are largely empirical ones, and thus we can look forward to their resolution through the development of well reasoned experimental evidence in the coming years.

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