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Syntactic Priming: Investigating the Mental Representation of Language

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We argue that psycholinguistics should be concerned with both the representation and the processing of language. Recent experimental work on syntax in language comprehension has largely concentrated on the way in which language is processed, and has assumed that theoretical linguistics serves to determine the representation of language. In contrast, we advocate experimental work on the mental representation of grammatical knowledge, and argue that syntactic priming is a promising way to do this. Syntactic priming is the phenomenon whereby exposure to a sentence with a particular syntactic construction can affect the subsequent processing of an otherwise unrelated sentence with the same (or, perhaps, related) structure, for reasons of that structure. We assess evidence for syntactic priming in corpora, and then consider experimental evidence for priming in production and comprehension, and for bidirectional priming between comprehension and production. This in particular strongly suggests that priming is tapping into linguistic knowledge itself, and is not just facilitating particular processes. The final section discusses the importance of priming evidence for any account of language construed as the mental representation of human linguistic capacities.

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Psycholinguistics is concerned with two issues: the mental representation of linguistic knowledge, and the way in which that knowledge is employed in production and comprehension in combination with nonlinguistic knowledge. In practice, recent work in sentence comprehension has largely concentrated on the second issue. It has recognized that the mental representation of language is an important component of a theory of language processing, but it has in general been content to assume that theoretical linguistics seeks to describe this mental representation, and that theories of comprehension can draw upon the accounts that theoretical linguistics constructs.

This paper argues that this position is neither desirable nor necessary. It is not desirable because an empirical study of an aspect of mental representation ought to be able to draw upon any relevant empirical method to investigate it. If linguistics seeks to explain mental representation (via generalizations based on grammaticality judgments and the like), then its methods are valuable but not unique. If it does not seek to explain mental representation, then it cannot be the final arbiter of a theory of language understanding and production.

If there were no experimental method available to study mental representation, then we might be forced to accept that traditional linguistic theories offer the best hope of capturing the knowledge drawn upon in processing. However, priming can provide such a method. If the processing of a stimulus affects the processing of another stimulus, then the two stimuli must be related along a dimension that is relevant to the cognitive system. Under certain circumstances, we can conclude that they are represented in a related manner. If the relationship between two stimuli is syntactic, then we can use this relationship as a way of understanding what syntactic information is represented, and how that information can interact with other information.

We define *syntactic priming* as the proposal that processing a particular syntactic structure within a sentence affects the processing of the same (or a related) syntactic structure within a subsequently presented sentence. In principle, this priming could be either facilitatory or inhibitory. However, we know of no evidence for inhibitory syntactic priming at present, and so shall merely consider facilitatory priming. Below, we argue that syntactic priming can be used to probe into the representation of syntax. We discuss empirical evidence in detail, considering the study of corpora, priming in production, and priming in comprehension. These methods provide good evidence about the mental representation of syntax, but it is possible that priming is tapping into some specific process rather than representation itself. Stronger evidence comes from *bidirectional* experiments that show priming between comprehension and production. It is unlikely that there is

great overlap between the processes related to syntax that are involved in comprehension and production, so we have good reason to believe that any bidirectional priming is due to shared knowledge. Finally, we discuss the reasonably straightforward implications of syntactic priming for sentence processing research, and the less straightforward implications of syntactic priming for linguistic theory.

PRIMING

Lexical priming experiments demonstrate that the time spent processing a word like *doctor* is reduced if the subject has recently processed a related word like *nurse* (e.g., Meyer & Schvaneveldt, 1971). In these experiments, the categories that subsume the experimental items are assumed, so the experiments are not designed to explore categorization.

However, we can also use priming to investigate categorization. It can address the issue of whether the cognitive system recognizes a relationship between two stimuli, when that relationship is not available to introspection and its existence is open to question. If two stimuli are related only along one particular dimension, and the processing of one stimulus affects the processing of the other for reasons attributable to that relationship (i.e., if priming occurs), then we can infer that the cognitive system is sensitive to that dimension, and that it treats the two stimuli as related within that dimension.

For example, consider the processing of two sentences:

(1) The teacher gave the boy the exercise.
(2) The man showed the woman the letter.

Following standard linguistic assumptions, (1) and (2) are syntactically identical but lexically and semantically distinct. They are lexically distinct, because they employ different sets of open-class words. They are semantically distinct, because their meanings are different. However, they are syntactically identical, because they involve the same syntactic representation. Both sentences might be characterized by the "double-object" rule VP $\rightarrow$ V NP NP, together with the rules S $\rightarrow$ NP VP and NP $\rightarrow$ Det N, to give the following structure:

$$[[\text{DetN}]_{\text{NP}}\ [\text{V}\ [\text{Det N}]_{\text{NP}}\ [\text{Det N}]_{\text{NP}}]_{\text{VP}}]_{\text{S}}$$

If the processing of (1) affects the subsequent processing of (2), or vice versa, then we can infer that syntactic priming occurs. More specifically, the cognitive system is sensitive to syntactic information, and it treats (1) and (2) similarly in this respect. This priming could manifest itself in many ways.

We might find that people would read (2) faster after reading or producing (1), or we might find that they would produce (2) more fluently after reading or producing (1). Priming might also make them more likely to produce (2) rather than the "prepositional object" sentence in (3), which describes the same event:

(3) The man showed the letter to the woman.

If we wish to suggest that such effects arise from syntactic priming, we must attempt to rule out explanations based on nonsyntactic factors. We now consider how syntactic priming effects might be found.

Priming in Corpora

Schenkein (1980) and Tannen (1984, 1989) found a tendency toward repetition in natural dialogue at many different levels, including the lexical and the discoursal levels. Crucially, they found evidence for repetition of syntactic form. Weiner and Labov (1983) found the same effect in interviews, centered upon the repetition of passive sentences.

These syntactic repetition effects do not necessarily demonstrate syntactic priming, because there are several nonsyntactic factors which could lead to syntactic repetition. Language-internal factors include lexical, prosodic, and semantic repetition. Language-external factors include the register of the discourse. For example, formal registers are associated with a high incidence of passive sentences. Weiner and Labov's (1983) results might just reflect shifts in the register used during the interviews which they studied. The relationship between the discourse participants could also be important. Researchers have noted that there is a general tendency for speakers to adapt their speech style according to the listener's style for reasons connected to the social relationship between them (Giles & Powesland, 1975). This could lead to repetition of syntactic structure without any occurrence of syntactic priming. Discourse content could also induce syntactic repetition, either for rhetorical purposes or simply because similar communicative intentions (in elaborating on a topic, for example) might lead to the same syntactic forms. Estival (1985) tried to rule out these types of explanation for syntactic repetition in interviews but it is impossible to be sure that all of the relevant factors were excluded. Corpora have proved useful as a means of hypothesis generation, but unequivocal demonstrations of syntactic priming effects can only come from controlled experiments.

Production-to-Production Priming

Under the guise of a memory test, Bock (1986) presented subjects with prepositional- and double-object sentences like (4):

(4) a. The rock star sold some cocaine to an undercover agent.
b. The rock star sold an undercover agent some cocaine.

After repeating one of these sentences, the subject saw a picture which could be described using either a prepositional-object or double-object construction. For example, the picture might show a girl handing a paintbrush to a man. Bock found that the form of the priming sentence affected the form of the description. Subjects tended to produce a prepositional-object form like *The girl handed a paintbrush to the man* after a prepositional-object prime like (4a), and a double-object form like *The girl handed the man a paintbrush* after a double-object prime like (4b). Bock found similar effects using active and passive prime sentences.

It is possible that these effects are in fact lexical rather than syntactic in nature. Subjects might produce prepositional-object forms after (4a) because they are primed to repeat the preposition *to*. However, Bock (1989) found that prepositional-object sentences prime prepositional-object descriptions even when they involve different prepositions. The priming sentence *The secretary baked a cake for her boss* was as effective as *The secretary took a cake to her boss* in eliciting a description involving *to*, such as *The girl handed the paintbrush to the man.*

Bock and Loebell (1990) used the same technique to test whether priming reflected what they termed event-structural (roughly, thematic) or metrical similarities between the priming sentence and the description. They found that locative sentences such as *The foreigner was loitering by the broken traffic light* primed passive descriptions. This result suggests that the level of representation accessed by priming contains certain aspects of syntactic representation but does not include a specification of thematic information. In addition, it suggests that this level of representation does not include anything corresponding to NP-trace. In this experiment, the priming effect could conceivably be lexical rather than syntactic, but this is very unlikely, given Bock (1989). Bock and Loebell also showed that priming could not be attributed to metrical similarity. Priming did not occur when the prime had the same metrical structure as the target, but a different constituent structure. For example, *Susan brought a book to Stella* primed *The girl gave a brush to the man*, but *Susan brought a book to study* did not, despite the metrical similarity between the two priming sentences.

Bock, Loebell, and Morey (1992) examined the interaction of grammatical relations and constituent structure in language production. In particular, they investigated whether the grammatical role that a noun is initially assigned is the same role that it subsequently bears in the utterance. Some linguistic theories (e.g., Government-Binding theory: Chomsky, 1981) assume that the subject of a passive sentence bears the object relation at an

underlying level of structure. Other theories (e.g., Head-Driven Phrase Structure Grammar: Pollard & Sag, 1987, 1994) assume that the subject of a passive sentence always bears the subject relation. Bock et al. found evidence from syntactic priming which supports the latter position. These experiments suggest that syntactic priming can tap into distinctions of linguistic interest.

Similar effects occur in written language production. Pickering and Branigan (1995) asked subjects to complete booklets of sentence fragments. Embedded within the booklets were priming triplets, like (5) and (6) below:

(5) a. The messenger handed the unsigned note . . .
    b. The senior lecturer loaned the main textbook . . .
    c. The head waiter gave . . .
(6) a. The messenger handed the countess . . .
    b. The senior lecturer loaned the visiting professor . . .
    c. The head waiter gave . . .

The prime fragments (a and b) were designed so that subjects would complete them as prepositional-object sentences [as in (5a) and (5b)] or as double-object sentences [as in (6a) and (6b)]. For example, the first fragment might be completed as *The messenger handed the unsigned note to the prince* in (5a) and as *The messenger handed the countess the letter* in (6a). The target fragment (c) was the same in both conditions and could be completed in either way.

Pickering and Branigan (1995) found that the way in which subjects completed the target fragment was affected by their completions for the priming fragments. Subjects produced prepositional-object completions for the target fragment (e.g., *a drink to John*) more frequently after completing prepositional-object primes than after completing double-object primes. Likewise, they produced double-object completions (e.g., *John a drink*) more frequently after completing double-object primes than after completing prepositional-object primes. The latter finding demonstrated that the effect could not be the result of lexical priming, since there was no lexical repetition between the primes and the target (apart from the determiners which appeared in both conditions). Furthermore, the effect cannot be localized to specific verbs and their argument frames, since priming occurred from sentences containing one verb to sentences containing another.

These results demonstrate that syntactic priming can affect the sentences that are produced in both spoken and written language. In each case, the underlying message that the subject wishes to convey can be expressed in more than one syntactic form. With Bock and her colleagues, we assume that priming affects which syntactic form the subject chooses to produce. However, it is unclear whether priming affects the processes that map from

a deeper level of linguistic representation like functional structure (e.g., Garrett, 1980) to syntactic form or whether it instead affects the representations that specify the possible relationships between functional structure and syntactic form. We return to this issue below when we consider priming from comprehension to production.

Comprehension-to-Comprehension Priming

Mehler and Carey (1967) found evidence that comprehension of a sentence presented in white noise was adversely affected by the previous comprehension of sentences that were superficially similar but had a different syntactic structure (cf. Dooling, 1974). Cuetos, Mitchell, and Corley (in press) found that children were more likely to interpret an ambiguously attached relative clause as being attached to the head noun in a complex NP structure after being exposed to stories containing relative clauses with the same attachment over an extended period. This "tuning effect" may constitute a kind of syntactic priming. Frazier, Taft, Clifton, Roeper, and Ehrlich (1984) had subjects read sentences consisting of two clauses conjoined with *and*. In half the trials, the conjuncts were syntactically or semantically similar, but in the other half they were different. For example, the first conjunct might be the active *The tall gangster hit John*, and the second conjunct the passive *and Sam was hit by the small thug*. They found some evidence that the second conjunct was read more quickly if it was syntactically or semantically similar to the first conjunct than if it was different. However, it was not clear whether all construction types contributed to the priming effect, and whether the results were affected by lexical priming or by semantic relatedness between the conjuncts.

Branigan, Pickering, and Stewart (1995) conducted a more extensive exploration of comprehension-to-comprehension priming in reading, and found strong priming effects with some locally ambiguous constructions. For example, subjects read an "early closure" sentence like (7a) faster immediately after reading another "early closure" sentence, and a "late closure" sentence like (7b) faster after reading another "late closure" sentence:

(7) a. While the woman was eating the creamy soup went cold.
b. While the woman was eating the creamy soup the pudding went cold.

The prime sentence was semantically unrelated to the target and did not contain any of the same content words. The finding is consistent with the intuition that certain "garden-path" sentences become easier to process after repeated exposure. Branigan et al. also found priming effects with two other kinds of locally ambiguous sentences (reduced relatives/main clause ambi-

guities and complement clause/relative clause ambiguities). In these experiments, priming could affect the processes that map from a level of representation that specifies hierarchically unstructured syntactic categories to the level of constituent structure, or it could affect the representations that specify the possible relationships between this level of representation and constituent structure.

Urbach, Pickering, Branigan, and Myler (1995) used event-related brain potentials (ERPs) to investigate whether priming occurred with sentences like (7), when the thematic structure of the prime and the target were different. For example, the prime sentence might contain subordinate verbs that took a percept subject and an optional experiencer object:

(8) a. Although the film was frightening the young child enjoyed the plot.
b. Although the film was frightening the young child the mother enjoyed the plot.

ERP studies by Osterhout and Holcomb (1992) and Urbach and Pickering (1995) showed that, in a range of "garden-path" constructions, the disambiguating word elicited a characteristic positive deflection in the waveform between about 500 ms and 800 ms post-stimulus. In particular, Urbach and Pickering showed this effect for sentences like (7a). In the syntactic priming study, Urbach et al. found that the positive deflection elicited by the disambiguating word in target sentences like (7a) was reduced when the sentence was preceded by (8a) compared with (8b). These results demonstrate syntactic priming, and suggest that thematic information is not relevant to the level of representation accessed by priming, in accord with Bock and Loebell (1990).

Branigan et al. (1995) only found a priming effect in comprehension with sentence pairs where one of the sentences produced an intuitively strong garden-path effect. They did not find reliable priming with two other kinds of locally ambiguous sentences (reduced complement "NP/S" ambiguities and PP-attachment ambiguities). Nor did priming effects occur with prepositional-object/double-object pairs like (9a) and (9b) below:

(9) a. The hurdler gave the whistle to the judges.
b. The hurdler gave the judges the whistle.

Here the priming sentence did not facilitate reading of the target. Similarly, no reliable priming effects occurred with active/passive pairs or with subject/object relative pairs. These results in comprehension contrast with Bock (1986, 1989) and Pickering and Branigan (1995), who found priming effects with prepositional-/double-object sentences and active/passive sentences in production.

The results from comprehension and production can be reconciled under the assumption that priming occurs when the processor has to make a choice between two syntactic analyses. In garden-path sentences, an initial sentence fragment is compatible with more than one syntactic analysis. In production, an underlying message can be assigned more than one syntactic form. Following Branigan et al. (1995), there appears to be a strong competitive component to syntactic priming. At least a large part of any priming effect appears to be due to the processor reaching a point at which it has to choose one analysis and discard another. Priming appears to be able to influence the way in which an analysis is adopted. Weak garden-path sentences might not have produced detectable priming effects in comprehension because both analyses can be reached unproblematically in these cases. It is also possible that small priming effects occur in the absence of competition between syntactic alternatives.

Comprehension-to-Production Priming: Evidence About Knowledge of Syntax?

Production-to-production priming might reflect the activation of processes that map from a level of representation like functional structure to a level like constituent structure. Similarly, comprehension-to-comprehension priming might reflect the activation of processes that map from a level of representation containing hierarchically unstructured syntactic categories to one of constituent structure. Although priming in both cases must implicate syntactic rules and representations, we cannot be certain that either method taps into syntactic knowledge itself.

According to Bock and Loebell (1990), production-to-production priming could be due to the facilitation of procedures involved in production, and comprehension-to-comprehension priming could be due to the facilitation of procedures involved in comprehension: "Assuming that production mechanisms are distinct from parsing mechanisms, a strict procedural view would predict no intermodality [i.e., bidirectional] priming." (p. 33, our comment in brackets). Hence, evidence of bidirectional priming would support an account in which priming involves the accessing of knowledge involved in processing both prime and target. However, Bock and Loebell went on to say: ". . . if the assumption is wrong, even a procedural account would predict intermodal effects." In the absence of any clear theory about particular syntactic processes that are shared between production and comprehension, we assume that bidirectional priming should be explained in terms of shared syntactic knowledge.

Levelt and Kelter (1982) showed that the form of a question affects the form of answer produced (in Dutch). For example, they found that shop-

keepers more often answered the question *At what time does your shop close?* with *At five o'clock* than *Five o'clock*, but the question *What time does your shop close?* elicited more *Five o'clock* responses. The effect appeared to be short-lived, because it disappeared when an additional clause was added to the question.

These results provide some evidence for syntactic priming from comprehension to production. Clearly there is syntactic repetition here, but the effect could perhaps be due to lexical priming of the preposition. In addition, the circumstances are quite specific, and it is difficult to generalize on the basis of Levelt and Kelter's (1982) results. The prime sentence is very closely related to the response, as a consequence of the question–answer format. For instance, there is likely to have been a great deal of repetition of lexical items. It is also possible that the response simply "inherits" the syntactic form of the question, because the answerer implicitly employs the same verb. If the answer is simply *At five o'clock* (or *Five o'clock*), then the subject is assuming the verb employed by the questioner. It is reasonable to suppose that the subject also remembers the subcategorization frame used in the question as well, and employs that frame again. Phrasal answers are in many ways within the syntactic scope of the question (e.g., Q: *Who does John love?* A: *Himself.*) and the great majority of responses in Levelt and Kelter's experiment consisted of the temporal phrase alone. These results cannot be taken as strong evidence that bidirectional priming occurs between otherwise unrelated sentences that share syntactic structures.

Pickering and Branigan (1995) found comprehension-to-production priming in cases where there was no semantic relationship between prime and target. Subjects completed the final sentence in passages like (10a) and (10b) below:

(10) a. A soldier was in court, accused of attacking a young man. The victim showed his injuries to the judge. The judge gave . . .
b. A soldier was in court, accused of attacking a young man. The victim showed the judge his injuries. The judge gave . . .

Passage (10a) contains a prepositional-object prime sentence, whereas passage (10b) contains a double-object prime sentence. Subjects were more likely to complete (10a) with a prepositional-object construction, and (10b) with a double-object construction. Interestingly, this effect only occurred for materials in which subjects completed the target sentence without using any pronouns (see Pickering & Branigan, 1995, for discussion). More crucially, the priming occurred with respect to the double-object completions alone. This demonstrated that the priming effect could not be explained in terms of lexical repetition of the preposition.

This experiment suggests that syntactic priming occurs between comprehension and production. It is possible that a process common to both comprehension and production is the source of the priming, but it is extremely unclear what this might be. Instead, we suggest that the source of the priming is the fact that, in both comprehension and production, the syntactic information associated with prepositional-object/double-object alternation is accessed. This knowledge is independent of individual lexical items (e.g., individual verbs). It is instead defined over syntactic categories and is drawn upon whenever a particular construction is employed. We therefore suggest that the information accessed by bidirectional syntactic priming can be equated with the knowledge of language employed during language processing. Below we discuss the implications of this conclusion.

IMPORTANCE OF PRIMING

We distinguish two claims: that priming can provide evidence about how syntactic information is mentally represented and used in sentence processing, and that priming can provide evidence about linguistic theory. We argue that the first claim is straightforward to justify, but that the second claim is likely to be more controversial.

Importance of Priming for Sentence Processing

Syntactic priming has implications for sentence processing in at least two ways. First, it can inform us about the mechanisms of comprehension and production. For instance, research in comprehension is greatly concerned with the way that the processor employs different knowledge sources. Syntactic ambiguity resolution involves the interaction of at least the syntactic characteristics of alternative analyses, the plausibility of the analyses, the compatibility of the analyses with respect to discourse context, and the prosody or punctuation used (e.g., Clifton, Frazier, & Rayner, 1994). Much of the controversy regarding research in sentence comprehension concerns the question of whether particular factors are brought to bear immediately, or whether they have their effects upon reanalysis. Syntactic priming in comprehension demonstrates syntactic aspects of the prior context also affect comprehension. At present, we do not know whether priming affects initial analysis, reanalysis, or both. Eye-tracking may help us to resolve this question. In addition, we do not know how long priming effects persist.

Second, priming could provide evidence about the nature of the syntactic information which is drawn upon during processing. In order to draw this inference, we must rule out the possibility that priming is due to repe-

tition of processes. We have argued that bidirectional (e.g., comprehension-to-production) priming is unlikely to be explained in terms of shared processes, and hence that it provides the best evidence about this syntactic information. However, it is reasonable to suppose that unidirectional priming probably provides evidence about this syntactic information as well.

Experimental evidence from syntactic priming suggests that the syntactic information drawn upon during processing reflects at least some of the distinctions captured by phrase structure rules. Additionally, the fact that syntactic priming takes place between sentences containing different verbs indicates that syntactic information is specified over classes of verbs and is not stored separately as part of each verb's lexical entry.

Most current syntactic priming evidence does not address controversial issues concerning the characterization of the syntactic information drawn upon during processing. For example, all processing theories assume a distinction between prepositional-object and double-object sentences, because they draw upon linguistic theories that make this distinction. Hence the fact that priming occurs between prepositional-object sentences on the one hand and double-object sentences on the other does not provide evidence about the information involved in processing a construction whose analysis is linguistically controversial.

However, the findings of Bock and Loebell (1990) and Bock et al. (1992) from production-to-production priming are potentially more interesting in this respect. Their findings suggest that the production of passive sentences does not involve a structure containing an NP-trace or any process of relation changing (e.g., an underlying object eventually being realized as the subject). Such findings suggest that the transformational account of passive sentences, which assumes both NP-traces and relation changing, cannot be directly incorporated into a theory of language production. Similar evidence in comprehension-to-comprehension priming would suggest that the transformational account could not be directly incorporated into a theory of language comprehension. At present, the question of whether comprehension involves the postulation of entities corresponding to NP-traces is controversial (Barss, 1993; Bever & McElree, 1988; Fodor, 1989, 1993; MacDonald, 1989; McElree & Bever, 1989; Nicol & Swinney, 1989; Pickering & Barry, 1991).

Relevance of Priming to Linguistic Theory

The importance of priming for linguistic theory depends largely on whether we are formalists or cognitivists with respect to linguistic theory. Hence we discuss these two positions in turn.

Formalism. This approach assumes that the aim of linguistic theory is to provide systematic generalizations about the structural properties of lan-

guage construed as an abstract collection of formal objects (e.g., Katz, 1981). The only relevant data are the sentences of the language. Hence, the truth of a linguistic rule is not affected by the mechanisms of processing, any more than the truth of a proposition in mathematics is affected by whether that proposition is used correctly.

If formalism is adopted, then characteristics of mental representation cannot have a direct bearing on linguistic theory. The formalist could pay attention to evidence from syntactic priming or other techniques as a kind of heuristic. If the processor is adaptively successful, then the mental representation of syntactic structure might correspond to the most elegant and economical characterisation of the sentences of the language. However, data about mental representation would have no status within a formalist linguistic theory.

Cognitivism. This approach assumes that linguistic theory seeks to provide an account of language construed as the mental representation of human linguistic capacities. It is clearly the dominant position within generative grammar. This is apparent in the title of Chomsky (1986), *Knowledge of Language*, and throughout his work:

> I would like to think of linguistics as that part of psychology that focuses its attention on one specific cognitive domain and one faculty of mind, the language faculty. (Chomsky, 1980, p. 4)

However, it is not clear that linguistics solely seeks to account for aspects of the mental representation of language that are used during language processing. Any distinctions that are mentally represented must be captured by a cognitivist linguistic theory. But there may be some distinctions motivated by distributional evidence that play some role in language acquisition, but which are irrelevant to the adult speaker. This is discussed in the next section.

If cognitivism is adopted, then experimental findings are evidentially relevant to theory choice, in combination with traditional linguistic findings:

> . . . evidence derived from psycholinguistic experimentation [and] the study of language use (e.g., processing) . . . should be relevant, in principle, to determining the properties of . . . particular grammars. (Chomsky, 1981, p. 9)

The issue is whether the methods that are actually available can produce findings that have any relevance to this choice. It is often claimed that current techniques simply do not tap into knowledge of language:

> One common fallacy is to assume that if some experimental result provides counter-evidence to a theory of processing that includes a grammatical theory T and parsing procedure P . . . , then it is T that is challenged and must be changed. The conclusion is particularly unreasonable in the light of the fact

> that in general there is independent (so-called "linguistic") evidence in support of T while there is no reason at all to believe that P is true. (Chomsky, 1981, p283 fn39)

This argument has some prima facie appeal. As an example, Pickering and Barry (1991; cf. Traxler & Pickering, in press) argued that empty categories are not employed during processing, by presenting evidence that the processor forms unbounded dependencies before the empty category location is reached. However, Gibson and Hickok (1993) showed that the processor can postulate empty categories in a top-down manner before the empty category location is reached. Hence the processing evidence is compatible with either a theory without empty categories and a bottom-up parser, or a theory with empty categories and a partly top-down parser. The problem is that traditional processing evidence does not tap into knowledge of language directly. All we can do is argue that some accounts of representation can be combined with more straightforward accounts of operations that act over those representations than others, and that there should be a preference to adopt these accounts of representation.

Note that Chomsky's argument demonstrates a problem with traditional linguistic methods as well. Grammaticality judgments are clearly complex pieces of processing (which include parsing the sentence, as well as metalinguistic judgments). We cannot be certain that these judgments provide a direct line to knowledge of language; Chomsky (1981) has identified a problem for his own methodologies, as well as those of psycholinguists. These issues are discussed by Bever (1970) and Garnham (1985, pp. 25–27).

Similar worries may occur in the interpretation of priming evidence. However, they are reduced as much as possible. There is no additional judgment beyond comprehending or producing a sentence. Two mental structures that can affect each other must be related in some way. Priming merely assumes that these structures must be placed into the same mental category. Priming between comprehension and production must be explained in terms of some factor that is common to both modalities. Above, we proposed that this common factor is most likely to be the syntactic information that is drawn upon during processing. We now suggest that this information is the knowledge of language that cognitivist theories of linguistics seek to describe.

Need All Linguistic Distinctions Be Mentally Represented?

As stated above, syntactic priming can only tap into linguistic distinctions that are mentally represented in the speaker at the time of testing. More specifically, these distinctions must be actively used in language processing. We say that these distinctions are *rule-guided.* But there may also be ac-

curate linguistic generalizations that are not mentally represented in a manner that is relevant to processing. We say that these distinctions are *rule-describable.* Priming can only provide evidence about rule-guided distinctions, since it is only rule-guided distinctions that can be drawn upon in a theory of sentence processing.

Rule-describable distinctions may in principle exist by chance. But it is most likely that they will correspond to distinctions that are real at some stage in language acquisition, or possibly in language evolution, but which are not relevant to the adult speaker. For example, language users might have once represented a rule that states that the language is strictly head-final. However, adult users of that language might not represent the rule, or employ it during language use. Instead, they might simply represent a set of phrase structure rules, like TVP $\rightarrow$ NP V, DTVP $\rightarrow$ NP NP V, PP $\rightarrow$ NP P. These rules would be used during processing. There would, for instance, be no possibility of priming occurring between these rules on the basis of the rule-describable head-final generalization. This would be the case even if this generalization were rule-guided during language acquisition.

Marslen-Wilson, Tyler, Waksler, and Older (1994) appear to have demonstrated that some distinctions within morphology are rule-guided and some are rule-describable. They found priming between *governor* and *govern*, which suggests that *governor* is decomposed into the stem *govern-* and the suffix *-or*. However, they found no priming between *department* and *depart*, which suggests that *department* is not decomposed into *depart-* and *-ment*. The difference is that *governor* has transparent morphology, whereas *department* does not. There may be good linguistic evidence that *department* is morphologically complex, but this fact does not appear to be mentally represented in a manner that is used during language processing.

In contrast, Bock (1986, 1989) and Pickering and Branigan (1995) showed that priming occurred between dative-alternating verbs like *give* and *show*. It is not in dispute that *give* and *show* share subcategorization frames, and that they must be related in some sense. However, it would have been possible that the information relating them was not mentally represented in the adult. Each verb could have been represented entirely independently. If so, we might have expected priming between one instance of *give* and another instance of *give*, but not between *give* and *show*. The priming effect demonstrates that this is not the case. Instead, the dative-alternation generalization must be rule-guided at a syntactic level. For instance, there might be two rules VP $\rightarrow$ V_{dat} NP NP and VP $\rightarrow$ V_{dat} NP PP, and also two lexical rules V_{dat} $\rightarrow$ *give* and V_{dat} $\rightarrow$ *show*.

CONCLUSIONS

We have discussed experimental evidence that suggests that syntactic priming occurs, within production, within comprehension, and between comprehension and production. We argued that all the distinctions found in syntactic priming are mentally represented in a manner relevant to language processing. Any cognitivist account of syntactic theory needs to incorporate these distinctions. However, there may be other distinctions that are rule-describable, but that are not mentally represented. If so, theories of language should seek to distinguish those linguistic rules that are mentally represented from those that are not.

Syntactic priming is a promising means of investigating the way that language is mentally represented. The strongest conclusions follow from bidirectional syntactic priming, because we can then be most certain that we are tapping into knowledge of language. If syntactic priming provides evidence that is compatible with one linguistic account, and not with another, then we believe that any cognitivist linguistic theory should be modified accordingly.

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