

The Ties That Bind: Creating Number Agreement in Speech

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Coherence in language relies in part on basic devices like number agreement. To assess meaning-based (notional) versus form-based (morphological) control of number agreement, we examined how speakers created number agreement for collective nouns, which can carry conflicting notional and morphological number. The agreement targets were verbs and two types of pronouns, produced in the course of a sentence-completion task. Comparisons of the verbs and pronouns indicated that verbs tended to reflect the morphological number of the collective controller, whereas pronouns were more likely to reflect the notional number. This argues that the number features of pronouns may be retrieved under control from the speaker's meaning, while the number features of verbs are more likely to be retrieved under control from the utterance's form. The implication is that the retrieval of words during language production is influenced by two distinct types of information, consistent with an inflectional account of agreement. © 1999 Academic Press

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The cognitive processes that implement number agreement during fluent speech are unexpectedly illuminating pieces in the puzzle of explaining normal language use. Despite a reputation as an effete detail of English grammar, number agreement embodies many of the basic functions that syntax serves in language. Syntax is a kind of code used for stringing words together to represent relations in thought. Number marking is part of the code, used to signal that

linguistic constituents carrying the same number are linked regardless of whether they appear together or apart in an utterance. The workings of these markers are illustrated in the contrast between

(a) *Descriptions of the massacre that were discovered yesterday . . .*

and

(b) *Descriptions of the massacre that was discovered yesterday . . .*

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Sentence (a) mentions the discovery of descriptions, whereas sentence (b) mentions the discovery of a massacre. Languages around the world use agreement in number, grammatical gender, animacy, and other features to signal which of the individual words and phrases of an utterance should be interpreted together.

The linguistic significance of agreement (sometimes called *concord*) is enhanced by the

frequency with which it is required in speech. Even in English, which makes comparatively little use of the devices of agreement, every sentence requires overt or covert number concord between verbs and their subjects. Every personal pronoun, except for *you*, requires concord in number with its antecedent. Speakers must therefore make tacit mention of number in virtually every utterance they produce.

The psycholinguistic significance of agreement stems both from its syntactic functions and from its normally effortless use in speech. Like other syntactic mechanisms, the implementation of agreement demands the joint satisfaction of constraints from meaning and constraints from grammar. For instance, the requisite singular and plural marking of most English nouns forces speakers to attend to numerosity, to distinguish between singletons (·) and multiples (· · ·). Numerosity is a property of the intended meaning (the message) that in turn has consequences for the syntax of an utterance, because of the role that number agreement plays in the grammar. An explanation of how speakers forge links among agreeing elements must therefore fit into a theory of the mapping from thought to language.

This mapping is complex and dynamic. To implement it, speakers retrieve words, order them, and articulate them at the same time that they prepare later parts of an utterance. However intricate this performance may be, the further complexities that agreement introduces are not a common source of disruption. The incidence of deviations from normal agreement patterns is low (relative to speakers' own idiolects and to opportunities for error (Bock & Miller, 1991)), and children use the patterns correctly long before they receive any formal training in the details of grammar. Even 4-year-olds have been observed to use correctly agreeing verbs over 94% of the time in spontaneous speech (Keeney & Wolfe, 1972). This makes it all the more plausible to view agreement, in its typical manifestations, as one of the automatic mechanisms of normal language production rather than a nicety of carefully prepared speech.

So, the features of agreement loom larger among basic syntactic mechanisms than their

small scale among the elements of language might suggest. The present research was designed to use these features in evaluating two broad conceptions of how speakers create language structure in general, and agreement in particular, during production. These alternatives take different stances toward the relationship between thought and language and in turn toward the question of how the dimensions of specific ideas come to be reflected in individual utterances.

NUMBER IN THOUGHT AND NUMBER IN LANGUAGE

A simple, intuitive, and widespread view of the relationship between thought and language is that they are inner and outer aspects of the same thing: Thought is inner speech, or speech is a socialized form of thinking out loud. In the tradition that regards thought as an internalization of language, it is natural to suppose that thinking comes to embody the systematic restrictions of language (as in the Sapir-Whorf hypothesis; see Lucy (1992b), for a comprehensive review and analysis). Standing in opposition to such views are some equally time-honored traditions which treat language and thought as separable realms. One of the earliest psychological treatments of thought, that of the Würzburg school, held that it proceeds within an abstract, amodal conceptual code that is not isomorphic with any of the several perceptual, motor, or language systems that thought serves and guides (Humphrey, 1963).

Contemporary debates over the nature of language and language processing reflect the same polarization. On one side are arguments that language is an inextricable part of general cognitive functioning, with linguistic elements and patterns continuously and seamlessly integrated into ongoing mental operations (Bates & MacWhinney, 1989). On the other side are claims that language is a separable system with its own operating characteristics, isolable from other perceptual, cognitive, and motor systems in its mechanisms and underpinnings, but nonetheless entwined with perception, thought, and action in normal use (Fodor, 1983).

Whatever the nature of the processing inter-

face between thought and language, the interface must provide a conduit for the information that is required for the fluent working of grammatical agreement systems. Perceived or conceived singletons and multiples support the distinction in English between singulars and plurals and, in turn, the correlations among number-marked words within utterances: Singular subjects take singular verbs, and plural subjects take plural verbs. The cognitive foundation for this system is present early in life, with the perception of numerosity in place at about 6 months of age (Starkey, Spelke, & Gelman, 1983). In later development, however, differences among languages in the systematicity with which their grammars code numerical contrasts have been argued to create differences in the conceptualizations of objects (Lucy, 1992a). So, understanding the workings of number agreement may be one key to understanding the relationship between thought and language.

There are two general classes of linguistic explanations for how the patterns of agreement arise, aligned respectively with the two alternative conceptions about how thought and language are related. The simplest is that the linguistic elements that code number reflect *notional* properties having to do with the numerosity of objects in perception or conception. On such an account, subject–verb agreement in English is attributable to a joint coding of number in the subject noun phrase (e.g., the phrase *The ships* denotes multiple vessels) and in the verb phrase (e.g., *are sailing* denotes a continuing activity by each of multiple entities). This notional account makes subject–verb agreement an epiphenomenal consequence of separate lexicalizations of different pieces of the same event, each of which reflects something about numerosity (for the linguistics of such an approach, see Pollard and Sag (1988, 1994, Chapter 2)). Since words must be retrieved under the control of meaning on any view of language use, the notional hypothesis brings agreement neatly under the umbrella of this same set of processes.

Other accounts of number agreement entail additional cognitive machinery. According to

these views, agreement is the product of implicit matching operations between the features of linguistic units (e.g., phrases and morphemes), which take place during the assembly of utterances. Consider subject–verb agreement. It may be the product of an operation that evaluates the grammatical number of the subject (e.g., *The fleet* is singular) and sets the number on the verb to the same value (*is sailing* is also singular). This is an *inflectional* account of agreement. On the inflectional account, the mechanics of agreement involve structurally controlled matches between linguistic features. The role of notional number is to set the stage for agreement, by directing lexical retrieval toward a subject noun (for example) that is singular or plural. This inflectional view of agreement is one facet of a general theory that both a lexical and a syntactic system are needed to account for the ways in which morphologically complex words are used in speaking and understanding (Marslen-Wilson & Tyler, 1997).

Some of the arguments for inflectional control of agreement come from well-known disparities between notional and linguistic number. Disparities can be found in collectives, like the noun *fleet*. Collectives permit two readings, only one of which is singular (the actual collective sense). The second sense reflects the fact that the collective is made up of individuals, and this sense (the so-called distributive interpretation) is notionally plural. So, collectives can denote multiple objects. Nonetheless, they are treated mostly as singulars for purposes of verb agreement in American English (Bock & Eberhard, 1993). Another anomalous category includes words that denote singleton objects but are treated as plurals for agreement purposes (e.g., *binoculars*); the same objects are denoted by singular words in other closely related languages. The examples can be multiplied by considering the referents of mass nouns (*is news* singular or plural?), abstractions (*is religion* singular or plural?), so-called corporate nouns (*is government* singular or plural?), and so on. All of these things can be construed as multiples, but the words are singular in American English, again for purposes of verb agreement.

Of course, if speakers simply learn to con-

strue the intended referents of such words in line with their linguistic properties, these apparent disparities between notional and linguistic number would evaporate. One way to examine this possibility is to look for systematic patterns in singular and plural concord beyond the realm of subject–verb agreement. This takes us to a comparison of number marking on English verbs and pronouns.

VERB AND PRONOUN AGREEMENT

In linguistic theory, verbs and pronouns are traditionally treated as reflecting similar sorts of agreement restrictions. Accordingly, if speakers construe number properties in uniform ways, verbs and pronouns would be expected to carry the same number features when they agree with the same things. But in fact, verbs and pronouns are used in ways that suggest differences in the number properties that they convey. This is a common enough occurrence to provide fodder for popular commentators on language use. Citing a television advertisement that proclaimed *Tonight on MTV, Bill Clinton faces the generation that holds the future in their hands*, William Safire (1992) wrote

Members of a straitlaced, out-of-it generation looked at that ad, shook their heads and said, ‘in *its* hands.’ The word *their* is a pronoun, which is a word that substitutes for a noun; that pronoun must agree in number with the noun for which it substitutes, which we call its antecedent. But in this case, the antecedent is *generation*, undeniably singular, calling for a pronoun that agrees with it—namely, *its*. That would give you *the generation that holds the future in its hands*. [Yet] in this ad, the copywriter—who when it came to pronoun–antecedent agreement had been chewing gum to the rhythm of a different drummer—twice faced the problem of subject–verb agreement [and] twice . . . stepped up to the challenge with perfect agreement.

Prescriptive dogmatism aside, the difference in number between the singular verb *holds* and the plural pronoun *their* is a puzzle. It obviously runs counter to any view that would make both verb number and pronoun number dependent on grammatical-feature matching between an agreement controller (*generation*) and any agreement targets (the verb and the possessive pronoun). It is equally troublesome for a no-

tional view that traces both verb and pronoun number features to the speaker’s interpretation. On this view, the verb and the pronoun should reflect the number meaning implicit in their relationships to *generation*. For the verb, this would be the number of holdings, and for the pronoun, it would be the number of holders. By either view, one would expect number to be consistent, at least within the scope of a single sentence.

On its face, the existence of this sort of inconsistency suggests that two different kinds of number may be at work. Perhaps the plural pronoun reflects the notional number of the conceptual referent of the word *generation*, whereas the singular verb is inflected to agree with the grammatical-number feature associated with the word *generation*. Cast into a hypothesis about language production, the claim would be that verb number can be set by processes that differ from those that normally set pronoun number. Specifically, pronouns may be retrieved with their number directly controlled from the speaker’s message, rather than from a linguistic representation of the to-be-spoken sentence. Verbs may be more likely to undergo inflectional operations that change morphological number to conform to the linguistic environment, even though verbs, too, can be influenced by notional number. If so, the number that a verb reflects may be different from the number that a pronoun reflects, both in its value and in its source: Verbs could behave in accord with the predictions of the inflection hypothesis, in the same environments where pronouns behave in accord with the predictions of the notional hypothesis.

To go beyond the anecdotal evidence and systematically assess the number properties that speakers assign to verbs and pronouns, we examined verb and pronoun number-agreement under controlled conditions. For this purpose, we asked college students to create simple, spontaneous spoken completions for sentence fragments, or *preambles*. The preambles established an overt number context that was identical for verbs and pronouns, which we expected to influence the number properties of a subse-

TABLE 1
Sample Preambles Constructed for One Experimental Item

Type of subject noun	No. of local noun	Preambles for three types of agreement targets		
		Verb	Tag pronoun	Reflexive pronoun
Singular	Singular	The actor in the soap opera	The actor in the soap opera rehearsed	The actor in the soap opera watched
	Plural	The actor in the soap operas	The actor in the soap operas rehearsed	The actor in the soap operas watched
Plural	Singular	The actors in the soap opera	The actors in the soap opera rehearsed	The actors in the soap opera watched
	Plural	The actors in the soap operas	The actors in the soap operas rehearsed	The actors in the soap operas watched
Collective	Singular	The cast in the soap opera	The cast in the soap opera rehearsed	The cast in the soap opera watched
	Plural	The cast in the soap operas	The cast in the soap operas rehearsed	The cast in the soap operas watched

quent agreement target. Table 1 gives a full set of examples.

The key preamble feature was the head of the subject noun phrase, the *subject noun*. In a third of the preambles, the subject noun was notionally and grammatically singular (e.g., *The actor in the soap opera*). In another third it was notionally and grammatically plural (e.g., *actors*). In the remaining third it was a notionally plural but grammatically singular collective (e.g., *cast*). The speakers were asked to finish each of

the preambles in a way that turned it into a complete sentence. One group received preambles for which the creation of a complete sentence required a verb (e.g., . . . *was popular*), and two other groups received preambles that allowed pronoun completions, either tag pronouns (e.g., . . . *didn't he?*) or reflexive pronouns (e.g., . . . *himself*). Table 2 shows sample singular and plural responses for each condition.

The main question was whether the morpho-

TABLE 2
Experimental Procedures for Eliciting Verb, Tag Pronoun, and Reflexive Pronoun Number with Sample Responses

Event	Elicitation conditions with sample responses		
	Verb	Tag pronoun	Reflexive pronoun
1. Auditory presentation of preamble:	"The actor in the soap operas . . ."	"The actor in the soap operas rehearsed . . ."	"The actor in the soap operas watched . . ."
2. Speaker immediately repeats preamble and completes	as a full sentence: "The actor in the soap operas was popular"	with a tag question: "The actor in the soap operas rehearsed, didn't he?"	with a reflexive pronoun: "The actor in the soap operas watched himself."
3. Scoring: Is the number of the agreement target singular or plural?	Singular "The actor in the soap operas <i>was</i> popular"	Singular "The actor in the soap operas rehearsed, didn't <i>he</i> ?"	Singular "The actor in the soap operas watched <i>himself</i> ."
	Plural "The actor in the soap operas <i>were</i> popular"	Plural "The actor in the soap operas rehearsed, didn't <i>they</i> ?"	Plural "The actor in the soap operas watched <i>themselves</i> ."

logical number of the spontaneously generated verbs and pronouns (the agreement targets) would be equivalent after the same subject nouns (the agreement controllers). For singular and plural subjects, the notional and inflectional accounts of agreement make identical predictions for both agreement targets, since the notional and grammatical numbers of the subject nouns are the same in each case. With collective subjects, however, verb and pronoun number should be the same only if both targets are controlled in similar ways. If they are controlled differently, and pronouns lean toward notional allegiance, pronouns should reflect the speaker's conception of the number of the referential controller (e.g., *cast*), which is likely to be plural. Similarly, if verbs lean toward grammatical allegiance, they should take their number from the morphological features of the subject noun. This predicts that verb number will reflect the grammatical number of the collective, which is singular.

A subsidiary question had to do with psycholinguistic differences between tag and reflexive pronouns. To a rough approximation, reflexive pronouns have antecedents within their own clauses, while tag pronouns do not (Chomsky, 1981). These differences in clause membership might be expected to influence the cognitive workings of pronoun agreement: Clauses are linked both to the scope of preparation for sentence production (Bock & Cutting, 1992; Garrett, 1980) and to limitations on immediate memory for the formal properties of sentences (Jarvella, 1979). So, if pronoun types vary in their inclinations toward grammatical compared to notional agreement and, correspondingly, in their reliance on the number features of explicit linguistic controllers, the number-agreement process may be different when the controller is in the same clause. Since reflexives and their antecedents are in the same clauses, just as verbs and their agreement controllers are, the tendency toward grammatical agreement may be stronger for reflexive than for tag pronouns.

The experimental method exploited the phenomenon of *attraction* (Bock & Miller, 1991) to amplify the normally minimal variation in canonical number agreement in English. Attrac-

tion occurs when an agreeing word shares its number features with a spurious controller, most often a grammatically plural noun-phrase in the immediate vicinity of the verb. For example, in *The road to the mountains are closed*, the number of the verb *are* is unexpectedly plural, under the influence of the local noun *mountains*. Attraction affects both verbs and pronouns (Bock, Eberhard, & Cutting, 1992), increasing the incidence of plural agreement after singular subjects. We induced it in the present work with a manipulation of grammatical number on a local noun.

METHOD

Participants. The participants were 216 undergraduates at the University of Illinois who received payment or partial credit toward an introductory psychology course requirement. All were native speakers of American English.

Materials. The materials consisted of preambles designed to elicit number-marked verbs and pronouns from speakers. Each of the 36 experimental items was rung through three sets of six variations on a basic preamble, shown in Table 1 for one of the items. The preamble components included a subject noun (e.g., *actor* in Table 1) that was singular, plural, or collective and a local noun (*opera* in Table 1) that was singular or plural. The verb-eliciting preambles consisted of a subject noun phrase with a prepositional phrase. The pronoun-eliciting preambles were the same but added a past-tense verb. The verb was intransitive in the tag-eliciting preambles and reflexive in the reflexive-eliciting preambles. Appendix A lists the basic forms for all 36 items.

An additional 48 preambles served as filler items. These were more diverse in structure than the experimental items and included simple as well as complex noun phrases. Every participant received the same set of these, modified according to experimental condition. For verb elicitation the filler preambles were presented alone, and for pronoun elicitation, the preambles concluded with an intransitive or reflexive verb in the tag and reflexive conditions, respectively.

Eighteen lists of 84 preambles were con-

structed from these materials. In all lists, the order of filler and experimental items was the same. Six filler preambles began each list, followed by a random arrangement of experimental and filler preambles constrained so that there were no consecutive experimental trials.

Six of the lists contained only verb-eliciting preambles, six contained tag-eliciting preambles, and the remaining six contained reflexive-eliciting preambles. Every list contained one version of each of the 36 items, and six preambles from each combination of type of subject noun (singular, plural, or collective) and type of local noun (singular or plural). Across lists, every version of every item occurred exactly once.

Procedure. Preambles were recorded and presented auditorily, over headphones. The participant repeated the preamble and immediately completed it as a full sentence of the designated kind, as shown in Table 2.

The instructions (see Appendix B) illustrated the kinds of completions desired by example only, without mentioning number agreement, without variations or errors in number agreement, and without samples of any critical features of the experimental materials (i.e., the examples contained no collective subjects and no mismatches between head and local nouns). Four practice trials were presented prior to the start of the experimental list. Like the examples, the practice items illustrated none of the critical features of the experimental materials. The entire session was tape recorded.

Each of the 18 experimental lists was presented to a total of 12 participants, each of whom received only one list. The participants were tested individually.

Design. The construction of the experimental lists ensured that each of the 216 participants received equal numbers of items (6) in each of the six experimental conditions defined by the crossing of the factors of subject noun (singular, plural, collective) and local noun (singular, plural). Agreement target (verb, tag pronoun, reflexive pronoun) was varied between participants. The design for items was fully crossed, so that each of the 36 items was presented to 6 participants in all 18 experimental conditions.

Scoring. The responses on the experimental trials were transcribed and scored for the grammatical number of the agreement target in the sentence completion. There were two types of valid responses, classified as Plurals and Singulars. Responses were scored as Plural or Singular only when the preamble was correctly reproduced, it was spoken just once, and the completion contained an unambiguously plural or singular agreement target of the intended kind (i.e., the verb in the Verb condition, the tag pronoun in the Tag condition, and the reflexive pronoun in the Reflexive condition). Representative examples of Plurals and Singulars are presented in Table 2 for each condition.

All other responses were assigned to one of several defective-response categories. These categories included incorrect preamble repetitions (generally, changes in the number of the head or local noun), completions in which the agreement targets were unmarked for number (most of these were regular past tense verbs, such as *walked*), completions that omitted the agreement target, and occasional completions in which agreement targets were anomalously marked (e.g., reflexive forms such as *himself*).

Application of these criteria resulted in the following distributions of valid responses within the three agreement-target conditions. In the Verb condition 33.6% of the responses were valid, with 411 singular-marked and 461 plural-marked verbs. In the Tag pronoun condition 71.8% of the responses were valid, with 693 singular and 1169 plural tag pronouns. The Reflexive pronoun condition yielded 71.4% valid responses, 721 singular reflexives, and 1129 plurals.

The largest categories of defective responses in the Verb condition were incorrect preamble reproductions (442, or 17.1% of the responses) and number-unmarked targets (1278, or 49.3% of the responses in the condition). The frequency of verbs that were unmarked for number resulted from the heavy use of past-tense verbs. This past-tense bias seems to be a general property of English rather than an artifact of the sentence completion task (Svartvik, 1966), and to the extent that we have been able to measure

its consequences, it does not selectively compromise the distribution of marked singular and plural responses over conditions (for discussion and analyses, see Bock & Eberhard, 1993; and Bock & Miller, 1991).

In the Tag condition the only sizeable category of defective responses was incorrect preamble reproduction (730, or 28.2% of the responses). In the Reflexive condition the majority of the defective responses were again incorrect preamble reproductions (692, or 26.7%) and anomalous reflexives (50, or 1.9%). The variations in numbers of defective responses are attributable to differences in the agreement targets themselves (i.e., only verbs could be unmarked for number) and to differences in preamble-reproduction success. The pronoun conditions were more vulnerable to this kind of failure, simply because the preambles in these conditions were longer.

Analyses. The substantial proportion of verbs that were unmarked for number created a missing-data problem that we addressed in several ways, in order to ensure that the results could not be readily explained in terms of differences in the base rates of employing number-marked verb forms. Initially, to adjust for base-rate differences, we examined the overall proportions of Plural responses among the total number of Singular and Plural responses in each condition. These proportions, shown in Table 3, revealed a pattern whose reliability we evaluated in subsequent statistical analyses.

The first set of analyses of variance were performed on the raw numbers of valid Plural responses in each condition for each type of preamble and, separately, on the raw numbers of valid Singular responses in each condition for each type of preamble, setting empty cells equal to zero. In each set of analyses, one was performed with participants as the random factor, and a second with items as the random factor. The results for Singulars were complementary to those for Plurals, suggesting that any variations in the use of number-unmarked (i.e., regular past-tense) verbs did not influence one type of response more than the other. Under Results, we report the inferential statistics from the Plural analyses only.

TABLE 3

Proportions of Plural Agreement-Targets after Three Types of Subjects

Agreement target	Local noun no.	
	Singular	Plural
Singular subject		
Verb	.02 (154)	.10 (140)
Tag pronoun	.04 (366)	.18 (236)
Reflexive pronoun	.02 (361)	.17 (246)
Plural subject		
Verb	.99 (161)	.99 (152)
Tag pronoun	.98 (323)	.99 (283)
Reflexive pronoun	.96 (327)	.99 (281)
Collective subject		
Verb	.36 (122)	.60 (143)
Tag pronoun	.74 (364)	.83 (290)
Reflexive pronoun	.71 (344)	.84 (291)

Note. The total number of valid responses in each cell is shown in parentheses. The 95% confidence intervals for pairwise comparisons between individual cells (calculated from the analysis of the proportions of plurals for items) are .08 for a planned contrast and .17 for a post hoc Scheffé contrast.

A second analysis of variance was carried out on the arcsine transformed proportions (Smith, 1976) of Plural responses among all the Singular and Plural responses for each item in each cell in every condition. We restricted this analysis to items because there were no empty cells in the items data. These results are also reported below. Confidence intervals for planned and post hoc comparisons were calculated from this analysis using the mean square of the error term for the interaction between head type, local-noun number, and response condition. The confidence intervals are provided with the accompanying data in Table 3 and Fig. 1.

To ensure that the item results were representative of the response distributions for individual participants, we carried out one further analysis on the participant data alone. Because data replacement schemes yield especially poor estimates when there are interactions among factors (Winer, 1971), and because of the missing cells in the participant data, this analysis was carried out only for participants without missing data. We examined the proportions of Plural

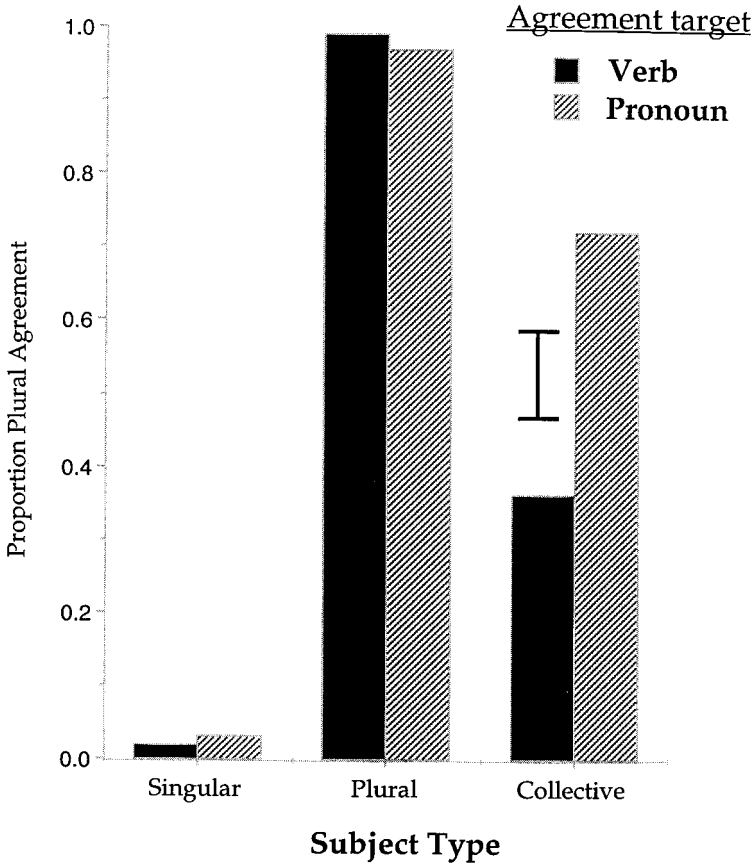


FIG. 1. Mean proportions of plural-agreeing verbs and pronouns after singular (e.g., *actor*), plural (e.g., *actors*), or collective (e.g., *cast*) subjects with singular local nouns. The error bar shows the 95% confidence interval (.07) for the verb/pronoun contrast, calculated from the analysis of the proportions of plurals for items.

responses for all participants without empty cells in the Verb condition (35) and the proportions of Plural responses for equal numbers of randomly selected participants without empty cells in the Tag and Reflexive conditions (these conditions each had only three participants with missing data).

RESULTS

Table 3 gives the proportions of plural forms for the agreement targets after each of the three types of sentence subjects. The total number of valid responses (Singulars and Plurals combined) in each cell is indicated in parentheses. Tag and reflexive pronouns behaved similarly in all conditions, regardless of the type of subject or the number of the local noun. Likewise,

when the sentence subjects were singular and plural, the results for verbs were comparable to those for the pronouns. Only after collective subjects did the verbs depart noticeably from the prevailing pattern. Figure 1 pools the pronoun results to display the contrast between the overall proportions of plural-agreeing verbs and pronouns after singular, plural, and collective subjects.

In the statistical analyses, all effects that are reported as significant were reliable at or beyond the .05 level. Table 4 lists the outcomes for the analyses of variance on the raw numbers of Plurals for all participants and items, on the proportions of Plurals for items, and on the proportions of Plurals for participants without missing data, showing all sources for which

TABLE 4
Analyses of Variance

Source	Participant analysis			Item analysis		
	df_1	F_1	MS_e	df_2	F_2	MS_e
Analysis on raw numbers of Plurals						
Agreement target	2,213	150.4	2.48	2,70	179.9	4.13
Subject type	2,426	790.3	1.48	2,70	382.1	6.13
Local-noun number	1,213	.00†	.873	1,35	.00†	3.94
Subject type × Agreement target	4,426	47.25	1.48	4,140	39.75	3.50
Subject type × Local-noun number	2,426	14.46	.965	2,70	11.25	2.48
Agreement target × Local-noun number	2,213	4.33	.873	2,70	3.04	2.56
Agreement target × Subject type × Local-noun number	4,426	3.90	.965	4,140	3.40	2.26
Analysis on proportions of Plurals among valid responses for all items						
Agreement target				2,70	457.7	.073
Subject type				2,70	13.43	.083
Local-noun number				1,35	388.2	.120
Subject type × Local-noun number				2,70	17.52	.058
Subject type × agreement target				4,140	5.12	.064
Agreement target × Local-noun number				2,70	787.2	.069
Agreement target × Subject type × Local-noun number				4,140	5.43	.053
Analysis on proportions of Plurals among valid responses for participants with no missing data						
Agreement target	2,102	15.62	.059			
Subject type	2,204	1021	.042			
Local-noun number	1,102	34.80	.032			
Subject type × Local-noun number	2,204	7.78	.032			
Subject type × agreement target	4,204	22.03	.032			
Agreement target × Local-noun number	2,102	.73†	.032			
Agreement target × Subject type × Local-noun number	4,204	2.65	.032			

Note. The sources shown are only those that yielded significant effects in one or more of the three analyses.

† Nonsignificant F values, $p > .05$.

there were significant effects in any one of the three analyses.

In all the analyses, the large differences among agreement targets and subject types yielded significant main effects for both of these factors. Local-noun number also had a clear impact except when the subject itself was plural, reflected in main effects in some of the analyses and in interactions with other factors in all analyses. With a single exception in one analysis (the interaction between agreement targets and local-noun number in the analysis of participants without missing data), all of the

interactions were significant, including the theoretically critical interaction among the agreement targets, the subject types, and the local-noun number. This interaction reflects the pattern displayed in Fig. 1: After singular local nouns, with no grammatical source for spurious plural agreement, pronouns were roughly twice as likely as verbs to reflect the tacit notional plurality of a collective subject.

DISCUSSION

The wide disparity in agreement patterns for verbs and pronouns points to what may be a

systematic difference in the type of number that verbs and pronouns reflect. The disparity was confined to sentences whose subjects were collective nouns. Collectives carry conflicting grammatical and notional number: A noun such as *choir* is morphologically singular, but can be notionally plural. As agreement targets for collectives, verbs were more sensitive to the grammatical number, while pronouns were more sensitive to the notional number.

The inclination of verbs toward grammatical number, with the same agreement controllers that evoked notionally based number in pronouns, argues that languages can make systematic linguistic distinctions that are not directly triggered by conceptual distinctions. This suggests a corresponding limitation on the influence from language to thought. Since number in English is a highly systematic, ubiquitous feature of the grammar, this finding challenges linguistic determinism hypotheses (Lucy, 1992a, b) as well as theories that countenance linguistic determinism as a consequence of a fluid cognitive architecture (McNeill, 1987).

The findings are more consistent with the sort of separation between the conceptual and grammatical properties of words that is found in many theories of language production (Bock & Levelt, 1994; Dell, Schwartz, Saffran, Martin, & Gagnon, 1997). Speakers retrieve words from the mental lexicon on the basis of conceptual properties represented in an intended message. Depending on the syntactic role that a word is destined to play in an utterance, it may also have to be inflected in accordance with its grammatical properties. For example, if a verb like *jump* appears in a context that calls for the third-person singular present form, the form *jumps* will be used; if the context instead calls for the third-person singular past, the form will be *jumped*.

Inflectional processes like these have been implicated in an ongoing debate about the need for abstract grammatical properties to account for the cognitive workings of language (Pinker, 1997; Seidenberg, 1997). In principle, English inflection could occur either by retrieving inflected word forms from memory in the same way that uninflected forms are retrieved or by a

mechanism that assembles inflected forms from separable parts. In theories of production, the separability of inflections and word stems has long been inferred from the existence of a kind of speech error called *stranding*. A stranding error in the intended utterance *He ended up ordering some fish dish* yielded "He ordered up ending some fish dish" (Garrett, 1993), exchanging two verb stems (*end* and *order*) while stranding their inflections (*-ed* and *-ing*). Stranding is a reliable feature of speech errors (present in 89% of the errors in which it can occur (Stemberger, 1985)), and its distributional properties suggest a different source for inflections than for stems: It rarely occurs for words that are phonologically or even morphologically identical to inflected forms but are not actually inflected (as Humphreys (1998) has confirmed under controlled conditions). The difference that we obtained between verbs and pronouns adds more weight to the argument for distinct processes, suggesting that verb inflections can be controlled by mechanisms that differ from those that set word retrieval, including pronoun retrieval, into motion.

The divergent behavior of verbs and pronouns poses other problems for a standard view about how verbs and pronouns acquire agreement features. Within formal linguistic treatments, agreement properties for verbs and reflexive pronouns normally have the same feature restrictions from the sentential subject (Gazdar, Klein, Pullum, & Sag, 1985). A basic prediction from this view is that verbs and reflexive pronouns should pattern together in their number-agreement properties against tag pronouns. Our results argue otherwise. Although tag pronouns did behave differently from verbs, so did reflexive pronouns, with no discernible differences between the two pronoun types.

The disparity between pronoun and verb number in English may have its ontogenetic roots in functional differences in the accessibility of number information from message versus morphological features. For many of the entities denoted by nouns and pronouns, number is rooted in properties that are transparent in perception and conception, even to infants. Because English pronouns in conversational

speech often refer deictically, without the explicit prior mention of an antecedent that occurs in anaphoric reference, pronoun number should be accessible directly from the features of a message representation.

In contrast, verbs denote things whose number properties are at best slippery. As a property of states and events, number is abstract (Shipley & Shepperson, 1990; Wynn, 1990) and often indeterminate. Is hand-shaking singular or plural? Is kissing singular or plural? Is football-playing singular or plural? It may well be that the syntactic work of indicating what goes with what in a string of words is more readily accomplished by using the number features of the subject to mark the verb, especially since English verbs usually occur with a morphologically explicit subject. Likewise, in learning language, the problem-solving difficulty of notional-number determination for events may lead to the grammaticization of verb agreement: Children learning English may find it easier to learn covariations in the distribution of number features on subjects and verbs than to detect differences in the meanings of singular and plural verbs (Maratsos & Chalkley, 1981).

Even so, there is another side to our results that argues against the view that verbs get their number properties exclusively from linguistic features or that pronouns get their number properties exclusively from notional features. This other side is clearest for verb agreement after collective subjects and for plural attraction in pronouns. The next section considers these results, beginning with attraction in pronouns.

Plural Attraction in Verbs and Pronouns

One similarity between verbs and pronouns was their apparent susceptibility to attraction. After plural local nouns, pronouns as well as verbs tended to display a plural-agreement feature, replicating Bock et al. (1992). Perhaps this similarity can be traced to the operation of mechanisms that enforce local consistency in morphological features, either in implementing or in checking agreement among word forms. Local inconsistency is jarring, notably so when adjoining verbs and pronouns conflict in num-

ber (consider *The class was advised to finish the exam, wasn't they?*).

This proposal is attractive in its simplicity, but it is undercut by the size of the "attraction" effect for pronouns¹: When the subject was a singular noun (but not collective) and the local noun was plural, pronouns were proportionally almost twice as likely as verbs to be produced in a plural form. For this reason, another explanation should be entertained. If there are two kinds of number and two sources of number marking, both may be at work in attraction as well as in agreement. That is, verbs may tend to undergo spurious grammatical agreement with a plural local noun (normal attraction), whereas pronouns may sometimes participate in spurious coreference with a plural local noun. On this two-source account, the explanations for spurious plural features on verbs and pronouns may differ, but the features nonetheless originate in just those types of information that dominate normal verb and pronoun number agreement: respectively, linguistic and notional.

Of course, the two-source account has its own drawbacks. One is the weakness of plural attraction from local collective nouns to pronouns (Bock et al., 1992). Plural attraction from collectives did occur more often for pronouns than it did for verbs in the Bock et al. (1992) data, which is consistent with the two-source explanation, but the fact that it occurred not at all for verbs makes it hard to evaluate the small difference that was found. Potentially more damaging to a simple version of the two-source view are findings for collective subjects. In Bock and Eberhard (1993) and in our own results, when the subject was collective, there was more attraction from plural local nouns to verbs than from plural local nouns to pronouns, which is exactly the opposite of the pattern seen for singular subjects.

A realistic, albeit less simple, variant of a

¹ Note that if the mechanism that creates spurious plural pronouns is different from the mechanism that creates spurious plural verbs, it may be misleading to call them both attraction. However, until the evidence for such a difference is better than what we can presently muster, we will continue to refer to the phenomenon of spurious plurals in the environment of noncontrolling plural nouns as attraction.

two-source theory can still be reconciled with these data. It requires consideration of two further points. First, notional features must play a role in verb agreement, even if it is a weaker or more indirect role than in pronoun agreement (see Bock & Eberhard, 1993, and Vigliocco, Butterworth, & Semenza, 1995, for discussion). Second, the number features that control verb agreement, in the normal flow of speaking, are the features associated with the entire subject noun phrase, not the head or local noun individually. These things mean that when a speaker has in mind a plural referent for the subject noun phrase and the phrase allows a plural feature to be associated with it, the verb can be plural (as in *Four are expected for dinner*, in contrast with *Four is an even number*).

This has clear consequences for collective subject-noun phrases. Unlike most singular nouns, collectives can have distributive senses: In everyday contexts, one can sensibly say *The crowd dispersed*, or *The students dispersed*, but not *The man dispersed*. Distributive intentions are not reliably signalled with plural number in American English speech (again, see Bock & Eberhard, 1993, as well as Bock & Miller, 1991, and Vigliocco, Butterworth, & Garrett, 1996). Still, after singular local nouns, in the present experiment slightly over one-third of the verbs that were used with collective subjects were plural. This suggests that distributive senses were in play. Since the distributive sense may be amplified when a collective subject has a postmodifying phrase with a plural local noun, the disproportionate increase in plural agreement after plural local nouns may be attributable to the combined effects of distributivity and simple attraction.

Tag and Reflexive Pronouns

One of the null results of our experiment merits a comment. The equivalence of tag and reflexive pronouns runs counter to formal linguistic principles that would put them into different classes by virtue of differences in the locations of their supposed antecedents (Chomsky, 1981). The antecedent of a reflexive pronoun is the subject of the pronoun's

clause, whereas the antecedent of a tag pronoun is the subject of a preceding clause, albeit in the same sentence. Clause boundaries have a wide range of effects on language use, including the production of verb agreement (Bock & Cutting, 1991), that might have been expected to make pronouns more likely to display grammatical number when the antecedent was in the same clause compared to when the antecedent was in a different clause. Our findings suggest that these differences do not strongly influence how pronouns acquire their number features, though they are clearly important in determining whether a pronoun will be reflexive.

Some Limitations

Any interpretation of the results is obviously constrained by the circumstances of the experiment, the typical complications of production data, and the peculiarities of American English. These and other limitations are discussed at length elsewhere (Bock, 1995, 1996; Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Eberhard, 1997; Vigliocco et al., 1995; Vigliocco et al., 1996), but some of their consequences deserve brief notice here.

The sentence-completion task aims to strike some balance between experimental control and spontaneous production, in an effort to elicit speech with the relevant properties for testing specific hypotheses about the cognitive mechanisms for sentence production. At the same time, the task has some obvious shortcomings. A penalty for how the task controls number properties is that it combines production and comprehension in ways that may compromise both processes. A penalty for how the task engages spontaneous speech is that many of the utterances elicited lack the features needed to evaluate the questions at hand. To overcome these kinds of problems, better techniques and converging lines of research are needed.

The peculiarities of American English pose problems that warrant some explicit cautions. One of the severest limitations to studying morphological processes of any kind in En-

glish is the poverty of English morphology. Other languages, even closely related languages such as Dutch and German, have systematic morphological marking for distinctions that do not exist in English (e.g., in grammatical gender) or have all but disappeared from English (e.g., case), and they make broader use of the distinctions that the languages share (e.g., number). Accordingly, unless a language mirrors the morphology of English, any findings about number marking for English verbs and pronouns cannot be expected to replicate in detail in other languages (Vigliocco et al., 1995; Vigliocco et al., 1996; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996). For example, certain pronouns in Dutch must carry the grammatical genders of their antecedents, and gender is unpredictable from semantic or notional properties. With these constraints, Dutch pronouns might be expected to work more like English verbs, and they do (Meyer & Bock, 1998).

Even other varieties of English may display agreement properties that diverge from American patterns. Most pertinent is that speakers of British English and related dialects treat collective subjects differently than American speakers. Whereas British speakers can be heard to use plural verbs with collectives (like *team*) and even with corporate nouns (like *government*), such usages are rarer among English speakers in the United States. Bock and Eberhard (1993) reported norming results for a large set of simple collective subjects which showed that Britons used plural verbs 22% of the time, while Americans used plurals only 3% of the time. Ongoing research is aimed at assessing whether this reflects divergent and more diverse patterns of grammatical-number marking for collective nouns among British speakers or, more intriguingly, greater reliance on notional number in verb agreement.

CONCLUSION

When an agreement controller carries a grammatical number different from its notional number, verbs serving as agreement targets tend to reflect the grammatical number

and pronouns serving as agreement targets tend to reflect the notional number. This indicates that either kind of number can be active in ongoing language production and argues against efforts to anchor linguistic number and number agreement in a single semantic or linguistic source.

We have proposed that the principal mechanism for accomplishing verb number-marking in spontaneous speech involves morphological feature adjustments with the cooperation of a syntactic system, to inflect verbs for their linguistic environments. Coupled with evidence that number-marked pronouns can be directly retrieved, this proposal brings a different perspective to bear on an ongoing debate about the nature of the mental lexicon (Pinker, 1997; Seidenberg, 1997). Our results reflect mature language production, rather than recognition or acquisition, and they point to a production process for the syntactically engaged properties of inflectional morphemes that is separable from the meaning-driven retrieval of words.

APPENDIX A: EXPERIMENTAL MATERIALS

A base form for each of the 36 experimental preambles is shown below. The head of the subject noun-phrase occurred in three versions (singular, plural, and collective). The local noun occurred in two versions (singular and plural). There were also three endings for each preamble, corresponding to the three elicitation conditions. The endings consisted of a reflexive verb (for reflexive-pronoun elicitation), an intransitive verb (for tag-pronoun elicitation), and a zero ending (for verb elicitation). The reflexive and intransitive verbs are listed in order for each item.

*Template for preamble base forms: The **singular head-noun** (plural)/collective noun preposition the **singular local-noun** (plural) (**reflexive verb/intransitive verb**)*

1. The gang leader(s)/gang with the dangerous rival(s) (armed/vanished)
2. The judge(s)/jury for the trial(s) (disqualified/deliberated)

3. The representative(s)/committee from the union(s) (defended/voted)
4. The politician(s)/majority at the meeting(s) (represented/prevailed)
5. The elephant(s)/herd near the waterfall(s) (cleaned/grazed)
6. The protester(s)/protest group behind the fence(s) (entertained/chanted)
7. The student(s)/mob outside the state building(s) (handcuffed/picketed)
8. The soldier(s)/army with the easygoing commander(s) (indulged/relaxed)
9. The relative(s)/clan of the Scottish monarch(s) (introduced/disappeared)
10. The singer(s)/choir for the church service(s) (dressed/practiced)
11. The driver(s)/fraternity with the warning(s) (reformed/reformed)
12. The spectator(s)/audience at the tennis match(es) (behaved/shouted)
13. The player(s)/team in the commercial(s) (disgraced/sprinted)
14. The ship(s)/fleet with the distinctive flag(s) (betrayed/surrendered)
15. The pupil(s)/class in the writing competition(s) (prepared/improved)
16. The dancer(s)/dance troupe under the bright light(s) (presented/complained)
17. The actor(s)/cast in the soap opera(s) (watched/rehearsed)
18. The sailor(s)/crew with the peacekeeping force(s) (fooled/caroused)
19. The professor(s)/faculty with the research award(s) (prided/persevered)
20. The firefighter(s)/fire brigade outside the building(s) (distinguished/rested)
21. The officer(s)/police with the security company(ies) (protected/gambled)
22. The debutante(s)/sorority in charge of the prom(s) (allowed/gossiped)
23. The competitor(s)/crowd at the Olympic event(s) (enjoyed/waited)
24. The cleaning lady(ies)/service for the clinic(s) (outdid/arrived)
25. The famous actress(es)/actors guild in charge of the charity benefit(s) (embarrassed/celebrated)
26. The director(s)/delegation from the wealthy foundation(s) (exempted/departed)

27. The priest(s)/clergy from the country church(es) (absolved/prayed)
28. The widow(s)/couple with the trust fund(s) (consoled/retired)
29. The young boy scout(s)/boy scout troop at the campground(s) (warned/misbehaved)
30. The band leader(s)/rock band with the powerful amplifier(s) (deafened/strutted)
31. The secret agent(s)/service from the foreign country(ies) (hid/blundered)
32. The jazz player(s)/quartet at the Las Vegas nightclub(s) (promoted/improvised)
33. The vacationing tourist(s)/family with the expensive camera(s) (photographed/posed)
34. The secretary(ies)/staff for the training program(s) (asserted/quit)
35. The nudist(s)/nudist colony near the sand dune(s) (concealed/sunbathed)
36. The photographer(s)/camera crew from the local station(s) (endangered/hurried)

APPENDIX B: INSTRUCTIONS FOR SENTENCE COMPLETION TASKS

“In this experiment I’m going to play some phrases for you from a tape. Your job will be to use each phrase as the beginning of a sentence and to complete it . . .”

Continuation for verb elicitation: “. . . as a full sentence. For example, if I gave you the phrase ‘The accident victim,’ you might complete it as a sentence like ‘The accident victim was rushed to the hospital.’”

Continuation for tag-pronoun elicitation: “. . . with a tag question. Tag questions are the little questions that people sometimes put at the ends of sentences, like ‘She’s crazy, isn’t she?’ or ‘He’s not there, is he?’ So if I gave you the phrase ‘The accident victim died,’ you might complete it as ‘The accident victim died, didn’t he?’”

Continuation for reflexive-pronoun elicitation: “. . . with a reflexive pronoun. Reflexive pronouns are words like *herself*, *himself*, *itself*, *themselves*, and *ourselves*. For example, if I gave you the phrase ‘The accident victim blamed,’ you might complete the sentence as ‘The accident victim blamed himself.’”

“There are about 80 phrases in all. Before we begin, let’s try a few. I’ll give you a phrase, and then you repeat it and complete it [as a full sentence/with a tag question/with a reflexive pronoun] as fast as you can. Don’t think too long about what to say. Just give me the first

complete sentence that comes to mind. And try to talk as fast as possible. Do you have any questions?"

Practice items [bracketed verbs were added for tag and reflexive-pronoun elicitation, respectively]:

The wealthy young women [shopped/spoiled]

The prankster [laughed/tricked]

The air conditioner [exploded/regulated]

The youngsters [whispered/silenced]

REFERENCES

- Bates, E., & MacWhinney, B. (1989). Functionalism and the competition model. In B. MacWhinney & E. Bates (Eds.), *The crosslinguistic study of sentence processing* (pp. 3–73). Cambridge: Cambridge Univ. Press.
- Bock, J. K. (1995). Producing agreement. *Current Directions in Psychological Science*, **8**, 56–61.
- Bock, J. K. (1996). Language production: Methods and methodologies. *Psychonomic Bulletin and Review*, **3**, 395–421.
- Bock, J. K., & Cutting, J. C. (1992). Regulating mental energy: Performance units in language production. *Journal of Memory and Language*, **31**, 99–127.
- Bock, J. K., & Eberhard, K. M. (1993). Meaning, sound, and syntax in English number agreement. *Language and Cognitive Processes*, **8**, 57–99.
- Bock, J. K., Eberhard, K. M., & Cutting, J. C. (1992, November). *Controlling number agreement on verbs and anaphors*. Paper presented at the meeting of the Psychonomic Society, St. Louis, MO.
- Bock, J. K., & Levelt, W. J. M. (1994). Language production: Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 945–984). San Diego: Academic Press.
- Bock, J. K., & Miller, C. A. (1991). Broken agreement. *Cognitive Psychology*, **23**, 45–93.
- Chomsky, N. (1981). *Lectures on government and binding*. Dordrecht: Foris.
- Dell, G. S., Schwartz, M. F., Martin, N., Saffran, E. M., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review*, **104**, 801–838.
- Eberhard, K. M. (1997). The marked effect of number on subject–verb agreement. *Journal of Memory and Language*, **36**, 147–164.
- Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.
- Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language production* (pp. 177–220). London: Academic Press.
- Garrett, M. F. (1993). Errors and their relevance for models of language production. In G. Blanken, J. Dittmann, H. Grimm, J. Marshall, & C.-W. Wallesch (Eds.), *Linguistic disorders and pathologies* (pp. 72–92). Berlin: Walter de Gruyter.
- Gazdar, G., Klein, E., Pullum, G., & Sag, I. (1985). *Generalized phrase structure grammar*. Cambridge, MA: Harvard University Press.
- Humphrey, G. (1963). *Thinking: An introduction to its experimental psychology*. New York: Wiley.
- Humphreys, K. R. (1998, March). *The production of inflectional and derivational morphology: Evidence from elicited speech errors*. Paper presented at the CUNY Conference on Sentence Processing, New Brunswick, NJ.
- Jarvella, R. J. (1979). Immediate memory and discourse processing. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 13). New York: Academic Press.
- Keeney, T. J., & Wolfe, J. (1972). The acquisition of agreement in English. *Journal of Verbal Learning and Verbal Behavior*, **11**, 698–705.
- Lucy, J. A. (1992a). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis*. Cambridge, England: Cambridge Univ. Press.
- Lucy, J. A. (1992b). *Language diversity and thought: A reformulation of the linguistic relativity hypothesis*. Cambridge, England: Cambridge Univ. Press.
- Maratsos, M., & Chalkley, M. A. (1981). The internal language of children's syntax: The ontogenesis and representation of syntactic categories. In K. Nelson (Ed.), *Children's language* (Vol. II). New York: Gardner Press.
- Marslen-Wilson, W. D., & Tyler, L. K. (1997). Dissociating types of mental computation. *Nature*, **387**, 592–594.
- McNeill, D. (1987). *Psycholinguistics: A new approach*. New York: Harper & Row.
- Meyer, A. S., & Bock, J. K. (1998). *Representations and processes in the production of pronouns: Some perspectives from Dutch*. Submitted for publication.
- Pinker, S. (1991). Rules of language. *Science*, **253**, 530–535.
- Pinker, S. (1997). Words and rules in the human brain. *Nature*, **387**, 547.
- Pollard, C., & Sag, I. A. (1988). An information-based theory of agreement. In D. Brentari, G. Larson, & L. MacLeod (Eds.), *Papers from the 24th Annual Regional Meeting of the Chicago Linguistic Society II. Parasession on Agreement in Grammatical Theory* (pp. 236–257). Chicago, IL: Chicago Linguistic Society.
- Pollard, C., & Sag, I. A. (1994). *Head-driven phrase structure grammar*. Chicago: Univ. of Chicago Press.
- Safire, W. (1992, July 6). Its and its antecedents. *International Herald Tribune*, p. 11.
- Seidenberg, M. S. (1997). Language acquisition and use: Learning and applying probabilistic constraints. *Science*, **275**, 1599–1603.
- Shiple, E. F., & Shepperson, B. (1990). Countable entities: Developmental changes. *Cognition*, **34**, 109–136.
- Smith, J. E. K. (1976). Data transformations in analysis of variance. *Journal of Verbal Learning and Verbal Behavior*, **15**, 339–346.
- Starkey, P., Spelke, E. S., & Gelman, R. (1983). Detection

- of intermodal numerical correspondences by human infants. *Science*, **222**, 179–181.
- Stemberger, J. P. (1985). An interactive activation model of language production. In A. Ellis (Ed.), *Progress in the psychology of language* (pp. 143–186). London: Erlbaum.
- Svartvik, J. (1966). *On voice in the English verb*. The Hague: Mouton.
- Vigliocco, G., Butterworth, B., & Garrett, M. F. (1996). Subject-verb agreement in Spanish and English: Differences in the role of conceptual constraints. *Cognition*, **61**, 261–298.
- Vigliocco, G., Butterworth, B., & Semenza, C. (1995). Constructing subject-verb agreement in speech: The role of semantic and morphological factors. *Journal of Memory and Language*, **34**, 186–215.
- Vigliocco, G., Hartsuiker, R. J., Jarema, G., & Kolk, H. H. J. (1996). One or more labels on the bottles? Notional concord in Dutch and French. *Language and Cognitive Processes*, **11**, 407–442.
- Winer, J. B. (1971). *Statistical principles in experimental design*. New York: McGraw-Hill.
- Wynn, K. (1990). Children's understanding of counting. *Cognition*, **36**, 155–193.

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