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AUTHOR Goodluck, Helen
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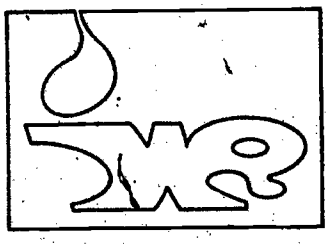
ABSTRACT

A study investigated the hypothesis that, for adult native speakers of English, increasing syntactic complexity would lead to increased salience of phonological properties of words. The study also examined whether syntactic simplicity would lead to a greater salience of semantic properties of words. Subjects were required to name a word presented on a monitor after a context sentence. Syntactic complexity of the context sentence was varied. The target word was phonologically or semantically related or unrelated to the last word in the sentence. The time interval between the end of the context sentence and the word to be named was also varied. Resulting data provided no support for the hypothesis. However, trends in the data suggested that there is some interplay between lexical accessing and syntactic processing. There was a tendency for frequency of the target word to correlate with naming time in complex syntax conditions (less frequent words were named more slowly), and there was also some indication that salience of activated words was maintained under conditions of syntactic complexity as time for sentence processing (the context sentence--naming word interval) was increased. (FL)



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by Helen Goodluck

April 1983

Wisconsin Center for Education Research
an institute for the study of diversity in schooling

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by

Helen Goodluck

Report from the Program on
Student Diversity in Learning and Development

Wisconsin Center for Education Research
The University of Wisconsin
Madison, Wisconsin

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Abstract

We investigated the hypothesis that for adult native-speakers increasing syntactic complexity would lead to increased salience of phonological properties of words; we also investigated whether syntactic simplicity would lead to a greater salience of semantic properties of words. Such effects would be consistent with a picture of lexical development in which the primacy of phonological properties observed in some studies of child- and adult-language learners resulted from failure to analyze the input in depth. In this study, adult native-speaker subjects were required to name a word presented after a context sentence. Syntactic complexity of the context sentence was varied; the word to be named was phonologically or semantically related or unrelated to the last word in the sentence. The time interval between the end of the context sentence and the word to be named was also varied (Ø, 50, and 200 msecs). Our data provides no support for the specific hypothesis that complex syntax leads to increased salience of phonological properties of words. However, trends in the data suggest that there is some interplay between lexical accessing and syntactic processing. There is a tendency for frequency of the word to be named to correlate with naming time in complex syntax conditions (less frequent words are named more slowly), and there is also some indication that salience of activated words is maintained under conditions of syntactic complexity as time for sentence processing (the context sentence--naming word interval) is increased. We suggest that these trends can be integrated into a processing model that contains autonomous subunits for syntactic processing and lexical access if time-sharing of processing energy between the components is permitted and there is reaccessing of words used in later stages of processing.

Introduction

This report summarizes experimental work done since May 1982 on the relation between syntactic complexity and lexical processing. Our aim was to test the hypothesis that for adults increasing syntactic complexity will lead to increased salience of phonological properties of words in the input; we also investigated whether syntactic simplicity would lead to a greater salience of semantic properties of the input. These hypotheses were formed in a general framework in which phonological properties of words are assumed to form part of the working units only in early stages of processing; syntactic complexity was hypothesized to lead to a lengthening of time needed to complete early processing and hence to relative saliency of phonological processes. A demonstration of increased salience of phonological properties under conditions of syntactic complexity would be consistent with an interpretation of phonological primacy effects in child and adult language learning studies that attributes such effects to the learner's failure to process the input in depth. Our experimental work provides no support for the specific hypothesis that complex syntax leads to primacy of phonological properties. However, trends in the data suggest that there is interplay between lexical accessing and syntactic processing, with syntactic complexity bleeding processing time from lexical accessing and also maintaining the salience of activated words as processing progresses. The first sections of the report describe the experiments and suggest ways in which the trends we observe can be fitted into an overall picture of processing. The final section briefly

discusses the potential relation between adult studies of lexical processing and the study of lexical development in the course of language learning.

Experiments

Materials

Two sets of experimental materials were developed. Two levels of syntactic complexity were present in each set, as follows:

SET 1: ACT/PASS. In these materials the syntactic complexity variable was active vs. passive sentence structure in the matrix clause of two-clause sentences. A number of experiments have shown passive to contribute to complexity in sentence processing (see, for example, Forster and Olbrei, 1973). Examples of the stimulus sentences from this set are given in Table 1.

SET 2: ACT/PASS-WH. In these materials, both passive and wh-movement (question-formation) were applied in the second clause of three-clause sentences to produce the complex sentence counterparts of active, non-wh-moved sentences. Question-formation, like passive, has been shown to contribute to sentence complexity (see, for example, studies reviewed in Fodor, Bever and Garrett, 1974, Cht 5). Table 1 gives examples of the stimulus sentences.

The last word in each easy/complex stimulus pair in both sets was matched with a word triple consisting of a phonologically related word (rhyme), a semantically related word (an antonym or near antonym), and a neutral (unrelated) word. See Table 1 for the triples used for the example sentences given there. Eighteen items (sentence plus semantic--rhyme--neutral triple) were constructed for each materials set.

Table 1

Examples

		Rhyme	Antonym	Neutral
Set I--two-clause sentences				
ACT	The troupe of ballet dancers expected the stage to be round	sound	square	cost
PASS	The stage was expected by the ballet dancers to be round			
Set II--three-clause sentences				
ACT	The maid learned that the housewife expected the bedroom to be clean	clean	dirty	stick
PASS-WH	The maid learned which bedroom was expected by the housewife to be clean			

Procedure and Subjects

The stimulus sentences were presented visually on a monitor screen in upper case letters using a rapid serial visual presentation (RSVP) technique at a rate of one word per 200 msecs. (I.e., sentences were presented one word at a time, each word remaining on the screen for 200 msecs.) Each word appeared in the same spot, approximately in the middle of the screen. Following the last word in each sentence a mask (a word-length series of Xs) was placed over the word position. One of the members of the rhyme-antonym-neutral triple was then presented in a spot one inch below the mask. The subjects' task was to name (say aloud) the word presented below the mask. The dependent variable was reaction time (RT) for naming. Responses stopped a msec timer started at the appearance of the word to be named. Subjects were tested in each of three stimulus-lag conditions: presentation of the word to be named simultaneously with the mask (Ø msec lag) and presentation of the word to be named 50 msecs and 200 msecs after the presentation of the mask. Each subject responded to all naming and syntactic conditions for the two materials sets, the only between-subjects variables being time-lag and version of the materials (the latter being necessary to prevent a subject from responding to the same word twice). Rotation of complex-easy conditions and naming word types led to each subject responding to three tokens within each subcondition (e.g., complex-rhyme, easy-rhyme, complex neutral, etc.) within each materials set. Each subject thus responded to 36 experimental sentences; 52 filler sentences using a variety of sentence structures and naming words unrelated to the preceding sentence were included in the experimental battery. Experimental sentence types were blocked and pseudo-randomly

ordered within the blocks. There were three fixed learning trials. There was a two-second interval between each trial. Each trial was preceded by the word READY placed on the screen in the place in which the stimulus sentences were presented. Subjects were instructed that they were to pay attention to the meaning of the sentences they saw, and that they would be questioned about the meaning in some cases. The sequence of presentation was stopped after six of the filler trials, and the subject was asked a question about the content of the sentence. Twenty-four subjects were tested in each time-lag condition.

Predictions

We anticipated that RTs would be overall longer in the complex syntax conditions relative to their easy counterparts in each set. We were concerned primarily to see whether RTs for words phonologically related to the last word in the sentence would be shorter in the complex syntax conditions (relative to the easy syntax conditions), indicating that any activation of the naming word that followed from prior presentation of a related (rhyming) word in the preceding sentence was increased and/or sustained when syntactic complexity mandated the processor's holding on to the last word in the sentence for a relatively long period. Activation of words due to prior presentation of a related word is generally referred to as priming and frequently leads to shortened RTs in naming and lexical-decision experiments. Concomitantly, we were interested to see if easy syntax would lead to sustained or increased priming (shortened RTs) for semantically related naming words; this would be consistent with

the view that as sentence processing progresses the phonological form of the word is dropped but its semantic representation maintained. If such were the case, a semantic priming word (sentence final word semantically related to the word to be named) might have a greater effect where the syntax is easier and semantic processing has consequently progressed further.

Results

Table 2 gives the overall mean RTs.[1] RTs are in the 600 msec range. This is comparable to RTs in other experiments testing for priming effects in the literature, but markedly shorter than RTs in the trials we carried out earlier, where we found RTs in the 900-1000 msec range. Differences in speed of sentence presentation (200 msecs per word for the experiment reported here vs. 300 msecs per word for the earlier trials) and/or the use of a post-sentential mask may account for this.

As inspection of the means in Table 2 indicates that our expectations concerning the effects of syntactic complexity and the relation between complexity and priming were not supported. There is no substantial or consistent increase in RTs in the complex syntax conditions as opposed to their easy counterparts. Nor is there a consistent trend towards shortened RTs for rhyme words in complex syntax conditions or towards shortened RTs for antonyms in the easy syntax conditions.

Should we conclude, then, that as far as the evidence goes the recognition (and hence naming) of words is a process that is not affected by

[1] 213 of a possible 2592 data points (8.2%) are missing through equipment failure or experimenter error, or were excluded either because the RT was shorter than 300 msecs or longer than 1000 msecs, or because the subject said the wrong word.

Table 2

Mean RTs X Condition

Syntax Condition	Named Word: Rhyme	Named Word: Antonym	Named Word: Neutral	Mean
	Ø Msecs Lag			
Set 1--ACT	646	615	675	/645
Set 1--PASS	667	615	669	/650
Mean	/656	/615	/672	
Set 2--ACT	681	655	668	/668
Set 2--PASS-WH	678	619	663	/653
Mean	/679.5	/637	/665.5	
	50 Msecs Lag			
Set 1--ACT	685	657	682	/675
Set 1--PASS	705	655	687	/682
Mean	/695	/656	/684.5	
Set 2--ACT	683	677	677	/679
Set 2--PASS-WH	699	681	706	/695
Mean	/691	/679	/691.5	
	200 Msecs Lag			
Set 1--ACT	655	612	635	/634
Set 1--PASS	644	607	642	/631
Mean	/649.5	/609.5	/639.5	
Set 2--ACT	651	620	662	/638
Set 2--PASS-WH	637	634	649	/640
Mean	/644	/627	/650.5	

the syntactic context in which the word is presented? Such a position seems on the face of it to be compatible with our data and has been put forward in the past by Swinney et al. (1979). In a cross-modal lexical-decision task, Swinney found that the ability to make a lexical decision (determine if a visually presented letter sequence was a word or not) was affected (facilitated) by the presence of a related word in the preceding (aurally presented) syntactic context. However, the presence or absence of a (relative) clause boundary between the context word and the decision word did not affect stimulus naming times, although clause boundaries have been found to be significant processing units in a variety of experiments (see Fodor, Bever and Garrett, 1974, Cht 6 for a review). This absence of an effect of clause boundary led Swinney to claim that lexical recognition is not affected by syntactic context.

Some trends in the data from this study suggest, however, that lexical recognition is not totally independent of syntax. Naming times appear to be differentially sensitive to frequency of the word to be named depending on the complexity of the syntactic context. In addition, there is some evidence of priming, and the priming that does occur is dependent on syntactic complexity differentially across the three time lags.

Frequency. The first indication that syntax does affect naming times comes from an analysis of the effect of word frequency on naming times. Constraints placed on the naming triples (rhyme--antonym--neutral), particularly that each word be a monosyllable[2] and that the rhymes be orthographically matched with the context word (last word in the sentence) pre-

[2]There were 6 bisyllables among the antonyms.

cluded exact matching for word frequency. The antonyms were overall more frequent in terms of Kucera-Francis (1967) frequency rankings, and the rhymes overall least frequent. Neutrals were intermediate in frequency between opposites and rhymes.[3]

An analysis of the RT data for all word types in all three stimulus-lag conditions pooled showed a weak negative correlation between frequency and RT for complex syntax for Set 1 materials and for both complex and easy syntax for Set 2 materials. (Since low Kucera-Francis values indicate low frequency, a negative frequency/RT correlation simply indicates that less frequent words are being named more slowly.) For both Set 1 and Set 2, the correlation was higher in the complex syntax condition (Set 1: Complex syntax, $r = -.177$, $p = .024$; Easy syntax, $r = .065$, $p = .441$. Set 2: Complex syntax, $r = -.255$, $p = .001$; Easy syntax, $r = -.123$, $p = .122$). It is not surprising that less frequent words should lead to longer RTs, since frequency has long been known to affect RTs in lexical tasks, although demonstrations of frequency effects have involved words of lesser frequency than those in our materials (cf. for example, Foss, 1969). What is of interest is that an effect of frequency seems to

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[3]The mean Kucera-Francis frequency and range for the triples for each materials set is:

		$\bar{x}$ frequency	range
SET 1	Rhyme	70	11-413
	Antonym	234 (157)*	10-897 (497)*
	Neutral	150	11-426
SET 2	Rhyme	79	7-312
	Antonym	182 (153)**	21-679 (366)**
	Neutral	126	14-329

*Mean/highest frequency if the top 2 items are removed.
**Mean/highest frequency if the top item is removed.
Ranges are similar to those used in Warren (1977).

take hold only where the naming word is preceded by a complex syntactic context. In some sense, then, lexical accessing and syntax are not totally independent (an explanation of this is suggested below).

An analysis of frequency and RT correlations for the materials broken down by time lag and naming word type (rhyme--antonym--neutral) showed (i) the Ø msec interval to show least effect of frequency and (ii) consistently higher negative correlations or negative as opposed to positive correlations for the complex vs. easy subconditions, with the exception of (a) the Ø msec condition for Set 1, where there are trends in the opposite direction (longer RTs for less frequent words in the easy syntax condition--cf. complex syntax, $r = -.037$; easy syntax, $r = -.213$, for all word types combined (differences in the same direction hold for the three naming-word types) and (b) a higher negative correlation for easy than for complex syntax for rhymes at the 50 msec interval in Set 2 ($r = -.477$ (easy) vs. $r = -.198$ (complex)). These breakdowns are given in the Appendix.

That the overall effect of frequency should be weak is not surprising, since the materials were constructed to avoid both infrequent words and (with one or two exceptions among the antonyms, see fn. 3) words of very high frequency.

Priming. The presence of frequency effects together with the asymmetry in frequency means for the rhyme--antonym--neutral word types argues that any distinction in naming times for these word groups should be treated cautiously. What follows is some observations based on an inspection of overall means and individual subject means. The two materials sets will be treated separately, for the reason that they differ in the stability of the RT patterns when a frequency-controlled subset of the data is inspected.

Set 1. Figure 1 shows the msec difference between naming times for rhymes and neutrals and for opposites and neutrals. A plus value indicates relatedness leads to facilitation (priming). Figure 2 shows the differences for one-third of the data, consisting of RTs for six triples, each of which was matched within 15 Kucera-Francis frequency points. (The mean frequency for the 18 words in these 6 triples was 27.5 and the range was 10-63.) The figures for the frequency matched triples show an overall pattern similar to that for the figures for all 18 triples, suggesting that differences observed in the data for the word types across the time lags are not solely a function of frequency (as, for example, might be the case for RTs in which antonyms are faster than neutrals, since the former word group is overall more frequent).

The patterns for both antonyms and rhymes across the time lags suggests an immediate-access priming effect at Ø msecs that drops off at 50 msecs, followed by some reactivation (increase in priming) at 200 msecs. (What exactly this "immediate access" effect represents will be returned to below.) For both rhymes and antonyms, at Ø msecs easy syntax appears to speed naming relative to neutrals more than hard syntax does. At 50 msecs, this remains the case for rhymes, but for antonyms hard syntax speeds naming more than easy syntax. At 200 msecs, hard syntax speeds naming somewhat more than easy syntax for both antonyms and rhymes (with the proviso that the facilitating effect of complex syntax is not seen for antonyms in the frequency-matched data).

For rhymes, we observe a depression of RTs relative to neutrals at 50 and 200 msecs. Frequency may play a role here (since rhymes were overall

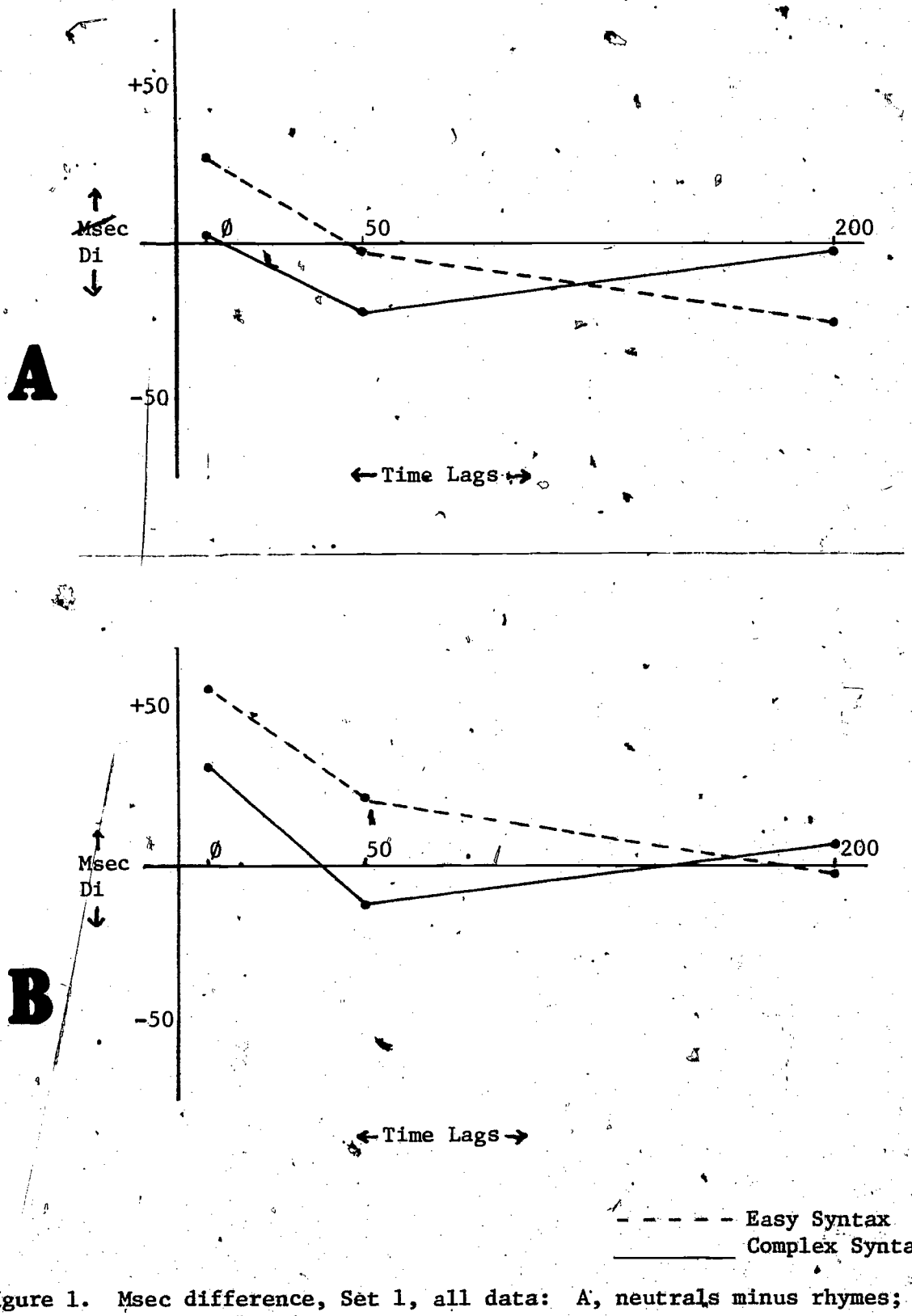

Figure 1. Msec difference, Set 1, all data: A, neutrals minus rhymes; B, neutrals minus antonyms.

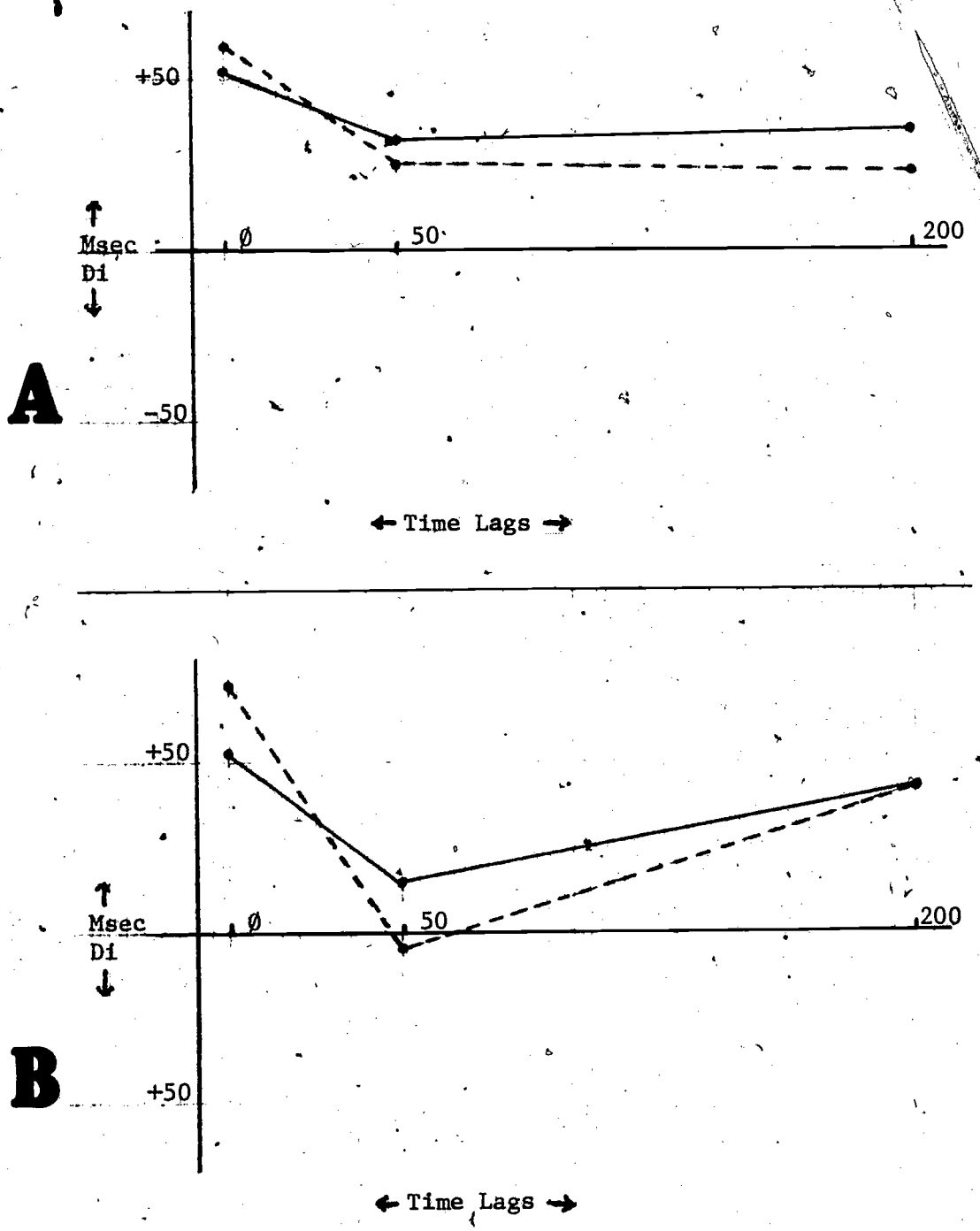

Figure 2. Msec difference, Set 1, frequency matched data: A, neutrals minus rhymes; B, neutrals minus antonyms.

least frequent and frequency had most effect at 50 and 200 msecs). Additionally, naming may be subject to some kind of inhibition induced by the priming word (last word in the sentence); many subjects noticed the rhymes (as they did the antonyms) and made comments to the effect that the rhymes were "hard to get out" after seeing a related word at the end of the sentence. An inspection of the individual subject means for direction of difference between rhymes and neutrals for the complete (non-frequency matched) data shows a distribution of plus/minus differences that fits the trends for easy and hard syntax across time lags in Figure 1a, with the exception that the negligible difference for rhymes vs. neutrals in the hard syntax condition at 200 msecs corresponds with a moderately consistent tendency for the neutral-minus-rhyme means for individual subjects to be negative (15/21 differences).[4]

For antonyms, the complete data set shows priming for both easy and complex syntax at all time lags (cp., however, the frequency matched data, where there is no priming for easy syntax at 50 msecs). The direction of differences in individual subject means shows a somewhat more consistent tendency toward shorter RTs for antonyms relative to neutrals in complex syntax conditions than in easy syntax conditions. There are only 5/24 subjects with negative (neutral-minus-antonym) means for complex syntax at Ø msecs (cf. 7/23 for easy syntax), 7/23 for complex syntax at 50 msecs (cf. 10/23 for easy syntax), and 7/21 for complex syntax at 200 msecs

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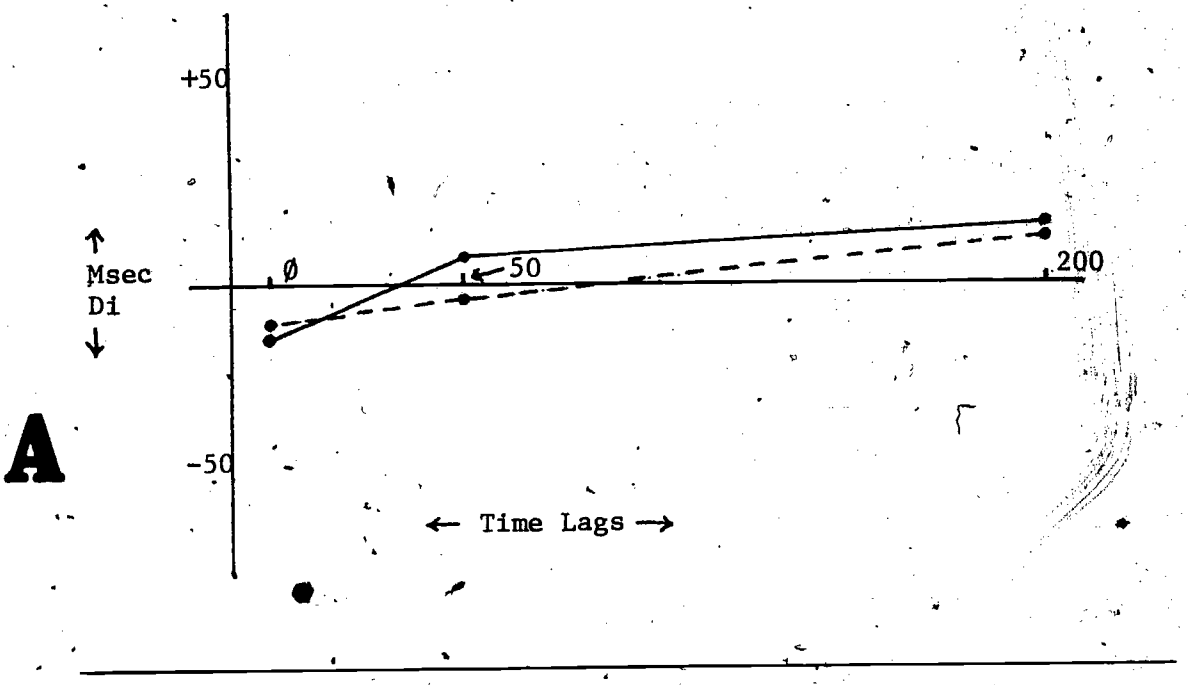
[4]The numbers of negative neutral-minus-rhyme differences for the other conditions are:

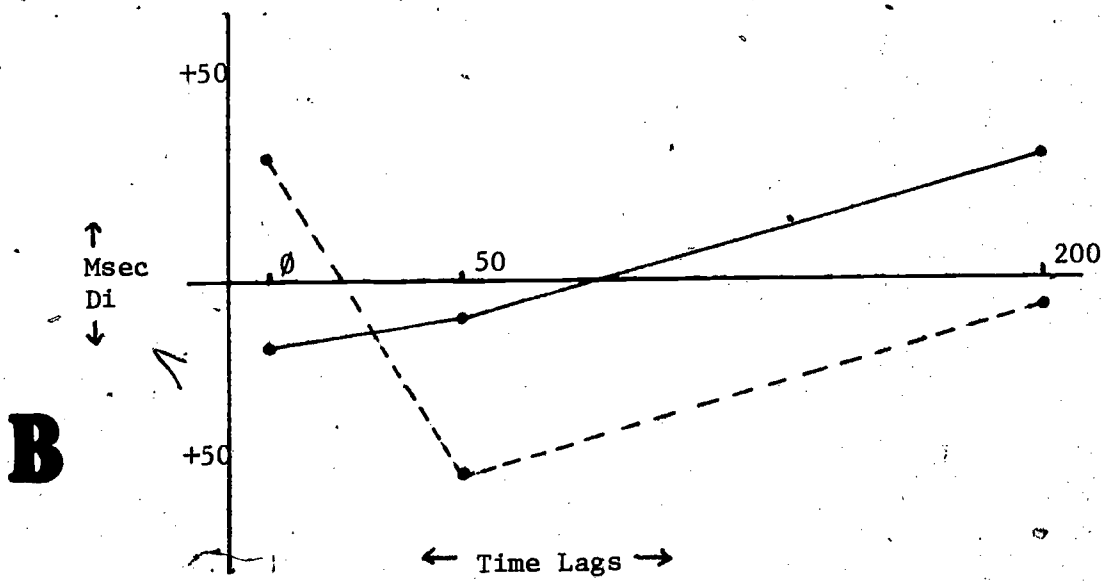
Complex: 11/24, Ø msecs; 12/23, 50 msecs.
Easy: 8/22, Ø msecs; 13/23, 50 msecs; 14/22, 200 msecs.

Total number of differences less than 24 per condition are accounted for by ties and cases where only 1 data point was available for a given subject and condition (cf. fn. 1).

(cf. 11/23 for easy syntax). These direction of difference figures fit the view that hard syntax promotes and sustains priming and suggests the apparently greater priming effect for easy syntax at Ø msecs in Figures 1b and 2b be treated warily.

Set 2. Figure 3 shows the differences between neutrals and rhymes and neutrals and antonyms for the materials in Set 2. Figure 4 shows the differences for 5 triples of rhyme-antonym-neutral words which were within 16 Kucera-Francis frequency points. (The mean for these 15 words was 35, and the range 10-60.) The patterns for the complete data (Figure 3) for Set 2 materials appear different from those for Set 1 materials. Notably, there is a depression of RTs relative to neutrals at Ø msecs (cp. Set 1 materials, for which RTs are depressed for rhymes at 50-200 msecs), and, for the opposites, hard syntax appears to promote priming most at Ø msecs and least at 200 msecs (in contrast to the trend toward greater priming for hard syntax at 200 msecs for Set 1, modulo the reservation in the preceding paragraph). However, when we look at the frequency matched data (Figure 4) we see patterns that look more similar to those for Set 1, with priming for easy syntax at Ø msecs and a trend into/toward priming for hard syntax at 50/200 msecs. Set 2 materials are overall more complex syntactically than Set 1 materials (containing three rather than two clauses) and the effects of frequency were greater for Set 2 than for Set 1, with negative frequency-RT correlations in both complex and easy syntax conditions. These facts suggest that frequency may be at work in determining the overall patterns in Figure 3 and that the patterns in Figures 4 and 1-2 are a more accurate reflection of the relation between word type, syntax, and naming condition across the time intervals.





- - - - - - Easy Syntax
_____ Complex Syntax

Figure 3. Msec difference, Set 2, all data: A, neutrals minus rhymes; B, neutrals minus antonyms.

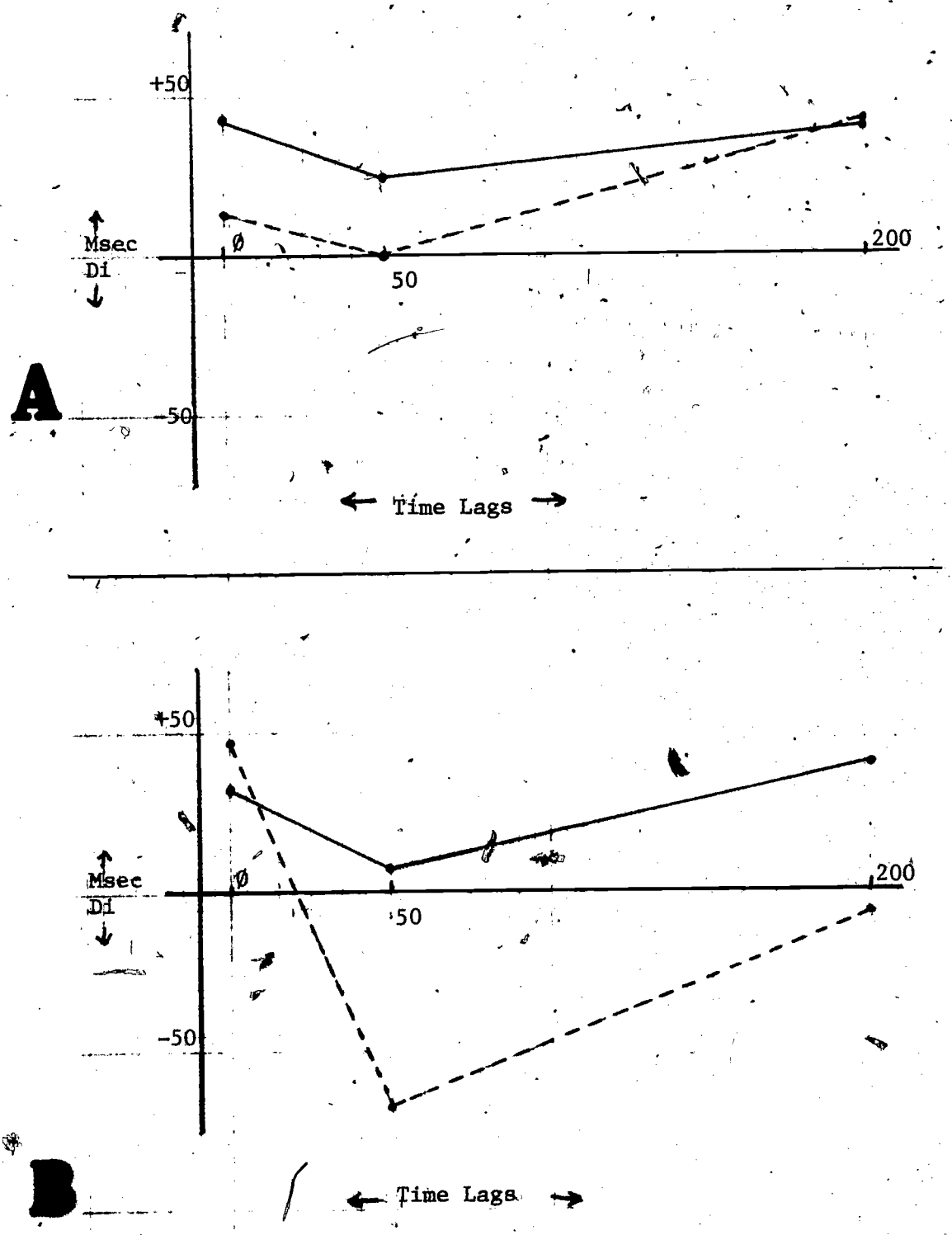


Figure 4. Msec difference, Set 2, frequency-matched data: A, neutrals minus rhymes; B, neutrals minus antonyms.

Discussion

Plainly, nothing at all firm can be said on the basis of this work, since we have little data that is not contaminated by effects of frequency. However, both the relation we observe between frequency and syntactic complexity (a negative correlation between frequency and RTs in complex syntax conditions at 50/200 msecs) and the suggestion of differential effects of syntactic complexity across the time lags (with naming facilitated more by easy syntax at Ø msecs and more by complex syntax at 50/200 msecs) deserve attention, since they challenge in a gross way the view that word recognition and syntactic processing are independent processes. (The differences in priming effects by complexity/time lag should be treated very skeptically, both because of the lack of consistency between overall means and the individual subject direction of difference figures at Ø msecs, Set 1, and because of the weakness/non-existence of the trend toward greater naming facilitation for complex syntax at 50/200 msecs for Set 1 frequency-matched data.) The effect of frequency needs to be verified in an experiment in which words of markedly different frequency are presented under conditions of differing syntactic complexity. The effects of syntax need to be verified in a study in which frequency is more tightly controlled. The upswing in/toward priming at 200 msecs suggests that a more marked effect of syntactic processing might be found if the time lag between the end of the sentence and the word to be named were to be increased. (In earlier trials, we found an effect of syntactic complexity on overall RTs with a lag of 300 msecs.)

Given that there is some trade off between syntactic processing and word recognition, we must assume that Swinney et al.'s failure to find an

effect of clause boundary on lexical decision times follows either from the independence of lexical access from the particular syntactic variable Swinney et al. manipulated, or from particulars of their design. Since Swinney et al. asked subjects to make a lexical decision about the critical (primed) word only three syllables after the clause boundary, it is possible that the interval between the boundary and the decision word was too short for the effects of clause structure integration (assumed to take place at clause boundaries and to be the source of clause boundary effects, ef. Frazier, 1978) to show up. Assuming the trends we observed reflect genuine processes, how can they be fitted into a picture of the process of language comprehension? Lack of an effect of syntax on word recognition has in the past been taken to fall naturally within an "autonomous"/"non-interactive" approach to language comprehension, where each of the lexical, syntactic, and semantic components of the speech analyzer goes about its business with minimal attention to the analysis performed at other levels (the "minimal" in minimal attention covering the need for some semantic integration and consistency principles, cf. Forster, 1979; Frazier, 1978). By contrast, cases where processing time at one level has been shown to be affected by manipulations at another level (particularly where syntactic processing has apparently been affected by semantic parameters) have been looked to by some as evidence in favor of an "interactive" view of processing, where information at one level can critically affect the sequency of processing steps at another level (cf. Marslen-Wilson and Tyler, 1980). Despite the tendency to correlate cross-component RT effects with interactive models, the following account of the trends we observe seems workable, and compatbile with the integrity-of-components property of autonomous models.

Assume: Processing at different levels involves procedures and representations at least partially unique to the level involved; computation at each level is exhaustive (there is no stage-skipping); in the normal case, lexical access precedes syntactic processing and syntactic analysis precedes semantic processing; the primary connections between levels are feed-forward; although the components of the processor are segregated, each will work simultaneously on whatever input is at hand; there is time-sharing between components of the total processing energy available to the processor. Within this general framework of assumptions, we might account for the fact that frequency of a word to be named appears to affect RTs most in the complex syntax conditions at 50 and 200 msecs in the following way: Frequency has been claimed to be a first stage organizing parameter of the mental lexicon (Forster, 1976). On Forster's account, words are organized in an access-file along various dimensions (phonological, orthographic, etc.) and are listed by frequency within those files. The files are the first access stage and provide a way into other networks of relations in the lexicon. If complex syntax occupies more processing time than easy syntax and consequently delays the search for the naming word in our experimental task, then we would expect negative frequency/RT correlations to show up more for complex syntax, since in the complex syntax case less time will have been available for accessing the word to be names and the response is made at a relatively early (frequency-sensitive) stage in lexical search. Note that it is consistent with this account that, as noted above, there was a weak reverse-direction tendency at Ø msecs for Set 1, with longer RTs for less frequent words in the easy syntax condition. The easy Set 1 condition

is syntactically the least complex of the four syntactic conditions in the two materials sets. It should therefore delay the onset of accessing for the word to be named least, and thus be the first condition to show frequency effects, i.e., it may show frequency effects early on, at the Ø msec lag.

How could the priming/nonpriming trends across time lags for easy/complex syntactic conditions, which hold at least weakly for the frequency-matched as well as the nonmatched Set 1 data and show up also for the matched Set 2 data, be accounted for in the type of model sketched above? Greater priming at Ø msecs for easy syntax seems natural, given that easy syntax will delay accessing least (more on this below). The fall-away of facilitation at 50 msecs and the upswing in/toward priming at 200 msecs, with greater facilitation for complex syntax, are harder to account for. One possibility is that the syntactic/semantic processing components continuously reaccess the word that triggers priming (the last word in the sentence) in the course of performing whatever analysis takes place on the way to the sentence's ultimate representation in memory--with, potentially, more reaccessing and hence more priming in complex syntax conditions, due to a greater number of processing operations that must be carried out. (While it might seem farfetched to assume that the processor keeps looking up the same word anew as it analyses the sentence, such reaccessing is not obviously less plausible (to me at least) than, say, the use of a special buffer for words in use.)

Although it seems plausible that there should be greater priming at Ø msecs for easy syntax than for complex syntax conditions, the fact that there is priming at all (or at least to a greater degree than at 50 msecs) for the complex syntax appears to be a puzzle, if we accept the account of

the frequency-complexity effect given above. Given that it is at the 50 and 200 msec lags that frequency (a first stage accessing parameter) shows most effect and that priming effects deriving from activation in the lexicon require prior accessing, we would not on the fact of it expect to see greater facilitation at Ø msecs than at 50 msecs, since the latter lag shows greater effects of an early accessing stage (frequency). A way out might be to propose that any priming at Ø msecs is not a normal accessing effect, but rather the reflection of a (conscious or unconscious) strategy for guessing the word to be named (consistent with our observation that subjects did notice the rhymes and antonyms and might well have started generating hypotheses about the word they would be required to name). This is not a satisfactory proposal, in that lexical-relatedness effects of short time lags (less than 250 msecs) have been associated with automatic, non-attentional processing rather than with conscious, attentional mechanisms.[5] A more satisfactory solution may be to assume that the frequency effects across time intervals reflect a trade off between syntactic processing time and lexical accessing that we see because there was an overall greater range in frequency for the nonmatched data (cf. fn. 3 and pp. 10, 12), and nonetheless some normal accessing/reactivation is going on at Ø msecs as well as 50 and 200 msecs; this normal accessing/reactivation will result in the priming/nonpriming trends for the frequency-matched data and for the data as a whole (to which of course the frequency-matched items are contributing).

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[5] Neely (1977) found inhibition for lexical decisions on words that violated (semantic) expectations generated by a prior stimulus word when the word to be judged was presented at a 2000 msec lag, but not when the word to be judged was presented at a 250 msec lag. Neely interprets this result as support for theories that posit two components of attention--"a fast automatic inhibitionless spreading activation process and a slow limited capacity conscious attention mechanism" (p. 226), the latter being responsible for the inhibition Neely observed at 2000 msecs.

Ontogeny

This study started out more or less as a reaction to some studies of child and adult learners' word processing. Such studies looked at the way learners handle words in memory tasks and attributed primacy of a particular type of word property (particularly phonological properties) to primacy of such properties in the mental lexicon. Changes over time in the (phonological-semantic) properties that have primacy were attributed to changes in the structure of the lexicon. Clearly, this is not a necessary conclusion. The structure of the lexicon may remain stable but the way our experimental tasks tap into lexical organization may vary over the course of development, due to factors such as the learner's distribution of processing energy. We had hoped to support this view by showing that sensitivity to (phonological-semantic) properties of lexical items varies as a function of the computational load on other (nonlexical) components of the language faculty in a way comparable to ontogenetic patterns in children. While the work we have done is suggestive of an interplay between lexical processing and other types of language processing operations, the precise nature of this relationship is far from clear, and more work would have to be done before parallel studies could be carried out with children. If we accept the view that it is next to futile to attempt to study development in language or any other cognitive domain without some sense of the adult end-state, then the particular focus of this study may not have been the most fruitful one at our present state of knowledge, since the organization and accessing of phonological and semantic information in the adult's mental lexicon is one of the more controversial and volatile areas of adult psycholinguistic

studies (see Cairns, 1982, for a recent review). A backdrop of adult knowledge against which to pursue the study of development is consequently hard to come by. With the benefit of hindsight, a better focus for child lexical studies at present might be those areas of lexical processing--such as the decision processes involved in the choice between lexical ambiguities--which are relatively well understood in adults.

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APPENDIX

Frequency/RT Correlations

SET 1

ALL DATA (word types) TIME LAGS POOLED

Easy -- r = .065, t(160) = -0.82, p = .411
Complex -- r = -.177, t(160) = -2.28, p = .024

ALL DATA (word types) BY TIME LAG

Ø Msecs

Easy -- r = -.213, t(52) = -1.57, p = .121
Complex -- r = -.037, t(52) = -0.27, p = .790

50 Msecs

Easy -- r = .005, t(52) = 0.04, p = .979
Complex -- r = -.399, t(52) = -3.14, p = .003

200 Msecs

Easy -- r = -.003, t(52) = -0.02, p = .982
Complex -- r = -.162, t(52) = -1.19, p = .240

RHYMES, TIME LAGS POOLED

Easy -- r = -.070, t(52) = -0.51, p = .616
Complex -- r = -.090, t(52) = -0.66, p = .515

RHYMES, BY TIME LAG

Ø Msecs

Easy -- r = -.390. t(16) = -1.69, p = .110
Complex -- r = -.069, t(16) = -0.28, p = .786

50 Msecs

Easy -- r = .064, t(16) = 0.26, p = .800
Complex -- r = -.194, t(16) = -0.79, p = .441

200 Msecs

Easy -- r = .002, t(16) = -0.01, p = .994
Complex -- r = -.236, t(16) = -0.97, p = .346

OPPOSITES, TIME LAGS POOLED

Easy -- r = -.036, t(52) = -0.26, p = .794
Complex -- r = -.173, t(52) = -1.27, p = .211

OPPOSITES, BY TIME LAG

Ø Msecs

Easy -- r = -.212, t(16) = -0.87, p = .398
Complex -- r = .097, t(16) = 0.39, p = .700

50 Msecs

Easy -- r = -.002, t(16) = -0.09, p = .931
Complex -- r = -.552, t(16) = -2.65, p = .018

SET 1 (Opposite only by time lags) Continued

200 Msecs

Easy -- r = .066, t(16) = 0.27, p = .794
Complex -- r = -.168, t(16) = -0.68, p = .504

NEUTRALS, TIME LAGS POOLED

Easy -- r = .098, t(52) = 0.71, p = .480
Complex -- r = -.001, t(52) = 0.01, p = .993

NEUTRALS, BY TIME LAGS

Ø Msecs

Easy -- r = -.062, t(16) = -0.25, p = .806
Complex -- r = .060, t(16) = 0.24, p = .812

50 Msecs

Easy -- r = .325, t(16) = 1.37, p = .189
Complex -- r = -.292, t(16) = -1.22, p = .239

200 Msecs

Easy -- r = .072, t(16) = 0.29, p = .775
Complex -- r = .290, t(16) = 1.21, p = .243

SET 2

ALL DATA (word types) TIME LAGS POOLED

Easy -- r = -.123, t(158)* = -1.56, p = .122
Complex -- r = -.255, t(159)* = -3.33, p = .001

ALL DATA (word types) BY TIME LAG

Ø Msecs

Easy -- r = -.119, t(50) = -0.85, p = .399
Complex -- r = -.227, t(52) = -1.68, p = .099

50 Msecs

Easy -- r = -.149, t(52) = -1.09, p = .281
Complex -- r = -.269, t(52) = -2.02, p = .049

200 Msecs

Easy -- r = -.107, t(52) = -0.77, p = .443
Complex -- r = -.319, t(51)* = -2.41, p = .020

RHYMES, TIME LAGS POOLED

Easy -- r = -.207, t(52) = -1.53, p = .132
Complex -- r = -.284, t(52) = -2.13, p = .038

RHYMES, BY TIME LAG

Ø Msecs

Easy -- r = -.017, t(16) = -0.07, p = .947
Complex -- r = -.347, t(16) = -1.48, p = .158

SET 2 (Rhyme only by time lags) Continued

50 Msecs

Easy -- r = -.477, t(16) = -2.71, p = .045

Complex -- r = -.198, t(16) = -0.81, p = .430

200 Msecs

Easy -- r = -.204, t(16) = -.084, p = .416

Complex -- r = -.365, t(16) = -.157, p = .136

OPPOSITES, TIME LAGS POOLED

Easy -- r = -.101, t(51)* = -0.73, p = .471

Complex -- r = -.241, t(52) = -1.79, p = .079

OPPOSITES, BY TIME LAG

Ø Msecs

Easy -- r = -.105, t(15)* = -0.41, p = .687

Complex -- r = -.123, t(16) = -0.49, p = .627

50 Msecs

Easy -- r = .061, t(16) = 0.25, p = .809

Complex -- r = .311, t(16) = -1.31, p = .209

200 Msecs

Easy -- r = -.239, t(16) = -0.99, p = .339

Complex -- r = -.349, t(16) = -1.49, p = .156

NEUTRALS, TIME LAGS POOLED

Easy -- r = .079, t(52) = 0.56, p = .575

Complex -- r = -.145, t(51)* = -1.05, p = .299

NEUTRALS, BY TIME LAG

Ø Msecs

Easy -- r = -.104, t(16) = -0.40, p = .692

Complex -- r = .019, t(16) = 0.08, p = .941

50 Msecs

Easy -- r = -.105, t(16) = 0.42, p = .679

Complex -- r = -.374, t(16) = -1.61, p = .126

200 Msecs

Easy -- r = .345, t(16) = 1.47, p = .161

Complex -- r = -.121, t(15)* = -0.47, p = .645

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* df less than 160/52/16 are due to missing data points.