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# Attention Mechanisms Mediate the Syntactic Priming Effect in Auditory Word Identification

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The syntactic priming effect and the involvement of attention in that process were investigated by testing identification of white noise–masked Hebrew words. Targets were either syntactically congruent or syntactically incongruent with the structure of the sentence. Relative to a neutral condition, similar facilitation and inhibition was found for congruent and incongruent targets, respectively. When syntactic congruency was blocked, the inhibition was attenuated, whereas the facilitation remained the same. A 350-ms silent interstimulus interval between context and target increased inhibition without affecting facilitation. We suggest that both the facilitation and the inhibition effects of syntactic priming are based on a veiled controlled process of generating expectations. The inhibition results from a controlled process of reevaluation that requires additional attention resources.

There is much evidence in the research literature that syntactic context influences the process of word identification (Carello, Lukatela, & Turvey, 1988; Goodman, McClelland, & Gibbs, 1981; Gurjanov, Lukatela, Moskovljevic, Savic, & Turvey, 1985; Katz, Boyce, Goldstein, & Lukatela, 1987; Lukatela, Kostic, Feldman, & Turvey, 1983; Lukatela et al., 1982; Marslen-Wilson, 1987; Miller & Isard, 1963; Seidenberg, Waters, Sanders, & Langer, 1984; Tanenhaus, Leiman, & Seidenberg, 1979; Tyler & Wessels, 1983; West & Stanovich, 1986; Wright & Garrett, 1984). The common finding is that performance is faster and more accurate when the target words are congruent with the syntactic structure into which they are integrated than when they are incongruent. This differential performance was found mostly in tasks such as lexical decision and naming (Carello et al., 1988; Goodman et al., 1981; Gurjanov et al., 1985; Katz et al., 1987; Lukatela et al., 1982, 1983; Seidenberg et al., 1984; Tanenhaus et al., 1979; West & Stanovich, 1986; Wright & Garrett, 1984). Analogous to the effects of semantic context in similar tasks, the effect of the syntactic context has often been labeled *grammatical* or *syntactic priming*. However, because the term *priming* was borrowed from the semantic domain, its use in the syntactic domain needs specific consideration. In the semantic domain, priming refers primarily to a process that affects the access to a particular lexical entry (Forester, 1981; Seidenberg, 1982). The syntactic context, on the other hand, refers primarily to a grammatical form that a word may take and its integration into a multiword structure such as a phrase or a sentence. This information may or may not be independently represented in the lexicon. Therefore, syntactic priming may indirectly influence the process of word identification by providing information about its expected grammatical structure without having an effect on the initial stages of accessing a particular entry in the phonological lexicon. It is in this sense that we use the term *syntactic priming* here.

Like other priming phenomena, syntactic priming may reflect the combined or independent contribution of two basic components: One component is the facilitation of processing syntactically congruent targets as a result of the agreement between the observed grammatical form and that predicted by the syntactic structure. Such facilitation may result in a more accurate (and faster) identification of congruent targets. The other component is the inhibition of processing incongruent targets, either because they do not conform with previous expectation, because they may require additional processing aimed at resolving the amorphic input, or because of both. This inhibition may harm (and delay) the identification of incongruent targets. Several studies have interpreted syntactic priming in terms of facilitation (Katz et al., 1987; Lukatela et al., 1982, 1983; Marslen-Wilson, 1987; Tyler & Wessels, 1983), whereas others emphasized the inhibitory aspect (Carello et al., 1988; Tanenhaus et al., 1979; West & Stanovich, 1986). However, the question of whether facilitation, inhibition, or both are operative is unsettled because, with the exception of one study in which only inhibition was found (West & Stanovich, 1986), the syntactic priming effect has not been assessed relative to a neutral condition.

The distinction between facilitation and inhibition is important because each of these two processes might reflect a different cognitive mechanism. In particular, current models of priming suggest that facilitation and inhibition differ in their attention requirements. In normal language communication syntactic congruity is expected. Therefore, it might be expected that syntactically congruent targets are automatically integrated into the sentence structure. In contrast, syntactically incongruent targets cannot be automatically integrated into

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the syntactic context. They may therefore require some reevaluation of the phonological input as well as of the context. In the semantic domain, it is assumed that these activities that inhibit word identification are actively controlled and require the allocation of attention resources (Neely, 1977; Posner & Snyder, 1975).

The role of attention in syntactic priming was approached indirectly in earlier studies. For example, dealing with inflectional morphology, Katz et al. (1987) suggested a modular syntactic processor whose involvement in word identification is mandatory and informationally encapsulated (Fodor, 1983). This interpretation implies that syntactic priming, particularly as it relates to facilitatory processes, should not require attention resources. Indeed, several authors have proposed that syntactic priming is automatic (Carello et al., 1988; Gurjanov et al., 1985; Lukatela et al., 1982; see also Seidenberg et al., 1984). Note, however, that in the studies just cited the automaticity of the syntactic priming effect was suggested primarily by inflectional processing in pairs of words presented in the highly inflected Serbo-Croatian language. Testing English-speaking subjects with word-pair materials, Goodman et al. (1981) found evidence that syntactic priming may be strategy controlled and modulated by attention. A role for attention in syntactic priming can be inferred indirectly from the assumption that attention is involved primarily during lexical (or postlexical) processes that are involved in lexical decision more than in naming. Indeed, several studies using single-word context in English (Seidenberg et al., 1984) as well as in Serbo-Croatian (Carello et al., 1988) reported that syntactic priming in naming was significantly weaker than in lexical decision, or was even absent. In addition, by using sentential context, West and Stanovich (1986) found significant inhibition for incongruent targets without facilitation of congruent targets.

The involvement of attention may be especially conspicuous in the case of incongruent targets when reevaluation of the target–sentence relationship, although possibly unavoidable, necessarily requires attention resources. Such an interpretation of the syntactic priming effect was suggested by Tanenhaus et al. (1979). By examining the process of selecting the contextually appropriate readings of noun–verb ambiguities in sentences, these authors suggested that the syntactic selection process in general and, more specifically, the suppression of the inappropriate meaning are characterized by a veiled controlled mechanism (i.e., a process that by virtue of being overtrained is performed without intention and, although the subject is able to control it if he or she wishes to, is not transparent to consciousness by default. See Shiffrin & Schneider, 1977.)

To summarize, the present evidence for a role of attention-mediated strategies in syntactic processing is not conclusive. Indeed, most authors suggest that the application of syntactic rules is mandatory and does not require much attention. However, the empirical basis for this conclusion is weak. First, attention was not directly manipulated in any of those studies. Second, the conclusions were based mostly on studies of syntactic priming by single word context. Finally, the absence of neutral conditions in most studies prevents any distinction between the facilitatory and inhibitory components of the syntactic priming effect. The present study is a systematic investigation of the syntactic priming effect in spoken sentences. We sought to determine the relative contribution of facilitatory and inhibitory mechanisms to syntactic priming and to examine the attention-mediated strategies that might be involved in each of these mechanisms.

## Methodological Considerations

In the present study, we manipulated the Hebrew agreement rule between subject and predicate regarding gender and number and a morpho-syntactic rule that involves the decomposition of the conjunctive form of pronoun-plus-preposition. The essential role of an agreement rule in Hebrew, which has no effect on the semantic processing, is to specify the syntactic relation between the constituents of a sentence. For example, the predicate agrees with the subject in person, gender, and number but, because the specification of the gender and number is already available in the subject, violation of one or more of these types of agreements does not affect the meaning of the sentence (Shanon, 1973). Moreover, because the agreement rule is at the level of inflectional morphology, violation of it does not cause changes in word class (changes that may have semantic implications; Carello et al., 1988). Take, for example, the sentence "A nice boy is writing," which translates into Hebrew as "Yeled (subject) yafeh (attribute) kotev (predicate)." The morphological unit *yeled* (*boy*) contains information about gender (masculine) and number (singular). The same root (y–l–d) with different affixes is used to form the word *yaldah* (*girl*) or change the number *yeladim* (boys).[1] The agreement rules require that the attribute and predicate agree with the subject in gender and number: *yafeh* (*nice*) is a singular, masculine form, as is *kotev* (*is writing*). The sentence "Yaldah yafah kotev" contains a syntactic violation because the predicate is in masculine form, whereas both the subject and attribute are in feminine form. As was noted above, the morpho-syntactic rule referred to the rule that provides that a pronoun and a preposition appear in a composed form. For example, the preposition *el* (*to*) and the pronoun *ata* (*you*) are composed into one form *alecha*. The decomposition of this form into *el* plus "*ata*" is illegal. (See additional examples and details in the *Materials* section.)

These rules were chosen for two reasons. First, both agreement between the subject and predicate and the morpho-syntactic rule that we used are simple and essential in Hebrew grammar. Second, we were interested in isolating the effect of the syntactic context from the effect of the semantic context. Although the agreement rule that we chose operates between the subject and the predicate, we were not constrained to

[1] In Hebrew, words are formed by combining two morphemes: a root and a word pattern. The root is a sequence of usually three (but sometimes four) consonants, whereas the word pattern provides the vowels (with occasional addition of more consonants). Neither of these two morphemes is a word by itself and jointly they determine the meaning and the syntactic form of the word. (See a detailed description of Hebrew morphology in Bentin and Frost, in press.) For a correct interpretation of the results of the identification task used in the present study, it is important to realize that neither the root nor the word pattern can be independently pronounced as a coherent phonological unit.

present the two sentential elements in succession. Therefore, we could avoid lexical priming effects that may operate between adjacent words and focus on processes related to the syntactic structure of the sentence. It should also be noted that to avoid lexical priming based on semantic relationship, none of the targets was semantically related to preceding words in the context or could have been predicted on the basis of the sentence's semantic context. Moreover, although the application of the agreement rule is based mainly on the addition of or changes to suffixes, they usually also involve phonological modifications in the whole word structure as imposed by phonetic rules. As in the above example, the addition of the plural suffix *im* to the singular, masculine form *kotev* changes the morphological form *kotev* into *kotvim* rather than *kotevim*. It should also be noted that there are several suffixes that are used to mark gender and number, some of which are shared by nouns and verbs. For example, the feminine form of the noun *zamar* (*a singer*) is *zameret*, whereas the feminine form of *rakdan* (*a dancer*) is *rakdanit* and the feminine form of *yeled* (*a boy*) is *yaldah*. Similarly, in the verb system, the feminine form of *yashen* (*[he] sleeps*) is *yeshenah* and that of *roked* (*[he] dances*) is *rokedet*. Thus, although the subject and the predicate agree in gender and number, they do not have to end with the same specific suffixes. Consequently, although the morphological form of the predicate can be predicted by the morphological form of the subject, its specific morpho-phonological form is not unequivocal. In summary, targets could neither be activated by semantic network connections nor predicted or easily guessed on the basis of the sentential context.

Most of the previous studies of the effect of syntactic context (with the exception of Katz et al., 1987; Marslen-Wilson, 1987; Tyler & Wessels, 1983) used visually presented stimuli. In the present study, we examined syntactic priming in speech perception rather than reading because speech is more basic than reading in human language and a more natural expression of human linguistic ability.

Previous studies of semantic or associative priming in the visual modality suggested that the degradation of stimulus intelligibility magnifies the effect of contextual effect on word identification (Becker & Killion, 1977; Meyer, Schvaneveldt, & Ruddy, 1975; Neely, 1991; Stanovich & West, 1983). Therefore, in an attempt to focus our investigation on the nature of the syntactic context effect, our basic task required the identification of target words masked by white noise. The addition of noise may alter the normal process of word identification (e.g., by emphasizing the contextual influence) and therefore may hamper conclusions about word identification in natural speech. However, it should not interfere with our ability to examine, using this method, the nature of the syntactic contextual processes whenever the linguistic system sets them in motion and uses them for word identification.

## Experiment 1

The purpose of the present experiment was to assess the relative contribution of facilitatory and inhibitory processes to syntactic priming. In a previous study (Bentin, Deutsch, & Liberman, 1990), we observed a large syntactic context effect on the identification of words masked by white noise. The identification of target words was four times as accurate when they were syntactically congruent than when they were incongruent with the context sentence. In the present experiment, we replicated and extended our former study by adding a neutral condition. The addition of the neutral condition enabled us to disentangle the facilitatory effect of syntactic congruity and the inhibitory effect of syntactic incongruity that were confounded in our previous study (see also West & Stanovich, 1986; Neely, 1976).

The neutral context that we used with all targets was "the next word is . . . ," as was originally suggested by McClelland and O'Regan (1981) and applied to an investigation of syntactic priming in reading by West and Stanovich (1986). We chose this neutral condition because, at least in Hebrew, this sentential structure does not impose any structural syntactical limitations, and therefore it is unlikely to involve any bias toward specific syntactic units or morphological forms (West & Stanovich, 1986).

We assumed that the facilitatory and inhibitory components that may contribute to the syntactic priming effect should be differentially reflected in comparison to the neutral condition. Facilitation was measured by the difference between the percentage of correct target identification in the congruent and the neutral context, whereas the difference between the correct identification in the neutral and the incongruent context conditions was the measure of inhibition.

### *Method*

#### *Subjects*

The subjects were 30 undergraduate students who participated in the experiment for course credit or for payment. They were all native speakers of Hebrew with no known hearing problems.

#### *Materials*

The auditory identification test included 44 target words. Each sentence included a syntactically congruent context phrase followed by a target. The target was a predicate in three sentence types and a pronoun plus a preposition in the fourth type (see below). The syntactic congruity between the target and the context was manipulated to form three congruity conditions: (a) congruent, the target word fit the syntactic structure of the sentence; (b) incongruent, the target word did not fit the syntactic structure of the sentence, that is, caused a violation of a syntactic rule; and (c) neutral, as explained above.

The syntactic violations were constructed by changing the congruent sentences in one of the following ways.

*Type 1: violation of the agreement in gender between subject and predicate.* For example, the Hebrew sentence "Hasachkan harazeh **yashen**" (the skinny actor sleeps) includes a noun, *hasachkan* (preceded by the definite article *Ha*), as the subject; an adjective, *harazeh* (also preceded by the definite article), as the attribute; and a verb, *yashen*, as the predicate. In the congruent condition (the above sentence), both the subject and the predicate are masculine singular forms. In the incongruent condition, the same masculine predicate form was presented in a sentence in which the subject and the attribute were feminine forms: "Hasachkanit haraza yashen." (Note that according to another agreement rule in Hebrew, the attribute agrees with the subject in gender, number, and definite article.) In all of our examples, syntactic structure was intact until the last target word. This category included 12 target words that were repeated across the three

context conditions, forming a total of 36 sentences. In the incongruent condition, a masculine subject was presented with a feminine predicate (in 6 of the sentences) or a feminine subject was presented with a masculine predicate (in the other 6 sentences).

*Type 2: violation of the agreement in number between subject and predicate.* For example, in the Hebrew sentence "Hamechonit hayafa **yekara**" (the nice car is expensive), the feminine, singular predicate form, *yekara,* agrees with the feminine, singular subject form, *mechonit.* Violation of the agreement in number would be "Hamechonyot hayafot **yekara**" in which the same target is presented with a feminine, plural subject (and attribute). Twelve target words (different from those in Type 1) were repeated across the three conditions, forming 36 sentences. In the incongruent condition, a singular predicate followed a subject in the plural form (in 6 of the sentences) or vice versa (in the other 6 sentences).

*Type 3: violation of the agreement in both gender and number between subject and predicate.* For example, in the congruent sentence "Harakdan hamefursam **mitragesh**" (the famous dancer is anxious), the masculine, singular predicate form, *mitragesh,* is in agreement with the masculine, singular subject form, *harakdan,* whereas in the incongruent sentence "Harakdaniyot hamefursamot **mitragesh,**" the same predicate relates to a feminine plural form, *harakdaniyot.* This category also included 12 target words (different from those in Types 1 and 2), which were repeated across conditions to form 36 sentences. In the incongruent condition, the compatibility of gender and number between the subject and predicate was altered in each sentence. For example, a masculine, singular subject was followed by a feminine, plural predicate. (We constructed all four possible combinations, with 3 sentences for each.)

*Type 4: decomposition of the conjunctive form of pronoun and preposition.* This category included eight target pronouns, each of which was combined with a different preposition, forming 24 sentences. In Hebrew, the pronoun and the preposition are always in a conjunctive form. Thus, in the incongruent condition, the conjunctive form was decomposed into its two elements. For example, the conjunctive form *alecha* ("*on you*") was presented as two separate words: *al* (the preposition *on*) and *ata* (the pronoun *you*). In the neutral condition, the targets were presented as normal conjunctions.

The sentences of Types 1–3 consisted of three words in the following order: subject, attribute, and predicate. The masked target was always the predicate. The predicate was either a verb or an adjective (participle form in nominal clauses). Type 4 sentences consisted of a subject, a predicate, and a verbal completion (the conjunctive pronoun). The masked targets were the verbal completions in their normal conjunctive form (congruent and neutral conditions) or decomposed form (the incongruent condition).

The sentences were organized into three lists of 60 sentences, 20 in each congruity condition. Each group of 20 included 12 manipulations of the agreement rule (Types 1–3) and 8 manipulations of the morpho-syntactic rule (Type 4). The targets in sentences of Types 1–3 were rotated so that each subject saw each target only once, but, across subjects, each target appeared in each congruity condition. Because the number of the pronouns is limited, the rotation of pronouns between congruity conditions was within subject so that each appeared three times in a list (once in the decomposed form). To avoid the effect of repeating the context as much as possible, a different sentence was used in each condition. Moreover, the contexts were counterbalanced across the three lists.

All of the sentences were recorded on tape by a female professional speaker of Hebrew. The tapes were digitized at 20 Khz and edited as follows. The duration of the mask was determined by the duration of longest target (750 ms) and was equal in all sentences. The white noise was digitally added to the target, starting slightly before onset with a signal-to-noise ratio of 1:3.4. This ratio was determined on the basis of pilot tests so that the correct target identification level was about 50%.

The sentences in each list were randomized and output to tape at a 2-s intersentence interval and at a comfortable loudness.

### Procedure

Subjects were randomly assigned to one of the three stimuli lists. Each subject was tested individually. The experimenter and the subject listened to the stimuli simultaneously, both using earphones (HD-420).

The subject was instructed to listen to the sentence and to repeat the last (masked) word during the silent interval at the end of each sentence. No time constraints were imposed; in a few instances when the subject's response was delayed past the intersentence interval, the experimenter stopped the tape recorder. The responses were recorded verbatim by the experimenter.

The experimental session began with 12 practice trials (four sentences in each condition), followed by the test list.

## Results

Subjects' responses were initially coded as correct responses (accurate identification of the inflected word) or errors. The errors made in the incongruent condition were further categorized into four types: (a) syntactic correction (a correction of the syntactic violation using the same root), (b) semantic completion (a different word forming a semantically and syntactically congruent sentence), (c) nonsense (any completion that was semantically meaningless or syntactically incongruent, including nonwords), and (d) no response ("I don't know"). In the neutral and congruent conditions only, the last three categories were possible.[2]

Informal inspection of the percentage of correct identification in the different conditions revealed that syntactic congruity had a very similar effect in all four types of violation. Moreover, formal statistical analyses of 10 different types of syntactic and morpho-syntactic violations also revealed that these four violations were equally affected by syntactic context (Bentin et al., 1990). Therefore, and because a syntactic analysis of agreement and morpho-syntactic rules was beyond the scope of this article, we collapsed our analysis over the sentence types.[3]

Across subjects or stimuli, the percentages of correct identification were 74.8%, 50.2%, and 27.3% for the congruent, neutral, and incongruent syntactic conditions, respectively (Figure 1).

The statistical significance of the congruity effect was examined by one-factor analyses for subjects ($F_1$) and stimuli ($F_2$).

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[2] Recall, however, that in the neutral condition the structure of the sentence allowed any Hebrew word to appear. Therefore the only "nonsense" errors possible in this condition were nonwords, whereas any word other than the word that has been presented (even if it happened to contain the same inflection or the same root) was categorized as semantic completion.

[3] Some variation was observed, however, in the *absolute* percentage of correct identification across different types of violation. This variation, however, did not interact with the main effect of syntactic congruity and therefore was not relevant to the issues discussed in our article. The interested reader can find a detailed examination of the effect of 10 different types of syntactic violation in Bentin, Deutsch, and Liberman (1990).

The main effect of syntactic context was significant, $F_1(2, 58) = 110.5, p < .0001, MS_e = 153$, and $F_2(2, 118) = 49.8, p < .0001, MS_e = 661$.

The distribution of errors is presented in Table 1. Because a different number of error types could exist in different congruency conditions, the statistical evaluation of the distributions was based on an analysis of variance (ANOVA), followed by Tukey *a* post hoc comparison separately within each condition. This analysis showed that within each congruity condition, all differences were reliable at the $p < .05$ level.

Table 1
*Mean Percentage of Error and Standard Error of the Mean for Each Error Type*

| Congruity condition | Error type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Syntactic correction | | Semantic completion | | Nonsense | | No response | |
| | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ |
| Congruent | — | — | 62.8 | 4.1 | 3.1 | 1.9 | 34.1 | 4.3 |
| Neutral | — | — | 54.6 | 4.0 | 0.5 | 0.5 | 42.8 | 3.9 |
| Incongruent | 12.1 | 1.2 | 19.3 | 2.1 | 3.5 | 1.2 | 62.2 | 3.2 |

*Note.* Dashes indicate data not applicable to error type.

## *Discussion*

The results of Experiment 1 demonstrated that the syntactic priming effect, as it is revealed in our auditory word identification paradigm, consists of two components: facilitation and inhibition. The relative contribution of each component to the global context effect is approximately equal: Congruent context improved identification of white-noise-masked words by about 25%, whereas incongruous context reduced identification by the same amount, from a neutral baseline of about 50% correct.

Before discussing these results any further, two trivial interpretations should be considered. Because only verbatim accurate responses were considered correct, it could have been the case that the pattern of facilitation and inhibition simply reflected that, facing uncertainty, subjects used some partial phonological information that had been extracted from noise and the contextual information and guessed the target word. In line with this interpretation, the difference in the percentage of correct identifications of inflected targets in the congruent and incongruent conditions would reflect the correspondence or disagreement between the subject's intuition about how the identified word should have been inflected and what was actually presented. Such a strategy, however, implies that in the incongruent condition there would be a high percentage of Type I errors (i.e., errors reflecting the inappropriate use of the correct syntactic form). This implication was rejected by an analysis of the errors.

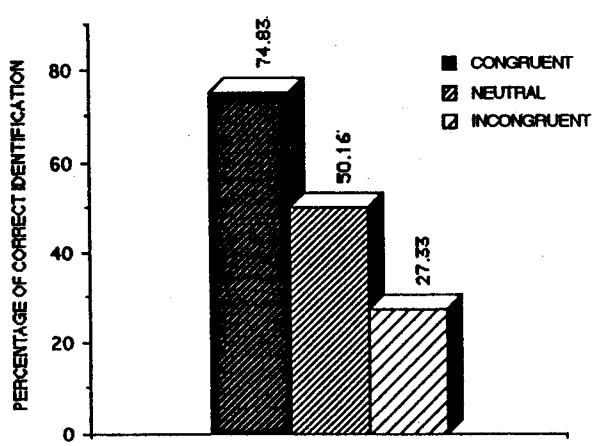


*Figure 1.* The percentage of correctly identified congruent, neutral, and incongruent targets.

As revealed in Table 1, the percentage of syntactic correction in the incongruent condition was very small, by far smaller than the percentage of no responses. Note also that the percentage of semantic completions (i.e., replacing the target with an incorrect but semantically and syntactically congruent word) was also relatively low in this condition in comparison with the neutral as well as with the congruent condition. This pattern does not support the intelligent guessing strategy but rather suggests that another factor was added to the system in the incongruent condition that inhibited identification on the basis of perceptual information. Because everything else was equal, we assume that this factor was syntactic incongruity. In other words, the low percentage of correct identification in this condition reflected a general process of inhibition caused by syntactic incongruence.

A second trivial interpretation of these results is that the subjects were reluctant to respond with words that "do not sound right" even if they identified them correctly. This interpretation is apparently supported by the percentage of "I don't know" responses that was higher in the incongruent than in the neutral and congruent conditions. Although possible, this interpretation is unlikely for the following reasons. First, the subjects were undergraduates who, although naive regarding the purpose of this particular study, were not naive about psycholinguistic experiments and were probably tolerant to this kind of manipulation. (In fact, after correctly identifying the first few incongruent targets they must have realized that syntactic incongruity is legitimate in the present experiment.) Moreover, the subjects were not required to repeat the whole sentence; therefore, their production was not grammatically right or wrong. Finally, support for our interpretation is also provided by comparing the pattern of semantic completions in the incongruent condition with those observed in the neutral and congruent conditions. It is evident that, in contrast to "I don't know" responses, the tendency to substitute a different but logical word for the misidentified target (semantic completions) is by far lower in the incongruent condition than in the neutral and congruent conditions. If subjects did not want "to sound dumb," they would have chosen the semantic substitution strategy at least as frequently as the "I don't know" response. Therefore, this pattern of errors can be better explained by assuming that syntactic incongruence enhanced uncertainty and inhibited responses when the percept was not sufficiently unequivocal. The absence of syntactic incongruence in the congruent condition eliminated inhibition and reduced uncertainty even when targets were misidentified. As

a result, the percentage of semantic completions in the congruent condition was twice as large as the percentage of no responses.

The present results diverge from those reported by West and Stanovich (1986), who, using a similar neutral condition, found only inhibition. However, in addition to differences in task (West & Stanovitch used a visual lexical decision task), the two studies differ in several other meaningful ways and, therefore, cannot be straightforwardly compared. First, we presented auditory masked words, whereas West and Stanovich used visually presented, unobstructed stimuli. Although we have no evidence for a differential effect of context in speech perception and reading, we cannot ignore this possibility. Moreover, empirical findings on associative and semantic priming in reading suggest that context effects are larger for degraded than for undegraded words (Stanovich & West, 1983). It is also possible that the divergence between the two studies is partly accounted for by differences between the material used in the two studies. In contrast to the semantically anomalous sentences used by West and Stanovich, our sentences, although they they were constructed so that their last word could not be predicated on the basis of semantic context, were always semantically sound. Finally, we cannot exclude the possibility that the difference between our results and the results reported in English studies reflect differences between the relative role that agreement rules play in Hebrew and English. Morpho-syntactic and syntactic agreement rules are language specific and vary across languages in number and perhaps in importance.

Because we have no direct evidence about the effect of the above-mentioned factors on context effects and how they interact with syntactic priming, our ability to draw general conclusions is limited. Therefore, inferences regarding the existence of facilitatory and inhibitory components in syntactic priming, and especially the finding of the equal contribution of the two components, may be restricted to the specific conditions of the present demonstration. In the next two experiments, we continued to investigate the nature of the syntactic context effects, focusing on the involvement of attention mechanisms in mediating each of these two components.

## Experiment 2

In Experiment 2, we examined the effect of separating the presentation of congruent and incongruent sentences on the inhibitory and facilitatory components of the syntactic priming effect.

Studies of semantic priming in visual word perception generally showed that lowering the proportion of related targets in the list reduced the amount of inhibition (Fischler & Bloom, 1979; Stanovich & West, 1981; but see Stanovich & West, 1983, Experiment 4). Most authors, accepting the two-process theory of Posner and Snyder (1975), have assumed that the effect of the ratio between related and unrelated targets is mediated by attention mechanisms (e.g., Fischler & Bloom, 1985; Stanovich & West, 1983; Tweedy, Lapinski, & Schvaneveldt, 1977). Specifically, it has been assumed that lowering the proportion of related targets discourages word-perception strategies based on context-related expectations.

A similar manipulation was used to compare semantic versus syntactic priming effects in visual word perception (Goodman et al., 1981; Seidenberg et al., 1984). These studies suggested that the syntactic priming effect is mediated primarily by postlexical strategic mechanisms. In these studies, however, no attempt was made to examine the effect of separately manipulating subjects' strategies to operate selectively on the facilitatory and inhibitory components of the syntactic priming effect. We applied the blocked versus mixed presentation technique to disentangle the effect of attention-mediated strategic mechanisms on each of these two components.

The blocked condition is an extreme case of manipulating the ratio between incongruent and congruent sentences in which the ratio of incongruent to congruent stimuli is either 1:0 or 0:1. This proportion was contrasted with a 1:1 ratio of incongruent and congruent stimuli that was used in the mixed condition. Therefore, the comparison between the blocked and mixed modes of presentation should maximize the effect of strategic processes that may mediate syntactic priming. A differential effect of the presentation mode on the percentage of correctly identified words in congruent and incongruent sentences should suggest that attention is differentially involved in the mediation of the facilitatory and inhibitory components of the syntactic priming effect. Particularly, the involvement of strategic or controlled mechanisms should reduce interference in the blocked presentation, leading to a higher percentage of identification of incongruent targets. On the other hand, the absence of an interaction between the modes of presentation and the congruity of the sentence should indicate that attention mediates the two components to a similar extent.

### *Method*

#### *Subjects*

The subjects were 60 undergraduate students who had not taken part in the first experiment. They participated in this experiment for course credit or for payment. They were all native speakers of Hebrew with no known hearing problems.

#### *Materials*

The sentences were those used in Experiment 1, not including the neutral stimuli. Thus, each stimulus list included 40 sentences, 20 congruent and 20 incongruent. In the mixed presentation, the 40 sentences were randomized and presented in one block. In the blocked presentation, congruent and incongruent sentences were clustered separately in two blocks of 20 sentences each. The sentences in each of the two blocks were randomized.

A target appeared only once in each list (with the exception of sentences of Type 4; see above). Across lists, each target appeared equally often in the congruent and incongruent conditions.

#### *Procedure*

A different set of 30 subjects was tested with each presentation mode. Subjects were randomly assigned to one of the lists so that each subject was exposed equally to syntactical congruous and incongruous sentences.

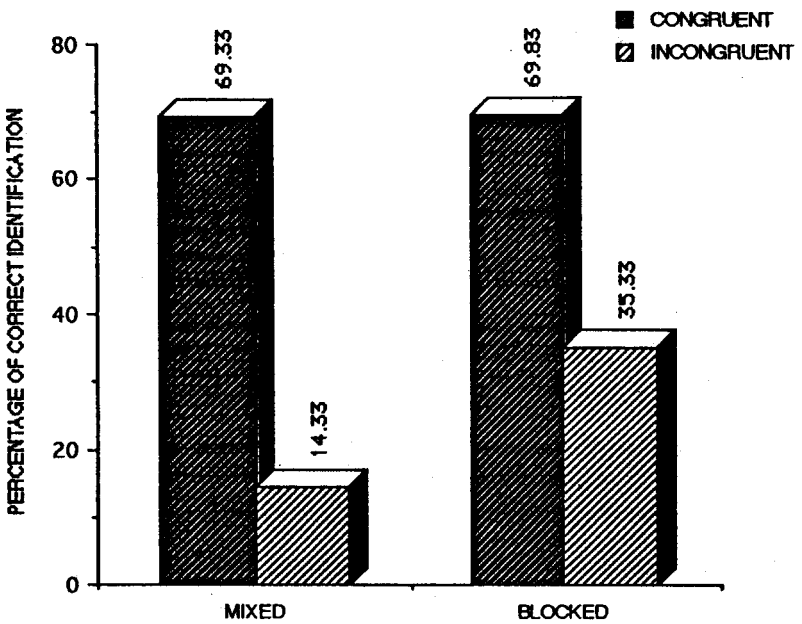


*Figure 2.* The percentage of correctly identified congruent and incongruent targets in the mixed and blocked presentation conditions.

The mixed presentation followed the same experimental procedures as in Experiment 1. The experimental list was preceded by a mixed list of 12 practice sentences (6 congruent and 6 incongruent).

In the blocked presentation, 15 subjects began with the congruent block and 15 with the incongruent block. Each block was preceded by eight practice sentences in the respective congruity condition. No special instructions were given before the incongruous block, but the "peculiar" structure of the sentences was not denied in reply to occasional queries raised by the subjects following practice with incongruous sentences (as was true for the mixed condition as well).

### *Results*

The percentage of correct identification of targets was averaged for each subject and target in each congruity condition. Separate means were computed for each presentation group. The percentages of correct identification of syntactically congruent targets were almost identical in the blocked and the mixed presentation groups. In contrast, more incongruent targets were identified in the blocked than in the mixed presentation (see Figure 2).

The statistical significance of the observed differences was tested by two-factor analyses for subjects ($F_1$) and for stimuli ($F_2$). The factors were Congruity Condition (congruent and incongruent) and Mode of Presentation (mixed and blocked). Both main effects were significant, $F_1(1, 58) = 486.7$, $p < .0001$, $MS_e = 123$; $F_2(1, 59) = 128.7$, $p < .0001$, $MS_e = 937$; and $F_1(1, 58) = 18.1$, $p < .0001$, $Ms_e = 192$; $F_2(1, 59) = 21.6$, $p < .0001$, $Ms_e = 296$, for the congruity and mode of presentation effects, respectively. The most interesting result, however, was the significant interaction between the two factors, which showed that presenting incongruent and congruent sentences in separate blocks improved the identification of incongruent targets but had no effect on congruent targets, $F_1(1, 58) = 25.6$, $p < .0001$, $MS_e = 123$; $F_2(1, 59) = 21.9$, $p < .0001$, $MS_e = 256$.

Errors in Experiment 2 were categorized and analyzed by using the same types as elaborated in Experiment 1 (Table 2). In the congruent condition, the distribution of errors was similar for mixed and blocked presentation modes; the interaction was not significant, $F(2, 116) = 0.67$, $p > .05$, $MS_e = 729$. Errors were unevenly distributed among types, $F(2, 116) = 70.9$, $p < .0001$, $MS_e = 729$. The pattern of this distribution was similar to that of Experiment 1: There were significantly more semantic completions than no-response errors ($p < .01$). In the incongruent condition, on the other hand, there was a significant interaction between the distribution of errors among the types and the mode of presentation, $F(3, 174) = 5.2$, $p < .01$, $MS_e = 294$. Post hoc analysis (Tukey *a*) revealed that, although significantly fewer correction than no-response errors were made in both presentation modes ($p < .01$), the difference was larger in the mixed than in the blocked presentation.

Table 2
*Mean Percentage of Error and Standard Error of the Mean for Each Error Type*

| Congruity condition | Error type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Syntactic correction | | Semantic completion | | Nonsense | | No response | |
| | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ |
| Congruent | | | | | | | | |
| Mixed | — | — | 63.7 | 5.7 | 0.4 | 0.4 | 33.9 | 5.2 |
| Blocked | — | — | 56.6 | 4.5 | 2.9 | 1.4 | 37.1 | 4.4 |
| Incongruent | | | | | | | | |
| Mixed | 17.5 | 1.8 | 22.2 | 2.5 | 4.0 | 1.2 | 56.4 | 3.3 |
| Blocked | 13.9 | 1.8 | 30.2 | 3.6 | 11.8 | 2.1 | 43.4 | 4.1 |

*Note.* Dashes indicate data not applicable to error type.

### *Discussion*

The present results demonstrated that manipulating the proportion of congruent and incongruent sentences in the experimental list affects only the inhibitory component of the syntactic priming effect. In comparison to a mixed presentation (1:1 ratio), the presentation of incongruent and congruent sentences in separate blocks reduced the amount of inhibition without altering the amount of facilitation. Assuming that this manipulation influences primarily strategic components, the present results suggest that syntactic priming includes attention-mediated mechanisms that are reflected more in its inhibitory than its facilitatory effects.

An attention-based mechanism that could have been affected by our manipulation may be related to a strategic process of forming context-based expectations about the target's grammatical form. Such expectations may be formed while processing the syntactic structure of the context and may lead to the anticipation of a particular grammatical form. Disconfirmation of these expectations may interfere with the integration of the target and the context and raise doubts about its identity. In particular, when the perceptual information is degraded, such a process may lead to an enhanced percentage of identification errors. This whole strategy, however, could have been discouraged by frequent syntactic incongruence because the subject no longer expected syntactic coherence.

In Experiment 2, the amount of inhibition of target identification should have decreased in parallel to the reduction of the percentage of congruent sentences in the list. Examination of the percentage of correctly identified incongruent targets, across Experiments 1 and 2, conformed to this prediction: Incongruent targets were identified least often (14.3%) in the mixed condition of Experiment 2, in which 50% of the sentences were congruent; more often in Experiment 1 (27.3%), in which, as a result of the neutral condition, only 33% of the sentences were congruent; and most often in the blocked condition of Experiment 2 (35.3), in which there were no congruent sentences. In contrast, the proportion of congruent sentences did not affect the percentage of correctly identified congruous words significantly (69.3%, 74.8%, and 69.8% in the mixed presentation of Experiment 2, in Experiment 1, and in the congruent block of Experiment 2, respectively). This suggests that the facilitatory component of the syntactic priming effect is less sensitive to strategic mediated processes.

Additional support for our interpretation is provided by the distribution of errors among the different types. A comparison between the mixed and blocked presentation modes revealed that the percentage of semantic completion and nonsense errors (those that appeared to be less concerned about the context sentence) was higher in the blocked than in the mixed presentation modes, whereas the opposite trend was observed for no response and syntactic correction errors (which reflect the effect of the priming effect induced by the syntactic structure of the sentence). Hence, it appears that the syntactic context effect on word identification was reduced in the blocked relative to the mixed presentation mode. The restriction of this interaction to the incongruent condition is in agreement with our hypothesis that context-based expectation is one of the factors involved in producing the syntactic priming effect on word identification.

It is worth noting that the results of Experiment 2 diverge from the results of Stanovich and West (1983), who found that the pattern of contextual (semantic) effects was not altered by increasing the proportion of congruent targets. This divergence could reflect task differences[4] or that the manipulation of blocking congruity condition was more powerful than changing the proportion of congruent and incongruent targets within a mixed block. However, this divergence might also suggest a fundamental difference between the involvement of attention in semantic and syntactic context effects.

In Experiment 3, we used a different method to manipulate the subjects' tendency to elaborate expectations as a strategy of word identification in an attempt to corroborate the differential involvement of attention with the facilitatory and inhibitory components of the syntactic priming effect.

## Experiment 3

In contrast to Experiment 2, in which our manipulation was meant to discourage the reliance on context-based expectations for specific syntactic forms, in Experiment 3 we sought to encourage this strategy.

Studies of semantic priming revealed that the length of the interstimulus interval (ISI), or the stimulus onset asynchrony (SOA), between the context and the target influences the relative weight of the attention-based component of the priming effect with single-word (Antos, 1979; Neely, 1977) and sentence contexts (Stanovich & West, 1979). Different ISIs were used in different studies, and the general consensus among authors is that, within a limited range of times, the tendency to use context-based expectations increases with longer ISIs. Perhaps at longer ISIs the distinction between the context and the target (particularly in sentences) is clearer and the subject has more time to process the context and generate such expectations.

The effect of the ISI between context and target on syntactic context effects is not as clear as on semantic priming. For example, using a lexical decision task with printed Serbo-Croatian stimulus pairs, Lukatela et al. (1982) found significantly larger syntactic priming effects when the SOA was 800 ms than when it was 300 ms. However, with auditory stimuli (in Serbo-Croatian), Katz et al. (1987) did not find a reliable interaction between the length of the ISI (0 ms vs. 800 ms) and the magnitude of the syntactic priming on lexical decision. Despite the apparently divergent results, both groups of authors suggested that the syntactic context effect reflects the operation of an autonomous automatic module rather than an attention-mediated mechanism. However, as Katz et al. pointed out, it is possible that this conclusion holds only for the particular case of inflectional morphology characteristic of Serbo-Croatian. Indeed, indirect evidence for nonautomatic aspects of syntactic priming has been found in English (Tanenhaus et al., 1979). By using a naming task, these authors reported that at 0-ms SOA subjects were insensitive to specific

[4] Stanovich and West (1983) used a speeded lexical decision, whereas in Experiment 2 we have imposed no time constraints on our identification task. It is possible that in speeded task, subjects are less likely to develop strategies in which they use all the information at their disposal to aid word identification.

syntactic (and semantic) forms of the prime, whereas at 200 ms the targets were facilitated only by appropriate forms. Summarizing these results, Tanenhaus et al. suggested that at longer SOAs syntactically inappropriate forms are inhibited by a veiled controlled process. The time course of the controlled process, however, was obscured by the finding that at 600-ms SOA its effect was not as evident as at 200-ms SOA. Together, the previous studies cannot unequivocally support or reject the existence of attention-mediated components of the syntactic priming effect. An additional step toward the clarification of the role of attention in syntactic priming can be made by distinguishing between effect of ISI manipulation on the inhibitory and facilitatory components of syntactic priming.

In Experiment 3, we used two ISIs between the context and the target. One was set at the normal speech rate (immediate target) and the other was 350 ms (delayed target).[5] On the basis of the results of Experiment 2, we anticipated that the ISI manipulation should affect primarily the inhibitory component. More specifically, we predicted that when the target is delayed, syntactic incongruity should have a more deleterious effect on the identification of targets than when it immediately follows the context, whereas the facilitatory effect should not change.

## Method

### Subjects

Thirty new subjects participated in this experiment. They were naive undergraduates who had not taken part in the previous experiments and participated in this experiment for course credit or for payment. Their performance was compared with that of the 30 subjects who were tested in the mixed condition of Experiment 2. All the subjects were native speakers of Hebrew with no known hearing problems.

### Stimuli and Design

The stimulus lists were those used in the mixed presentation condition of Experiment 2. The only alteration was the introduction of a silent period of 350 ms between the offset of the last unmasked word in the context and the onset of the masked target. The 30 new subjects were tested with these lists, that is, in the delayed target condition. Their performance was compared with the performance of the mixed presentation group in Experiment 2, who heard the same lists at a normal speech rate (thus, the ISI was close to 0). Each subject was exposed equally often to syntactical congruous and incongruous sentences. The subject analysis was a mixed model ANOVA. The effect of ISI was tested between groups and the syntactic congruity effect within subject.

Across subjects, each target appeared equally in the congruent or incongruent conditions and in the immediate and delayed conditions. Thus, the stimulus analysis was completely within stimulus.

### Procedure

The experimental procedure of Experiment 3 (in which we tested only the delayed condition) was the same as that used in the mixed presentation condition of Experiment 2. The test list was preceded by 12 practice sentences that included the silence interval. Except for being informed about the brief silence period preceding the masked target word, the subjects were instructed in the same way as in the mixed presentation condition of Experiment 2.

## Results

The percentage of correct identification of targets was averaged for each subject and each target in each congruity condition. These results were compared with the percentage of correct identifications of congruent and incongruent targets in the mixed presentation condition of Experiment 2 (see Figure 3). Congruent targets were identified almost identically as often in the two ISI conditions. In contrast, the percentage of identification of incongruent targets was smaller when the targets were delayed than when they were presented at speech rate.

The statistical significance of the observed differences was tested by two-factor analyses: mixed model for subjects ($F_1$) and repeated measures for stimuli ($F_2$). Both the congruity and ISI main effects were reliable: for the congruity effect, $F_1(1, 58) = 848.1, p < .0001, Ms_e = 123; F_2(1, 59) = 232.7, p < .0001, Ms_e = 880$, and for the ISI effect, $F_1(1, 58) = 5.2, p < .05, Ms_e = 159; F_2(1, 59) = 7.412, p < .01, Ms_e = 268$. The most important result, however, was the reliable interaction between the two factors, revealing that the 350-ms silent interval reduced the identification of incongruent targets but had no effect on congruent targets, $F_1(1, 58) = 4.1, p < .05, Ms_e = 123; F_2(1, 59) = 4.4, p < .05, Ms_e = 211$.

The distribution of errors in the different ISI conditions is presented in Table 3.

The ISI manipulation affected the distribution of errors in the incongruent condition, $F(3, 174) = 2.72, p < .05, MS_e = 209$, but not in the congruent condition, $F(2, 116) = 2.15, p > .12, MS_e = 833$. Across conditions, the distribution of errors was similar to that observed in Experiments 1 and 2 and was significant, $F(3, 174) = 179.3, p < .0001, MS_e = 209$, and $F(2, 116) = 61.2, p < .0001, MS_e = 833$, in the incongruent and congruent conditions, respectively. Post hoc analysis (Tukey *a*) of the interaction revealed that, although no-response-type errors were more abundant when targets were delayed than with normal speech rate, the percentage of the other three error types was less in the delayed than in the normal speech rate condition.

## Discussion

Presenting the targets with a delay of 350 ms from the context phrases reduced the percentage of correct identification of incongruent targets but had no effect on the identification of congruent targets. These results confirmed our previous observations that the facilitatory and inhibitory components of the syntactic priming effect are differentially sensitive to the manipulation of attention-based strategies of word identification.

In Experiment 3, as well as in Experiment 2, our manipulation affected only the inhibitory priming component, although

[5] This particular ISI was chosen on the basis of pilot studies. In Experiment 3, we wanted to demonstrate the ISI effect on the two components of the syntactic priming effect and not examine the precise time course of the putative controlled component. Therefore, we examined different ISIs (1,000 ms, 500 ms, and 350 ms), but completely analyzed only the latter, which had the most conspicuous effect.

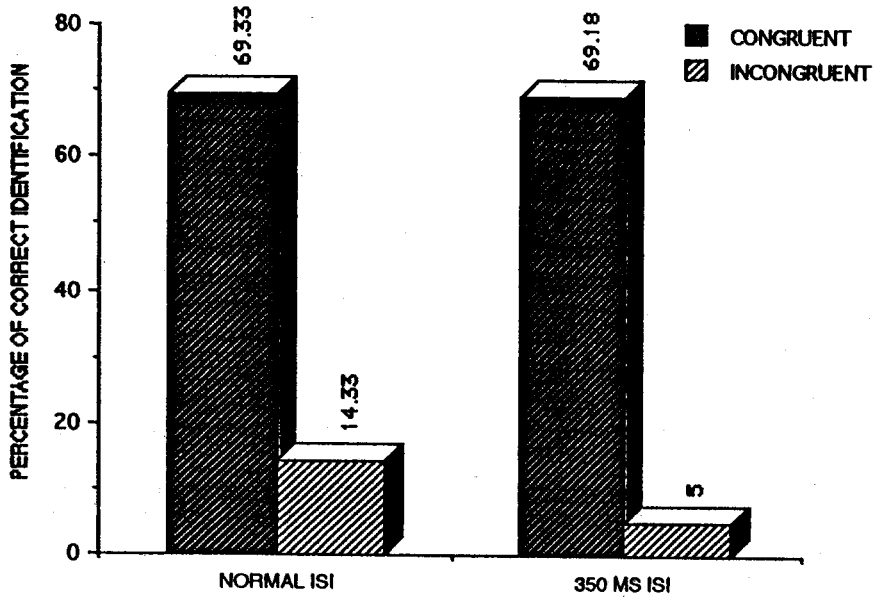


*Figure 3.* The percentage of correctly identified congruent and incongruent targets at normal speech rate and with 350-ms interstimulus interval (ISI) between context and target.

in the opposite direction for the two experiments. Because subjects were similarly instructed in both experiments, no a priori changes in task performance strategies should have been expected. Therefore, these results suggest that, despite the opposite effect, a similar attention-mediated priming process was manipulated in both experiments. Assuming that in both experiments the process involves context-based expectations, the results of both experiments support our distinction between an inhibitory component of syntactic priming, which reflects an attention-mediated process, and a facilitatory component, which is less reliant on attention mediation.

The distribution of errors is in complete agreement with the above interpretation. Again, the ISI manipulation affected the distribution of errors only in the incongruent condition. However, the trend of this interaction was opposite to that found in Experiment 2. Whereas discouraging the use of context-based expectations in the blocked, relative to the mixed, presentation mode increased the percentage of semantic completion and nonsense error types, encouraging such a strategy by introducing a longer ISI led to a decrease of such errors although increasing the percentage of no-response errors.

Despite the correspondence between the results of the two experiments and the coherence of the emerging picture, the ISI manipulation should be considered with caution. Previous studies of the time course of sentence-context effects on word perception are inconclusive. For example, Fischler and Bloom (1979, 1980) presented written sentences word by word, manipulating the presentation rate. Contrary to our results, they found almost no facilitation of lexical decision for expected target words, although the inhibition of incongruous targets was evident at all presentation rates. Their conclusion was that the effect of the sentence semantic context on word identification is limited to an inhibitory postlexical process. This inhibition is probably related to the sentences' semantic incongruity and is not sensitive to the manipulation of ISI. A closer look at their data, however, reveals that, in agreement with our results, the magnitude of the inhibition effect on lexical decision (speed and accuracy) was twice as large at the slower rates (4 and 12 words per second) than at the higher presentation rates (20 and 28 words per second).

One problem in analyzing the delay effect is that different studies manipulated different time intervals. It is possible that this effect is not monotonic and that it differs with factors such as task, presentation modality, and the linguistic context that is investigated. It is therefore possible that relatively small differences in the particular ISIs compared in different studies account for the variation of the results. The results of two pilot experiments that preceded Experiment 3 support this possibility. In these pilot experiments, we explored the effect of 500- and 1,000-ms ISIs as compared with normal speech rate. The effect of syntactic priming at these ISIs was not reliably

Table 3
*Mean Percentage of Error and Standard Error of the Mean for Each Error Type*

| Congruity condition | Error type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Syntactic correction | | Semantic completion | | Nonsense | | No response | |
| | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ | *M* | $SE_M$ |
| Congruent | | | | | | | | |
| Normal | — | — | 63.7 | 5.7 | 0.4 | 0.4 | 33.9 | 5.2 |
| 350 ms | — | — | 53.1 | 5.2 | 1.8 | 1.2 | 45.1 | 4.8 |
| Incongruent | | | | | | | | |
| Normal | 17.5 | 1.8 | 22.2 | 2.5 | 4.0 | 1.2 | 56.4 | 3.3 |
| 350 ms | 15.2 | 1.5 | 17.9 | 2.5 | 1.9 | 0.9 | 65.4 | 3.2 |

*Note.* Dashes indicate data not applicable to error type.

different than at normal speech rate. An interesting trend emerged, however, across the ISIs. At 1,000 ms, the increase in inhibition was accompanied by a decrease in facilitation. Relative to 1,000 ms, the 500-ms ISI caused a smaller decrease in the magnitude of the facilitation and an even bigger increase in the inhibition effect. Finally, as reported in Experiment 3, the 350-ms ISI had no effect on the magnitude of the facilitatory component although it significantly increased the magnitude of the inhibition. Thus, it appears that the interaction between ISI and the syntactic context effect is limited to a specific range. This limit might also account for the absence of a difference between the syntactic congruity effect at 0- and 800-ms ISI in the Katz et al. (1987) study. Despite this caution, however, our results suggest that ISI manipulations, when carefully applied, may reveal interesting aspects of context effects.

The inherent problems of ISI manipulations are not essential, however, to our conclusions regarding the involvement of attention in mediating syntactic priming effects. Therefore, we may resume our discussion of the relation between attention mechanisms and the syntactic context effects as revealed in Experiments 1–3.

## General Discussion

In these experiments, we examined inhibitory and facilitatory aspects of syntactic priming as reflected in the identification of auditorily masked Hebrew target words that were presented as the final words following unmasked sentence contexts. In Experiment 1, we found evidence for both components. In addition, the data indicated that, at least for our experimental conditions, facilitation and inhibition contribute equally to the syntactic priming effect. In Experiments 2 and 3, we found that manipulation of attention-related strategies affected the magnitude of the inhibition but had no effect on facilitation. The presentation of congruent and incongruent sentences in separate blocks attenuated inhibition relative to a mixed condition. On the other hand, the insertion of 350 ms of silence between the context and the target amplified the inhibition relative to the normal speech rate.

The scarcity of syntactic corrections across experiments allowed us to argue against the possibility that the variation in the percentage of correct identifications between the different congruency conditions simply reflected a strategy of intelligent guessing on the basis of partially identified information. This possibility was also refuted by the abundance of no-response errors relative to semantic completions in the incongruent condition, on the one hand, and the increased percentage of semantic completion errors at the expense of no-response errors in the congruent condition, on the other hand. Therefore, we suggest that the results indicate that the syntactic context effects observed in our study were probably related to syntactic priming, whose putative nature is discussed below.

In accord with the commonly held account of attention-mediated factors in semantic priming (Fischler, 1977; Fischler & Bloom, 1979; Neely, 1977; Stanovich & West, 1981, 1983), we suggest that our manipulations in Experiments 2 and 3 affected an attention-requiring mechanism that mediates elaboration of context-based expectations.

In an attempt to explain the role of these expectations in syntactic priming, we have borrowed one of the suggestions offered for explaining the attention processes involved in the construction of expectations on the semantic domain and extended it to the syntactic domain. This suggestion is the assumption of coherence formulated by de Groot, Thomassen, and Hudson (1982), which states that the processing of the linguistic message is affected by the reader's (or the hearer's) covert assumption that every linguistic message is coherent (de Groot et al., 1982). This covert assumption creates an expectation that each word in the linguistic message will be coherent with the context in which it appears. This expectation may induce a check aimed at verifying that the coherence really exists. The check is performed postlexically, and so the effect of the checking process on the process of word identification is always inhibitory, because it delays the final identification of the word until it has been verified that the provisionally identified word is coherent with the context. Consequently, although the effect of the checking process on word identification is always inhibitory, it is stronger in cases in which the coherence assumption is not satisfied. It is possible that the triggering of coherence checking is automatic, whereas its full expansion requires attention that may be attracted by the detection of an incoherent input. The last assumption is suggested by findings showing that in the semantic domain the inhibition process is unavoidable.

In contrast to previous studies of syntactic priming that found that the syntactic priming effect is mainly inhibitory (e.g., West & Stanovich, 1986), we found that the identification of congruent targets was facilitated relative to a neutral condition. Regardless of task-related reasons for this discrepancy (which were discussed in Experiment 1), we may speculate on possible sources of this facilitation. In semantic priming, facilitation is assumed to reflect two different processes (Neely, 1977): One is an automatic spreading of activation among related nodes in the semantic network (Collins & Loftus, 1975). The second process is the confirmation of context-dependent predictions regarding target identity (Becker, 1980). Because the existence of a syntactically organized network is supported neither by empirical evidence nor by theoretical considerations, the mechanism of spreading activation is an improbable source of facilitation in syntactic priming. Therefore, the facilitation of syntactically congruent targets can be better explained by a process that relates to an integrative process of syntactic analysis that may lead to an anticipation of some sort. The prediction of a specific word on the basis of semantic context cannot be directly applied to syntactic priming because the exact identity of the target (considering also its semantic meaning) could not be predicted by the context (Oden & Spira, 1983; Tanenhaus et al., 1979; Tyler & Wessels, 1983). Therefore, we suggest that the same covert assumption of coherence that is assumed to underlie the inhibition process also underlies, in the syntactic domain, the facilitation process. In contrast to the widely branching system of connections that is characteristic of the semantic network, the system of connections in the syntactic domain is limited by the closed and relatively small set of existent basic syntactic structures and by the limitations of the morphological system. It is therefore plausible that grammatical predictions based on

syntactic analysis are rather specific. Therefore, we suggest that, unlike the application of the coherence assumption in the semantic domain that may produce only inhibition, in the syntactic domain the same basic assumption may produce both inhibition and facilitation. The facilitatory effect of the syntactic context may be related to the activation of more specific expectations selected from a system with a limited number of possibilities. Such expectations might reduce the amount of phonological information necessary for an unequivocal identification of an inflected target relative to a situation in which syntactic expectations cannot be supportive.[6] However, as we elaborated above, the coherence check is triggered after some initial stimulus-identification processes have been accomplished. Consequently, it is unlikely that this mechanism may influence the syntactic parser that is assumed to act very early during sentence processing (e.g., Koriat & Greenberg, 1991). Rather, it may facilitate the definite stimulus identification by facilitating its integration with the syntactic structure of the context.

The above proposal, that in syntactic priming both the facilitation and the inhibition are mediated by the formation of context-based expectations, should not imply that they are based on an identical mechanism or that attention is similarly involved in both. It is conceivable that the mere tendency to generate grammatical expectations and the triggering of the coherence check are not under strategic control. This view is compatible with the residual inhibition observed in the incongruent block, which suggests that despite the clear incongruent structure of all sentences, the initial expectations could not be completely avoided. Hence, at the sentence level, the expectations are probably generated by a veiled controlled process that uses only minimal attention resources (Schneider & Shiffrin, 1977), and the triggering of the coherence check is automatic. Such a process probably underlies the facilitatory mechanism of syntactic priming. On the other hand, as discussed above, when the same expectations are violated by incoherent input, attention is mobilized to control the additional process of reevaluation, which we suggest is the main mechanism of the inhibition. Consequently, strategic changes should influence the magnitude of the inhibition but have only minimal effect on the facilitation. The interaction between the distribution of errors and the presentation procedure that was found in Experiments 2 and 3 only in the incongruent condition supports this view. Attenuating the tendency for reevaluation of context-based expectations (in Experiment 2) reduced no-response and syntactic-correction errors and increased the percentage of semantic and nonsense responses. On the other hand, facilitating the elaboration of context-based expectations (in Experiment 3) increased subjects' uncertainty as manifested by the increase in the no-response-type errors. Should this process influence lexical access rather than postlexical reevaluation, the opposite manipulations of subjects' strategies in Experiments 2 and 3 should have had an effect on the overall percentage of correct identification in the incongruent condition but not on the distribution of errors.

Our hypothesis, that attention-mediated mechanisms are the basis of both the facilitation and the inhibition of performance in the syntactic priming task, also implies that the allocation of attention, at least in language processing, is not an all-or-none phenomenon. Rather, on the basis of data-driven or predetermined strategies, different amounts of attention resources are directed to the different aspects of language perception processes.

Before concluding, we should raise two caveats regarding the above discussion. The first is that it is possible that the syntactic priming effects that were found in our experiments (and consequently our interpretation) are limited to the identification task that was used. The need to identify degraded stimuli might have induced a situation of uncertainty that might have augmented the need to reevaluate the auditory input vis-á-vis the context. In particular, the inhibition might have been much smaller if the auditory input was clear. However, electrophysiological studies of semantic incongruity have suggested that incongruous final words elicited additional brain activity even when clearly seen (for reviews, see Bentin, 1989; Kutas & Van Petten, 1988). Several authors attributed this activity to a need to reevaluate the context in an attempt to integrate the unexpected information, a mechanism fairly similar to the one that we suggested in our experiments (e.g., Rugg, 1990). Therefore, we believe that by using degraded stimuli, we were able to tap mechanisms of top–down processing of syntax that are available to the language speaker. The second caveat is that, in our experiments, we have used only a limited type of rules that are language specific. As briefly mentioned in the discussion of Experiment 1, agreement rules may play different roles and may vary in importance in different languages. Although in a previous study (Bentin et al., 1990), we found syntactic priming by using 10 different syntactic rules, claims about the universality of the syntactic context effect and the syntactic-coherence check mechanism should wait for similar investigations in languages other than Hebrew.

[6] A similar model was proposed within the frame of the cohort theory. According to this model, the syntactic context may facilitate word identification by limiting the size of an initial cohort to those members that belong to a single form-class category (Tyler & Wessels, 1983).

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