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Some Attractions of Verb Agreement

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In English, words like *scissors* are grammatically plural but conceptually singular, while words like *suds* are both grammatically and conceptually plural. Words like *army* can be construed plurally, despite being grammatically singular. To explore whether and how congruence between grammatical and conceptual number affected the production of subject–verb number agreement in English, we elicited sentence

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completions for complex subject noun phrases like *The advertisement for the scissors.* In these phrases, singular subject nouns were followed by distractor words whose grammatical and conceptual numbers varied. The incidence of plural attraction (the use of plural verbs after plural distractors) increased only when distractors were grammatically plural, and revealed no influence from the distractors' number meanings. Companion experiments in Dutch offered converging support for this account and suggested that similar agreement processes operate in that language. The findings argue for a component of agreement that is sensitive primarily to the grammatical reflections of number. Together with other results, the evidence indicates that the implementation of agreement in languages like English and Dutch involves separable processes of number marking and number morphing, in which number meaning plays different parts. © 2001 Academic Press

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Singular subjects take singular verbs, and plural subjects take plural verbs. This is the Simple Descriptive Rule of subject–verb number agreement in English (Quirk, Greenbaum, Leech, & Svartvik, 1985) and related languages, like Dutch. Behind the simple description lies a complex set of psycholinguistic issues. The issues in general have to do with explaining how speakers juggle mutual dependencies between separate words in sentences. For purposes of the present work, the specific questions involve explaining how speakers manage to produce singular verbs to accompany singular subjects and plural verbs to accompany plural subjects, and when speakers do not do this, explaining why.

There are several sources of psycholinguistic complexity. Speakers must identify the relevant contexts for number distinctions and know how to manipulate the elements that enter into relationships of number agreement. The simple description of subject–verb agreement in English hides the problem that it is not easy to identify singular and plural contexts in objective terms (the distinction is notoriously treacherous when speakers of languages that lack a singular/plural contrast try to master English). This makes it hard to explain how native speakers recognize when and how the distinction applies. Speakers also have to be able to mark number on nouns and verbs and to make number markings agree in value.

Doubling the complexity, there are at least two different levels at which agreement must work, calling on two different kinds of information. Speakers begin with messages, which embody the conceptual relationships they intend to communicate. The specific embodiments of concepts within messages are collectively called *notions,* comprising intended referents, ideas, states of affairs, and relationships among them. These notional components of messages carry features of the concepts that they instantiate, but in order to be communicated, they have to undergo linguistic coding as words standing in particular structural relationships to one another. Agreement may involve the notional features of messages, or the linguistic features of words and structures, or more likely both.

Our goal in this article is to test a proposed mechanism for one part of the agreement process. The mechanism has to do with the resolution of number mismatches—potential sources of error—during the production of sentences. To carry out these tests, we relied on the phenomenon of *attraction,* in which the number of a verb differs from what would be expected on the basis of typical agreement patterns. After we introduce the phenomenon, we argue that it represents the aberrant outcome of a normal resolution process, which we sketch in terms of a candidate model of agreement in language production. We then evaluate one of the predictions of this account in a series of four experiments on the factors that induce attraction in English and Dutch.

The Phenomenon of Attraction

Normally, verbs in both Dutch and English agree in number with the head noun of the subject noun phrase, yielding sentences such as ''Membership in these unions was voluntary.'' In attraction, the verb agrees instead with another noun in its vicinity, as in ''Membership in these unions were voluntary.'' We call the head of the subject noun phrase the agreement *controller* (e.g., *membership*), the number-carrying part of the verb the agreement *target* (e.g., the past tense of the copula *be*), and the number-attracting noun phrase the *local noun* (e.g., *unions*). Attraction is well known in the traditional literature on descriptive and prescriptive language use (including Follett, 1966; Fowler, 1937; Francis, 1986; Mann, 1982; Strang, 1966; Woodworth, 1938; Zandvoort, 1961; see Bock & Miller, 1991, for review). Here we focus on the implications of psycholinguistic research aimed at using attraction to illuminate the cognitive processes involved in implementing agreement during language production.

Attraction is most evident for verbs in the neighborhood of grammatically plural nouns. So, in the utterance ''good grammar that is favorable to listeners *are* often associated with people from an upper class,'' the verb *are* exhibits a plural inflection, in spurious agreement with the plural local noun *listeners.* The opposite pattern, attraction to grammatically singular local nouns in subject phrases with plural heads (as in ''All of the underpasses except University *was* flooded''), is weak and often may not differ reliably from chance (Bock, 1995a). Eberhard (1997) offered evidence that this singular–plural asymmetry is due to the existence of an underlying plural specification for plural nouns and the absence of singular specification for singular nouns. That is, most singular nouns do not bear a number feature (at least, do not bear a number feature within some representation that is functional for subject–verb number agreement in English). The plural feature seems to originate in a lexical or grammatical representation because nouns that are notionally plural (like collectives in American English) but grammatically singular have not been found to create attraction (Bock & Eberhard, 1993, Experiment 4). Singular–plural asymmetries have been reported in Dutch

(Hartsuiker, Schriefers, Bock, & Kikstra, 1999), German (Hartsuiker, Schriefers, et al., 1999), French (Fayol, Largy, & Lemaire, 1994), Italian (but weakly; Vigliocco, Butterworth, & Semenza, 1995), Russian (Bock, Zalkind, Sheyman, & Beard, 2000), and Spanish (Vigliocco, Butterworth, & Garrett, 1996).

Attraction also observes some of the same syntactic constraints that govern normal agreement. Subject–verb number agreement applies within the boundaries of clauses, and attraction is likewise stronger between elements of the same clause than between elements of different clauses (Bock & Cutting, 1992). This can be seen as a manifestation of a more general syntactic-distance principle (Vigliocco & Nicol, 1998) which follows from the fact that agreement involves interactions of elements within a structured representation.

Resolution of Notional and Grammatical Number Conflicts

Attraction is a kind of spurious resolution between conflicting number specifications (Corbett, 1983). Normally the number of the agreement controller dominates this contest, but occasionally the number of a local noun takes over the control of verb agreement. Other types of number conflicts also occur. After linguistic coding, the grammatical number of the subject noun phrase may mismatch the number represented in the speaker's message. For instance, a high school principal might have a half-dozen individuals in mind when formulating a message about those responsible for playing a prank on a teacher. At this point, the message entity that is most likely to be referred to in the subject noun phrase of the ensuing sentence (the half-dozen individuals) is notionally plural. However, if the principal elects to refer to these individuals as ''a gang'' and uses the word *gang* as the head of the subject noun phrase, the grammatical number of the subject will be singular. In these circumstances, a different resolution to the problem of what controls agreement is needed.

There are several ways in which mismatches between grammatical and notional number might be resolved. Stripped down to essentials, a noun phrase can be superficially marked as singular or plural, while the underlying argument in the message is the reverse, and the verb may agree with either. Bock, Nicol, and Cutting (1999) showed that verbs were considerably more likely than two other number-agreeing elements (personal and reflexive pronouns) to reflect grammatical number in American English. At the same time, verbs showed an appreciable amount of agreement with the plural notional number of collective subjects (such as *gang*). This kind of finding casts doubt on efforts to isolate the explanation of the resolution of number conflicts, or of agreement itself, within meaning or syntax alone.

Experimental tests of conflicts between grammatical and notional number have provided strong evidence for the existence of two separate components of number in the resolution process. This has been observed most often when

grammatically singular subject noun phrases can be construed distributively (Eberhard, 1999; Hartsuiker, Kolk, & Huinck, 1999; Potter & Eberhard, 1999; Vigliocco et al., 1995, 1996; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996). For example, although the phrase ''the picture on the postcards'' is grammatically singular, it has a distributive interpretation (e.g., hundreds of postcards bearing the identical picture of the Eiffel Tower) that may incline it toward notional plurality. In this event, plural verbs are likely to be used. Distributive construals also occur when a collective head noun is regarded as denoting the individual members of a group rather than the whole group: Humphreys and Bock (1999) found that speakers were more likely to employ plural verbs after subject noun phrases such as ''The gang on the motorcycles'' than after minimally contrasting phrases such as ''The gang near the motorcycles.'' Presumably, ''the gang on the motorcycles'' is interpreted in a way that puts gang members into a one-to-one relationship with motorcyles, thereby emphasizing their multiplicity more than ''the gang near the motorcycles'' does.

Agreement with notional plurality, in the face of grammatical singularity, also occurs in cases of deictic, elliptical, or figurative references to multiple individuals. For example, in answer to a question such as ''How many people do you expect?'', the reply might be ''Ten are definitely coming.'' When *ten* denotes the number 10, however, it is singular: ''Ten is an even number.'' Similarly, notional singularity overrides grammatical plurality for control of agreement in examples such as ''Forty acres is too much to plow in one day'' (Morgan, 1972, 1984).

Attraction and Agreement

To account for the diversity of normal subject–verb number agreement as well as the regularities in spurious resolutions of number conflicts, we outline a general theoretical framework for the psycholinguistic implementation of number marking and number agreement. Figure 1 illustrates the components of language production that are involved in these operations, drawing on previous proposals about the structural and syntactic processes of production (Bock, 1982, 1987, 1995b; Bock, Loebell, & Morey, 1992). An important feature of these proposals is the direct relationship between the message (the conceptual precursor of an utterance) and the assignment of syntactic functions such as sentence subject (the so-called surface subject), along with the absence of a direct relationship between message features and the hierarchically organized structural assembly processes that control the sequencing of sentence constituents.

Adapting this framework for agreement yields three major claims. First, agreement involves the integration and resolution of number information during two different sets of mapping operations (as in Vigliocco, Butterworth, & Garrett, 1996), including (a) the mapping between a message representation and an abstractly specified lexical-grammatical representation (rep-

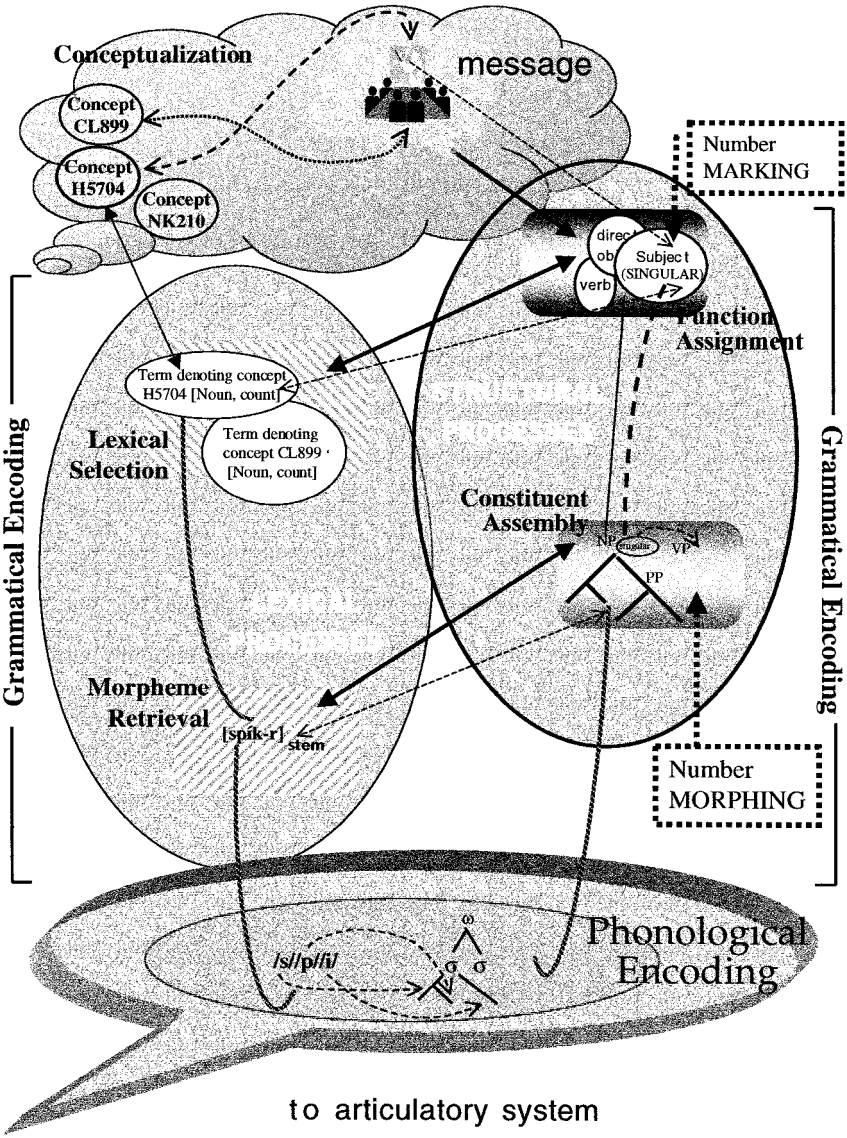

FIG. 1. A model of the structural processes of sentence production and their relationship to lexical processes indicating the proposed mechanisms of number marking and number morphing (dashed lines indicate temporary binding relationships between representations that arise during sentence formulation).

resented in Fig. 1 in terms of bindings between the message, function assignment, and lexical selection), which is formed during a process of function assignment; and (b) the mapping between the lexical-grammatical representation and a morphologically specified phrasal representation (represented in Fig. 1 as bindings between phrase structures and morpheme retrieval), which is formed during a process of constituent assembly. Second, during the mapping from the message to the lexical-grammatical representation, number features from the message are simultaneously specified on subjects and used in selecting lexical entries. Third, during the process of constituent assembly, the subject noun phrase inherits number features from the lexical-grammatical representation and uses them to control verb-phrase number features as agreement targets and does so without direct input from the message. This third claim is the focus of the present work.

Among the ways in which agreement could be implemented, we draw a distinction between *control* accounts and *compromise* accounts. With a control mechanism for agreement, the number of one element (the agreement controller) dictates the number of the second element (the target). The usual view of subject–verb agreement, embodied in the Simple Descriptive Rule as well as in most native speakers' intuitions about agreement in English, assumes a control relationship in which the subject is the controller and the verb the target. On this view, the verb is not independently specified for number, but takes its number from the subject.

The alternative to control is compromise. With a compromise mechanism, number-carrying elements are equal partners in the business of arriving at number agreement, and the problem is to arrange matters so that the elements end up with the same value. This requires a process that identifies number mismatches and a resolution process for fixing them. On this view, the subject and verb are capable of bearing independent number features (Vigliocco, Butterworth, & Garrett, 1996).

To account for the psycholinguistic facts of attraction and to integrate them into a theory of producing normal agreement, we propose that control and compromise both play parts in the operations of agreement, but different parts. They play these parts during agreement operations that we call *number marking* and *number morphing*. Number marking occurs during the mapping between messages and lexical-grammatical representations, while number morphing occurs during constituent assembly. In the next two sections we provide a rough sketch of how these proceed.

Number marking. In the course of the mapping from the message to a lexical-grammatical representation, the subject function is marked as singular or plural on the basis of message features (mainly, whether the notion expressed by the subject consists of a singleton or multiple things). Because noun phrases refer, and not bare words, phrases and the syntactic functions that control their realization may bear number. As noted above, the most persuasive evidence for the notional component of number marking comes

from findings that noun phrases may take plural agreement, despite having singular heads, when they support a highly accessible distributive construal (Eberhard, 1999; Humphreys & Bock, 1999; Vigliocco et al., 1995; Vigliocco, Hartsuiker, et al., 1996).[1]

In postulating number marking of the subject function and not the verb, our approach differs from that of Vigliocco, Butterworth, and Garrett (1996), who proposed a different mechanism for agreement in order to encompass data from Spanish. Specifically, they argued for message-based number marking (in our sense) of both the subject and the verb, with verb number as well as subject number being controlled by the message-level representation of the subject.

We adopt the more restrictive account in part for reasons related to English and in part out of more general considerations. In English, the ''meaning'' of verb number is largely opaque to native speakers: The word *sings* carries no sense of singularity (Keeney & Wolfe, 1972) to the point that even educated adults may be somewhat puzzled by explicit questions about a verb form's number meaning. So although notional features may have provided the historical foundations for verb agreement (Givón, 1976), their role in modern English agreement is weak. This being so, there is unlikely to be a direct assignment of number to the verb from the notions represented in the message, either the notions related to the subject or those related to the verb. For verb-related notions, in particular, it is difficult to differentiate or enumerate states and activities (e.g., kissing, bell-ringing, and applauding) in a principled way that could provide the notional underpinnings for verb number (see Bock et al., 1999, p. 341 for further discussion). For these reasons, the linguistic requirements of verb agreement may be more easily met by rooting the number features that support agreement in the notional referents of subjects alone (as in Vigliocco et al., 1995) and in English by providing access to the notional underpinnings of grammatical number to the subject alone.

Apart from the message-based contribution to lexical selection during function assignment, we tentatively assume that there is no specific lexical contribution to the number-marking process. Obviously, lexical entries must be chosen to satisfy constraints from message features in ways appropriate to the semantics of the language, and lexical selection is the culmination of the process by which lexical entries are identified that satisfy the relevant

[1] Of course, with normal variation in how speakers represent messages, along with uncertainty about the semantics of distributivity, something that *may* be construed as a plural need not be. For example, the phrase *the label on the bottles* may be notionally singular if the reference of *the label* is taken to be a single abstract label type rather than multiple concrete tokens of the same label. We assume that it is this commonplace interpretation that underlies normal singular agreement with subjects that can have distributive properties.

semantic constraints. The formal properties of words (as nouns, verbs, etc.) must interact with function assignment and enter into the bindings that create lexical-grammatical structures. However, apart from formally relevant features such as mass and count, which affect phrasal configurations, lexical-grammatical specifications of number do not come into play until the selected lexical entries are used in retrieving morphemes. This paves the way for number morphing.

Number morphing. Expanding on a proposal by Lapointe and Dell (1989), we assume that in English the number marking of the subject function controls the number features of the subject noun phrase. The subject noun phrase itself is assembled when the morphological representations of words and inflections are bound to specific positions within the phrase (during constituent assembly in Fig. 1), analogous to Garrett's (1988) positional level. At this point, the specifications of number in the lexicon are morphologically instantiated and, if necessary, reconciled with the number features on the subject. This, along with the implementation of agreement operations, constitutes number morphing.

Most morphemes in English carry no intrinsic number specifications, ensuring that most of the time a notionally determined number marking will prevail. However, some morphemes are specified as plural (e.g., the word *people;* the plural inflection *-s* itself), singular (e.g., the mass noun *water;* the collective *class*), or as simultaneously singular and plural (e.g., *sheep*). Consequently, number specifications can mismatch the marked number of the phrase. For instance, in Fig. 1 the subject noun phrase (NP) is marked as singular, which would be in conflict with any plural morpheme selected to be the head noun.

Such conflicts trigger an effort to resolve the marking of the phrase. In languages like English, number conflicts are often resolved by adjusting the number specification of the subject noun phrase. This adjustment (sometimes called *percolation* in formal linguistics; see Vigliocco & Nicol, 1998) is the compromise component of number morphing, and it aligns morphological number and phrase number. In English, a key feature of morphing is that only specified number matters (Eberhard, 1997). Because of this, it should be more likely for a notionally plural subject, expressed with a common singular morpheme as the head noun, to remain plural than for a notionally singular subject, expressed with a plural morpheme, to remain singular.

Number morphing culminates in a number feature for the verb, which fulfills the requirements of number agreement. This is the control component of number morphing: As shown in Fig. 1, the number of the subject noun phrase is transmitted to the verb phrase (VP in the figure). This transmission accounts for the findings regarding plural verb agreement with distributive subject noun phrases such as *the label on the bottles* (Eberhard, 1999; Humphreys & Bock, 1999; Vigliocco et al., 1995; Vigliocco, Butterworth, & Gar-

rett, 1996; Vigliocco, Hartsuiker, et al., 1996): The plural verbs in these cases are not products of attraction, we argue, but of notional plurality in the message.

Attraction reflects the resolution of number conflicts between morphological number and phrase number. Normally, when a singular subject contains a plural noun that is not the head (such as *students* in *the speaker in front of the students*), the number of the phrase does not change. However, if all number conflicts in a phrase are treated as candidates for reconciliation (restricted in ways that we return to later), percolation of a conflicting value may exert pressure on the number of a dominating phrase proportional to its depth within the phrase (Bock & Cutting, 1993; Vigliocco & Nicol, 1998). This means that structurally more prominent (and temporally earlier) number specifications will usually dominate the results, but disruptions to fluent preparation may allow structurally less prominent (and temporally later) number specifications to control number agreement. For instance, suppose that the intended subject noun phrase in Fig. 1 is *the speaker in front of the students.* The head noun *speaker* is structurally more prominent and earlier than *students,* but has no number specification of its own. *Students,* on the other hand, has a number specification that may compete with the number marking on the phrase. If the phrase marking gives way to the plural specification, the number of the subject noun phrase changes. When the number of the verb phrase follows suit, attraction happens.

In summary, we argue that agreement requires separable number-marking and number-morphing processes and that attraction arises during number morphing. If this is so, attraction should not occur for local notional plurals that are not also grammatically plural, but it should occur for grammatical plurals that are not notionally plural. The goal of the following experiments was to put these predictions through a series of tests. In all of the experiments, speakers produced sentences in which the notional and grammatical numbers of local nouns diverged, and we examined the consequences of these divergences for verb number. In the next section we describe the nature of the noun-number manipulation in order to lay the groundwork for specific predictions.

Noun Classes with Divergent Notional and Grammatical Number

To separate the notional and linguistic sources of influence on language use, one can examine noun classes whose notional and grammatical number differ. English has several classes of this kind. The ones we focus on in the present work involve three types called, respectively, *summation plurals* (for example, *scissors;* Quirk et al., 1985), collectives (e.g., *team*), and mass nouns (e.g., *rice*). Summation plurals are grammatically plural words that denote singleton objects; collectives are nouns that are grammatically singular (most of the time, at least in American English) and denote collections

of objects; and mass nouns are grammatically singular words that typically denote indivisible stuff, properties, or abstractions, but may also refer to groups or collections of objects and people (e.g., *baggage, furniture,* and *press*). In this section we describe the relevant properties of each class in more detail.

Summation plurals in English often refer to tools (scissors, binoculars, tweezers, pliers) or articles of clothing (trousers, pajamas, tights) with joined symmetrical parts. We will call these *bipartite* objects. Because a bipartite object is a single thing, it can be argued that the notional number of such an object is singular. In other languages, including Dutch and German, the translation equivalents of the summation plurals are singular (what an English speaker would call *a pair of scissors* is called in Dutch *een schaar;* literally, ''a shear''). Even in English, there are singular words for similarly symmetrical tools and articles of clothing (e.g., *wire cutter, shirt,* and *brassiere*). Despite this notional singularity, summation plurals are, as their name suggests, grammatically plural. They therefore carry two different kinds of number information that could play a role in language production.

Collective nouns likewise carry different kinds of number information, but in contrast to the summation plurals, they can be notionally multiple at the same time that they are grammatically singular. An army or a team or a fleet consists of multiple individuals or objects (soldiers, players, and ships). Despite this, most collective nouns are treated as grammatically singular in American English (with a smaller majority being singular in British English). Of course, collectives are semantically ambiguous in number, since they can denote the collective as a whole or the individuals it comprises. But the same collective nouns in the same contexts may be uniformly treated as singulars by American speakers and uniformly as plurals by British speakers (e.g., *team*), and some American speakers are likely to treat certain collective nouns as plurals (e.g., *faculty*) while treating very similar collectives as singulars (e.g., *staff*). For this reason, it is difficult to fully explain the number-agreement properties of collectives in terms of their semantic number ambiguity (Bock, Humphreys, Butterfield, & Cutler, 1999).

Mass nouns are in some respects like collectives in being notionally multiple but grammatically singular. What sets them apart from collectives is that they seem to have no productive plural forms in their basic senses. That is, *armies* means multiple armies, but *baggages* does not mean multiple piles of baggage (distributed around a hotel lobby, for example). If anything, it suggests different types or commercial lines of baggage (cf. *wine,* the substance, and *wines,* different kinds of wine). Although many mass nouns refer to substances that defy enumeration (e.g., *water* and *pudding*), others are as readily enumerated as similar, or even synonymous, count nouns. Well-known examples in English include the mass noun *pasta* and the count noun *noodle(s),* the mass noun *corn* and the count noun *bean(s),* and the mass noun *press* and the count noun *reporter(s).*

An Overview of the Experiments

In all four experiments, the procedure for eliciting subject–verb number agreement involved a sentence completion task (Bock & Miller, 1991). Participants heard and then repeated a sentence preamble such as *The advertisement for the razor,* with instructions to continue the repeated preamble in a way that created a complete sentence. The repetition of the phrase allowed us to ascertain whether the speaker had heard and correctly understood the preamble, and the completion task induced speakers to treat the phrase as the sentence subject. Consequently, the completions naturally contained verbs that would, in most circumstances, agree in number with the head of the subject noun phrase (e.g., *advertisement*). When the verb had an overt indication of its number (as *was* does in *The advertisement for the razor was deceptive*), it was scored as singular or plural.

The aim of the experiments was to assess how often notionally singular and plural local noun phrases elicited plural verbs relative to grammatically singular and plural noun phrases. The local noun phrases (local nouns, for short) were always the second noun phrases in the preambles, and in most participants' responses, directly preceded the number-carrying verb. In Experiment 1, we compared English summation plurals (e.g., *scissors*) to their Dutch counterparts, which are grammatically singular, and to singular and plural controls (e.g., *razor* and *razors*) in both languages. This made it possible to determine whether the bipartite nature of the concepts underlying the summation plurals (a potential source of notional plurality) is sufficient to cause plural attraction or if the notional singularity of the objects denoted by the summation plurals reduces the incidence of attraction. The morphological account of attraction predicts that summation plurals should be as likely to cause attraction as regular plurals and more likely than their Dutch counterparts. If bipartite object concepts are, in fact, singular, a notional account would predict summation plurals to be less likely than their regular plural controls to create plural attraction.

The second experiment was a replication of the English conditions from Experiment 1, using another type of English invariant plural for the local nouns. These were nouns such as *suds,* which are like the summation plurals in having no singular counterpart, but unlike them in carrying a notionally plural sense. The morphological account of attraction predicts the same effects for these local nouns as for the summation plurals in Experiment 1, whereas a notional account implies that there should be relatively more attraction than for summation plurals.

In the third and fourth experiments, the local nouns were English collectives and Dutch collective and mass nouns. Since collectives and mass nouns are grammatically singular but can be notionally plural in both languages, the morphological and notional explanations of attraction make a set of predictions complementary to those from Experiment 1: If attraction has a no-

tional component, collectives and mass nouns should yield more attraction than their singular controls, but if attraction is morphologically based, there should be no more attraction to collectives and mass nouns than to singulars and less than to grammatical plurals.

EXPERIMENT 1

In Experiment 1 we examined the roles of grammatical and notional number features in attraction by looking at the effects on verb number of local nouns that denote bipartite objects (such as *scissors* in English and *schaar* in Dutch). Because such objects consist of two symmetrical parts, it can be argued that this property supports a construal of the referents as multiple or notionally plural (for one argument of this kind, see Reid, 1991). To find out whether notional plurality can create attraction on its own, without the support of morphological plural marking, we compared a set of bipartite-denoting nouns in English and Dutch. The English nouns were drawn from the class of summation plurals (Quirk et al., 1985), which are invariant grammatical plurals; the Dutch translation equivalents were grammatically singular. If the presumed notional plurality of bipartite objects can induce attraction, the Dutch bipartite nouns should elicit plural verbs at a greater rate than the singular controls.

In addition, Experiment 1 assessed whether the invariable summation plurals behave like variable, inflected plural nouns in English with respect to attraction. This was done by comparing the incidence of attraction after both invariable-plural (*scissors*) and variable-plural (*razors*) local nouns. If the two kinds of plurals differ in their plural properties, they should elicit different numbers of plural verbs relative to singular controls.

Finally, to ensure that grammatically inflected plural nouns create attraction under the conditions and with the languages used in the experiment, we compared variable plurals to their singular counterparts (*razor*). If the results of past research hold, plural local nouns should elicit plural verbs more often than singular local nouns do.

Method

Participants. The participants were 96 undergraduates from Michigan State University and 48 from the University of Nijmegen. The Michigan State students were native speakers of American English and the Nijmegen students were native speakers of Dutch. In return for their service, the Michigan State students received extra credit in an introductory psychology course and the Nijmegen students received a small cash payment.

Materials. The experimental items are illustrated in Table 1, and listed in full in the Appendix. All of the items constituted *preambles* that were created to serve as the subjects of the experimentally elicited sentences. There were three versions of each of 18 items. All versions included a noun phrase followed by a prepositional phrase, which together formed a complex subject noun phrase. As shown in Table 1, the versions differed only in the nouns that served as the objects of the prepositional phrases (the *local nouns*). In the English versions, the local

TABLE 1
Experiment 1: Example Preambles and Mean Notional Number of Local Nouns in All Items

Local-noun condition	English example	Mean notional number (1 = singular; 2 = multiple)	Dutch example	Mean notional number (1 = singular; 2 = multiple)
Singular	The *advertisement* for the *razor*	1.17	De *reclame* voor het *scheermes*	1.09
Plural	The *advertisement* for the *razors*	1.75	De *reclame* voor de *scheermessen*	1.88
Bipartite	The *advertisement* for the *scissors*	1.20	De *reclame* voor de *schaar*	1.06

Note. The head nouns in all conditions were singular. Note that the Dutch versions of the bipartite local nouns are singular.

noun was either a simple singular (e.g. *razor*), the plural counterpart (*razors*), or a semantically related summation plural denoting a bipartite object (*scissors*). The Dutch versions were the same, except that the local noun in the bipartite condition was singular.

Norming of the local nouns from the English experimental items was carried out to verify the nouns' number properties. Three lists of words were created, each including one local noun from the 18 experimental items. Every list contained 6 singular, 6 plural, and 6 bipartite nouns in random order. A total of 45 raters, 15 per list, completed a forced-choice questionnaire in which they were asked to indicate, for each word, whether it represented ''one thing'' or ''more than one thing.'' The instructions were to evaluate each noun in the context of the question *If you were thinking about the* _____, *would you be thinking about one thing or more than one thing?* If both options seemed to apply (i.e., the word seemed ambiguous between ''one'' or ''more than one''), the raters were told to select the more sensible alternative. We assigned a value of 1 to the rating when ''one'' was chosen, and a value of 2 when ''more than one'' was chosen. The mean ratings for the singulars (1.17) and the bipartites (1.20) did not differ significantly, but both differed from the plurals (1.75). The 95% confidence interval for planned pairwise contrasts was .07, calculated using the mean-square error from a one-way analysis of variance by items that yielded an $F(2, 34) = 161.44$.

In addition to the experimental items there were 78 filler preambles. The fillers in the English lists included 48 simple noun phrases (half singular and half plural, equally divided in turn between unmodified noun phrases and noun phrases with adjective or nominal modifiers) and 30 complex noun phrases similar in structure to the experimental items. The latter phrases were divided into three groups, 12 with plural head nouns and singular local nouns, 12 with plural head and local nouns, and 6 with singular head and local nouns.

The Dutch materials were translation equivalents of the English items. The two sets of materials were developed and refined collaboratively to ensure overall acceptability to native speakers as well as comparability in meaning, using translation and backtranslation. The only significant disparity between the Dutch and English materials was built in by design: Because all of the Dutch equivalents of the English summation plurals are grammatically singular, the Dutch local nouns used in the bipartite condition were singular. (There was no condition in which the local nouns were Dutch invariant plurals with translation-equivalent English singulars because we were able to identify only one clear instance of this type: The Dutch word for *brain* is the invariant plural *hersenen.*)

Notional-number norming of the Dutch local nouns was carried out by 60 raters, 20 on each of three counterbalanced lists that were assembled and administered with instructions duplicating the English lists. The results are shown in Table 1. The mean ratings for the

singulars (1.09) and the bipartites (1.06) did not differ significantly, but both differed from the plurals (1.88). The 95% confidence interval for planned pairwise contrasts was .06, calculated using the mean-square error from a one-way analysis of variance by items that yielded an $F(2, 34) = 673.86$.

The Dutch fillers also paralleled the English in form and meaning, except in one respect that was necessary to balance the distributions of singulars and plurals in local-noun positions. Specifically, the Dutch counterparts of the six English fillers with singular head and local nouns had, instead, singular heads and plural local nouns.

The experimental and filler preambles for each language were divided among three 96-item presentation lists. Every list contained all of the filler items and one version of every experimental item. Within lists, there were equal numbers of experimental preambles representing each of the three experimental conditions, and across lists, all versions of the experimental items occurred just once. The order of the items across lists was random with three constraints: (a) The first 10 preambles were fillers, half with singular and half with plural head nouns; (b) experimental preambles were distributed across the list, separated by three to five fillers; and (c) preambles representing the same experimental conditions never occupied adjacent slots in the lists. The same random order was employed for all lists, so that fillers and alternative versions of each experimental item always occupied the same list positions. The Dutch lists were identical to the English lists in construction and in the order of items.

The preambles were digitally recorded by female native speakers of American English and Dutch. Each experimental and filler preamble was recorded just once and then dubbed onto audio tapes for presentation during the experimental sessions.

Procedure. The same general procedure was followed in the English and Dutch sessions. All participants were run individually in the sentence-completion task. The participants were told that they would hear phrases that were to be used as the beginnings of sentences. They were instructed to repeat each phrase and continue on with a completion to create a single sentence, proceeding as quickly as possible. The experimenter then demonstrated the procedure with two examples. No other instructions about the forms of the responses were given.

The preambles were played one at a time over a loudspeaker. After each one the experimenter paused the tape, which cued the participant to repeat and complete the preamble. Participants wore a tie-clip microphone connected to a tape recorder for recording their responses. The experimental sessions lasted approximately 15 min.

Scoring. The spoken completions of the experimental preambles were transcribed from the audio tapes and scored, with each response assigned to one of four primary scoring categories. The four categories consisted of *singular* number agreement, *plural* number agreement, *ambiguous* number agreement (in English), and *miscellaneous* responses.

In the English sentence completions, the criteria for each of these categories were as follows. *Singular* responses contained one complete, correct repetition of the preamble; the repetition was followed directly and without interruption by a verb overtly marked for singular number; and the completion formed a sentence. Responses were scored as *plural* when they met all the criteria for a *singular* response except that the number marking on the verb was plural. Responses that contained verbs not overtly marked for number (e.g., modals such as *should, could,* and *would* and the past tense forms of regular verbs) but otherwise met the criteria for a *singular* or *plural* score were assigned to the *ambiguous* category. All completions that did not meet the criteria for the above three categories were assigned to the *miscellaneous* category. Most of these involved preamble repetition failures or contained more than one repetition of the preamble before a completion was produced.

The same criteria were used in scoring the Dutch completions. The scoring categories themselves were also the same, although the ambiguous category did not apply: Dutch verbs carried unambiguous number marking in all their forms (as is normally the case).

Application of these scoring criteria yielded the distributions of responses shown in Table 2, broken down by experimental conditions. Overall, 796 of the 864 Dutch responses were either singular or plural (92.1%). In English, 1204 of the 1728 responses were either singular or plural (69.7%). Adding the 221 ambiguous responses to the English total brings the percent-

TABLE 2
Percentages of Responses in Four Scoring Categories by Local-Noun Condition in Experiment 1

Local-noun condition	Language of preamble	
	English	Dutch
	Singular-inflected verbs	
Singular	72.2 (416)	93.8 (270)
Plural	44.4 (256)	81.6 (266)
Bipartite	54.0 (311)	92.4 (235)
	Plural-inflected verbs	
Singular	.3 (2)	0.0 (0)
Plural	22.6 (130)	9.7 (25)
Bipartite	15.5 (89)	0.0 (0)
	Number-ambiguous responses	
Singular	22.2 (128)	—
Plural	17.5 (101)	—
Bipartite	21.2 (122)	—
	Miscellaneous responses	
Singular	5.2 (30)	6.2 (18)
Plural	15.5 (89)	9.7 (28)
Bipartite	9.4 (54)	7.6 (22)

Note. Raw numbers of responses are given in parentheses. The category of number-ambiguous responses applied only to English.

age of responses with intact preambles and fluently completed sentences to 90.0%, comparable to the rate of similar responses in Dutch.

Design and Analyses. The experimental design for participants included one between-subjects factor of language (English or Dutch) and one within-subjects factor, local noun type, with three levels (singular, plural, and bipartite). Each of the 48 Dutch and 96 English participants received 6 items in each cell of this design. The design for items was completely crossed, with each of the 18 items appearing in every cell of the language by local-noun-type matrix. Every item was administered to 32 English participants and 16 Dutch participants.

In this and all subsequent experiments, analyses were carried out on the proportions of plural verbs for each participant and item in each cell of the design, out of the total of number-marked verbs in the same cell. Proportions of number-marked verbs served as the dependent variable, rather than percentages of all responses, in order to neutralize any impact of the number-ambiguous responses in English (which cannot be validly categorized as either singular or plural) and to allow more direct comparisons between the English results and those in Dutch, where number-ambiguous responses do not occur.

One analysis of variance was performed on the participant proportions, treating participants as random effects. A separate analysis on the item proportions treated items as random effects, and *min F′* was estimated following the procedures advised by Clark (1973). The 95% confidence intervals for pairwise planned comparisons were calculated from the results of the separate participant and item analyses using the mean-square error of the interaction between local-noun type and language. All differences that are reported as significant were associated with α levels less than or equal to .05.

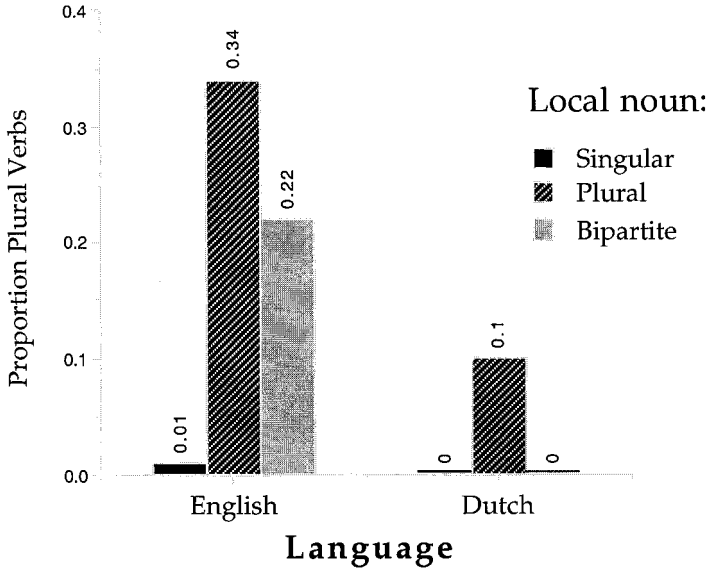

FIG. 2. Proportions of plural verbs in English and Dutch after grammatically singular subject noun phrases containing singular, plural, or bipartite local nouns.

Results

The proportions of plurals among all number-inflected verb forms are shown in Fig. 2. In both English and Dutch, the simple singular- and plural-local-noun controls yielded a large difference in agreement, with no Dutch and very few English verbs occurring in the plural after singular local nouns. After bipartite local nouns, the languages diverged. Dutch verbs were uniformly singular, whereas English verbs tended toward plural agreement.

The analyses of variance on the proportions of plural verbs reflected these differences. Table 3 gives the F values associated with each source in the subjects, items, and *min* F' analyses. The .22 to 0 difference between English and Dutch for bipartite local nouns was significant, with 95% confidence intervals of .04 in the subjects analysis and .06 in the items analysis.

For English, bipartite local nouns were less likely than normal plurals to create plural attraction, .22 plural verbs to .34 plural verbs, respectively. Analyses of variance on the English data alone yielded a significant effect of local-noun type (see Table 3). The 95% confidence intervals for Scheffé post hoc comparisons were .08 and .12 calculated from the subjects and items analyses, respectively.

Discussion

The results of Experiment 1 replicated the well-established findings that plural local nouns create plural attraction and do so in both English and

TABLE 3
Analysis of Variance Results for Experiments 1, 2, and 3

Source of variance	By subjects		By items		min F'	
	df	*F*	*df*	*F*	*df*	*F*
		Experiment 1				
Language	1, 142	53.97	1, 17	32.81	1, 42	20.41
Local-noun type	2, 284	48.25	2, 34	26.62	2, 79	17.16
Language × local-noun type	2, 284	20.27	2, 34	17.66	2, 109	9.44
English local-noun type	2, 190	65.99	2, 34	25.49	2, 64	18.39
		Experiment 2				
Local-noun type	2, 136	24.08	2, 34	16.60	2, 87	9.83
		Experiment 3				
Local-noun type	1, 47	.01*	1, 15	.04*	1, 61	.01*
Local-noun number	1, 47	20.90	1, 15	11.82	1, 33	7.55
Local-noun type × number	1, 47	.001*	1, 15	.04*	1, 49	.00*

* Not significant.

Dutch. Although there were fewer occurrences of attraction in Dutch than in English, there were nonetheless more plural verbs after plural local nouns than after singular local nouns in both languages. We set aside for the General Discussion our speculations about the reasons for differences between the languages in overall attraction rates.

The main findings of Experiment 1 had to do with the roles of morphological and notional number features in agreement. Bipartite-denoting nouns in English, which are morphologically plural, elicited significantly more plural agreement than singular controls but significantly less than variable plurals. In contrast, the Dutch bipartite nouns, which are grammatically singular, elicited no more plural agreement than other grammatically singular nouns. In fact, neither type of singular noun created any plural agreement at all in Dutch, unlike the grammatically plural nouns. The implication is that the verb-attracting properties of bipartite nouns reside in their morphological rather than notional properties.

One question about the English results for the bipartite nouns arises from the presence in the materials of two items that have polysemous variable-plural counterparts. The two words in question, *glasses* (used in the sense of *spectacles*, but cf. *magnifying glass*) and *braces* (used in the sense related to teeth, but cf. *shoulder brace*), consequently have singular count-noun counterparts (unlike *pliers*, for example).[2] To check whether this factor was associated with a different pattern of responding, we inspected the results for these items separately. The proportion of plural verbs employed was .19 in the bipartite local-noun condition compared to .14 after plural local nouns

[2] We are grateful to an anonymous reviewer for pointing these items out to us.

and .00 after singular local nouns. For the remaining items, the corresponding proportions were .22, .36, and .01. So, the results change very little, but it is intriguing that, relative to their normal plural controls, the two ambiguous items did not contribute to reducing the amount of attraction after bipartite local nouns.

Remaining to be explained is the finding that the English summation-plural, bipartite local nouns created significantly less attraction than the variable plurals. This suggests that the notional number of the bipartites did influence the magnitude of attraction. Experiment 2 tested this along with an alternative hypothesis to account for the effect.

EXPERIMENT 2

There are at least two plausible explanations for the reduction in plural attraction that was observed after the English summation plurals in the first experiment. One invokes the notional number of the objects denoted by plural nouns like *trousers* and *pajamas:* Since the individual objects are singletons, with no more intimations of plurality than individual objects like shirts or brassieres, the singular notional number of the summation plurals may have diluted the attraction of verb plurality.

An alternative explanation has to do with the invariance of summation plurals. Unlike other nouns, summation plurals have no singular forms for most speakers in most dialects of English. So, whereas most English nouns participate in a highly productive inflectional paradigm, alternating freely between singular and plural forms, summation plurals do not. The absence of an inflectional process for these nouns, or the absence of a singular competitor, may eliminate one component of the attraction mechanism.

To test these accounts, in Experiment 2 the local nouns were drawn from another type of invariant plural noun that carries plural rather than singular notional number. The so-called *pluralia tantum*[3] include English words (like *suds*) that lack singular noun forms. Unlike summation plurals such as *scissors,* they refer to things that tend to be conceived of as multiple. If the notional singularity of the summation plurals contributed to the reduction of plural attraction in Experiment 1, no such effect should be observed in Experiment 2. Instead, an increase in plural attraction would be predicted relative to semantically matched inflected plurals. But if an inflectional process contributes to attraction, the absence of this process for the invariable plurals should reduce plural attraction even for the notionally plural *pluralia tantum.*

[3] Classically trained readers may quibble with this Latin declension. The first author is classically ignorant, so the usage follows the authority of Quirk et al. (1985), perhaps too slavishly.

METHOD

Participants. The participants were 69 undergraduates at the University of Illinois. All of them were drawn from the Department of Psychology's subject pool, which is made up of introductory psychology students fulfilling a course requirement.

Materials. The experimental materials were analogous to the English items used in Experiment 1, except that the invariant-plural local nouns were selected to have notionally plural referents. Table 4 gives a sample item in its three versions, and the complete set of 18 items is shown in the Appendix.

The norming of the notional number of the local nouns was conducted in the same manner as in Experiment 1, but by a different group of 45 raters. The mean ratings of notional plurality for each of the three types of local nouns are shown with the example in Table 4. The ratings for the singulars (1.15), plurals (1.81), and pluralia tantum (1.56) all differed significantly from each other. The 95% confidence interval for planned pairwise contrasts was .09, calculated using the mean-square error from a one-way analysis of variance by items with an $F(2, 17) = 91.17$. For the purposes of the experiment, the essential result in these ratings is the difference of .41 between the pluralia tantum and the singulars (compared to the difference of .03 in Experiment 1 between the summation plurals and the singulars). The .25 difference between the pluralia tantum and the plurals (which may be due to the stuff-like, mass properties of the referents of many of the pluralia tantum nouns) makes the contrast less sharp, but does not invalidate it.

The construction of the experimental lists, including fillers and practice items, was the same as for the English lists in the first experiment. The 78 filler items were identical to those in Experiment 1 except for two minor wording changes that eliminated duplicate nouns. The recordings of all the materials were made by a male native speaker of American English.

Procedure. See under Experiment 1 for details of the procedure.

Design, scoring, and analysis. The experimental design for participants included a single within-subjects factor with three levels (singular, plural, or pluralia tantum local noun), so that each participant received six items in each cell of the design. At each of the three levels in the within-item design, every item was presented to 32 participants.

Response scoring and data analyses were the same as for the English conditions in Experiment 1. Table 5 lists the distributions of responses by experimental conditions. Overall, 769 of the 1242 responses were overtly singular or plural (61.9%), 394 were ambiguous (31.7%), and the remaining 79 (6.3%) were miscellaneous.

Results

Figure 3 displays the proportions of plurals among all the singular and plural responses. Compared to the verbs that followed singular local nouns,

TABLE 4
Experiment 2: Example Preambles and Mean Notional Number of Local Nouns for All Items

Local-noun condition	Example	Mean notional number (1 = singular; 2 = multiple)
Singular	The color of the soap bubble	1.17
Plural	The color of the soap bubbles	1.85
Pluralia tantum	The color of the soap suds	1.59

Note. The head nouns in all conditions were singular.

TABLE 5
Percentages of Responses in Four Scoring Categories by Local-Noun Condition in Experiment 2

Local-noun condition	Response percentages
	Singular-inflected verbs
Singular	62.8 (260)
Plural	52.2 (216)
Pluralia tantum	49.5 (205)
	Plural-inflected verbs
Singular	.7 (3)
Plural	13.5 (56)
Pluralia tantum	7.0 (29)
	Number-ambiguous responses
Singular	33.6 (139)
Plural	27.5 (114)
Pluralia tantum	34.1 (141)
	Miscellaneous responses
Singular	2.9 (12)
Plural	6.8 (28)
Pluralia tantum	9.4 (39)

Note. Raw numbers of responses are given in parentheses.

the verbs that followed normal plural and pluralia tantum local nouns were less likely to carry singular number. To test these differences statistically, confidence intervals were calculated from single-factor analyses of variance on the proportions of plural responses for the three local-noun types (see Table 3). The differences between the singular local nouns and each of the two types of plural local nouns were significant (with differences of .20 and .11 for plurals and pluralia tantum, respectively), assessed against 95% confidence intervals for planned, pairwise contrasts of .05 for participants and .06 for items. The difference of .09 between the two types of plural local nouns was also significant, tested against 95% confidence intervals for Scheffé post hoc comparisons of .07 and .08 for subjects and items, respectively.

Discussion

The goal of Experiment 2 was to evaluate two different accounts of the reduction in verb attraction after invariant-plural local nouns. For this purpose, the major finding was that notionally multiple invariant plurals (pluralia tantum such as *suds*) produced less attraction than inflected plural nouns. When coupled with the evidence from the notional-number ratings that the pluralia tantum are more strongly plural, relative to singular controls, than are the bipartite nouns that were used in Experiment 1, the implication is

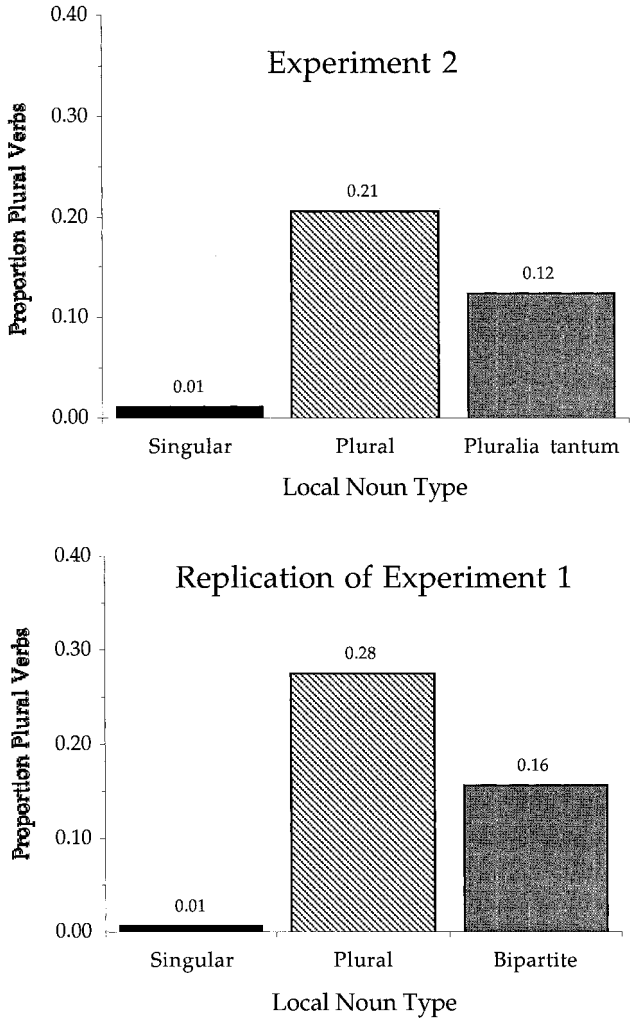

FIG. 3. (Upper panel) Results from Experiment 2, showing proportions of plural verbs in English after grammatically singular subject noun phrases containing singular, plural, or pluralia tantum (notionally multiple, invariant-plural) local nouns. (Bottom panel) Results from a replication of the English conditions in Experiment 1, using participants from the same source as Experiment 2.

that the similarities in attraction rates for the two types of invariant plurals stemmed from something other than notional number.

One puzzle in the results was that the rate of attraction, averaging a proportion of .16 plural verbs, was lower than the average of .28 in the corresponding English conditions in Experiment 1. To assess whether this reduction

might be traced to differences in the participants (recall that the two experiments were run at different universities), we replicated Experiment 1 with 69 undergraduates from the University of Illinois, none of whom had taken part in Experiment 2. The results of this replication are shown in the lower panel of Fig. 3. They suggest that differences in the samples could have affected the attraction rates: The average rate of attraction in the replication was .22.

More importantly, the general pattern of results in the replication of Experiment 1 was very much the same as in Experiment 2. One index of this similarity is how the instances of attraction were split between the normal plurals and the invariant summation plurals in the replication of Experiment 1 (.65 for the normal plurals and .35 for the invariants) and in Experiment 2 (.66 for the normal plurals and .34 for the invariant plurals). To directly compare the attraction effects for the bipartites to the attraction effects for the pluralia tantum, we performed an analysis of variance on the proportions of plural verbs in Experiment 2 and the replication of Experiment 1, with experiment as a factor in the design. Type of local noun was the other factor, with three levels (singular, plural, and invariant plural). The only significant difference was due to the type of local noun, $min\ F'(2, 143.3) = 20.60$. The notional number of the invariant plural, which is captured in the experiment factor, had no significant effect on its own [$min\ F'(1, 65.4) = .70$] or in the interaction with local-noun type [$min\ F'(2, 134.4) = .67$].

These comparisons indicate that the notional number of a local noun is unlikely to have a strong impact on the magnitude of attraction. On any measure, the rate of attraction for the local nouns in Experiment 2 was actually somewhat lower, although not significantly lower, than the rate of attraction for the local nouns in Experiment 1, even though the former were judged as being notionally more plural than the latter. This underscores the conclusion that the notional singularity of the summation plurals in Experiment 1 was unlikely to be responsible for the weakness of attraction to invariant plurals relative to regular plurals. Instead, the culprit is more likely to be something associated with the absence of inflection, or the absence of a singular alternative, for invariant plural nouns.

The remaining outcomes of Experiment 2 also duplicated the English results from Experiment 1 and the replication. Variable and invariable plurals both elicited more plural attraction than singular local nouns. Since many studies (beginning with Bock and Miller, 1991) have shown that singular local nouns create little or no singular attraction in English, this result adds weight to the hypothesis that there are verb-agreement operations in language production that are sensitive to the grammatical or morphological plurality of local nouns whose notional number has no effect on verb agreement.

Our results for invariant local nouns might be seen as contradicting those reported by Vigliocco et al. (1995, Experiment 3) for Italian. Using Italian nouns that have the same singular and plural forms (e.g., *camion* means both

truck and *trucks,* analogous to English words like *deer*), Vigliocco et al. found no difference in the incidence of attraction to invariable plurals relative to normal variable forms. In contrast, our results suggest less attraction for invariants. The difference can be readily explained by the properties of the Italian and English materials in the respective experiments. Even with invariant nouns, the number of the Italian noun phrases was indicated by a variation in the accompanying determiner: A singular truck is *il camion* but the plural is *i camion.* Because of this variation, the local noun phrases used in the Italian experiment presumably required a plural inflection of the determiner, unlike the invariant English phrases in Experiments 1 and 2.[4]

EXPERIMENT 3

The results of the first two experiments showed that invariant plural nouns were less likely to attract plural agreement than grammatical plurals with singular counterparts. One implication is that speakers are more sensitive to the grammatical number than to the notional number of local nouns. However, the evidence for this is somewhat indirect, coming as it does from the absence of differences in the amount of attraction for grammatically plural local nouns that differ in notional number. A more direct and potentially more sensitive evaluation of notional attraction is possible with a comparison of local nouns having different notional numbers but the same, singular, grammatical number. Since singular grammatical number does not seem to create attraction (Eberhard, 1997), any effect of plural notional number should be more readily discerned. This was the purpose of Experiment 3.

Collective nouns (like *army, class, herd, flock,* and so on) carry a plural sense that allows them to refer to groups of people, animals, and things. This plural sense supports the use of plural verb agreement with some collectives, and plural pronoun agreement with most collectives, in American English (e.g., *The faculty* ***are*** *threatening to protest* ***their*** *raises this year;* Bock, Nicol, & Cutting, 1999). In British English the tendency is even stronger, with larger numbers of collectives commonly participating in plural subject–verb agreement relationships (Bock, Humphreys et al., 1999).

Collectives nonetheless show little tendency to attract plural agreement as local nouns: Whereas a local noun such as *soldiers* reliably produces attraction, *army* does not (Bock & Eberhard, 1993, Experiment 4). Experiment 3 replicated Bock and Eberhard's work with a sample of participants from

[4] Vigliocco et al. (1995, Experiment 3) did find an effect of invariance on agreement when the invariant nouns were in head position, with invariant subjects associated with more agreement errors. In that position, however, invariance also produced a significant number of repetition errors, suggesting that the effect may have arisen in part because of problems in perceiving the utterance-initial articles and corresponding confusion about the number of the head noun.

TABLE 6
A Sample Item from Experiment 3

Local-noun condition	Example
Singular individual	The record of the player
Plural individual	The record of the players
Singular collective	The record of the team
Plural collective	The record of the teams

the same source as Experiment 2 to better secure the conclusion that notional plurality, by itself, exerts little impact on verb number.

Method

Participants. The participants were 48 undergraduates from the University of Illinois. All of them were members of the introductory psychology subject pool satisfying a course requirement; none took part in any of the previous experiments.

Materials and procedure. The experimental items consisted of 16 sets of sentence preambles that were drawn from the ones employed by Bock and Eberhard (1993, Experiment 4). Each set contained four preambles with a singular head noun followed by a prepositional phrase. The local noun that terminated the prepositional phrase was either a collective (e.g., *team*) or a semantically related individual noun (e.g., *player*). With one exception, the individual nouns referred to possible members of the group denoted by the collective noun in the same item set. The exception was *judge,* for which the matched collective was *jury*. The preambles in each set also differed in whether the collective and individual local nouns were singular (number match) or plural (number mismatch). The complete list of experimental materials is given in the Appendix, and an example is shown in Table 6.

There were 40 filler preambles, all simple noun phrases. Half of the phrases contained lone nouns preceded only by determiners, and the other half were nouns preceded by a determiner and an adjective. There were 12 singular and 28 plural fillers.

Four lists were assembled from the filler and experimental preambles, observing the same constraints on list design and construction as in the previous experiments. The preambles were recorded by a male native speaker of English, and presented to participants following the procedures described in Experiment 1.

Design, scoring, and analyses. The experimental design for participants included two within-subjects factors, local-noun type (individual or collective) and local-noun number (singular or plural). Every participant received four items from each cell of the matrix formed by crossing the two factors. The design for items had the same two factors, both of them within items, and every item was presented to 12 participants in each cell.

Response scoring and data analyses were the same as in the previous experiments. Table 7 gives the distributions of responses by experimental conditions. Of the 768 responses, 532 were marked as singular or plural (69.3%), 155 were ambiguous (20.2%), and the remaining 81 (10.6%) were miscellaneous.

Results

Table 7 lists the percentages of responses in each condition, and Fig. 4 shows the proportions of plurals among all of the verb forms that marked number. The analyses of variance confirmed the differences that are evident in the table and figure: Grammatically plural local nouns, both individual and

TABLE 7
Percentages of Responses in Four Scoring Categories by Local-Noun Conditions in Experiment 3

Local-noun type	Local-noun number	
	Singular	Plural
	Singular-inflected verbs	
Individual	71.9 (138)	58.3 (112)
Collective	74.5 (143)	54.7 (105)
	Plural-inflected verbs	
Individual	.5 (1)	8.8 (17)
Collective	.5 (1)	7.8 (15)
	Number-ambiguous responses	
Individual	19.3 (37)	21.9 (42)
Collective	18.2 (35)	21.3 (41)
	Miscellaneous responses	
Individual	8.3 (16)	10.9 (21)
Collective	6.8 (13)	16.1 (31)

Note. Raw numbers of responses are given in parentheses.

collective, created plural attraction on subsequent verbs. This significantly increased the incidence of plural verbs in both of the plural-local-noun conditions relative to the singular-local-noun conditions (see Table 3). The notional number of the local nouns (individual or collective) had no significant effect on verb number, either overall or in the interaction with local-noun number.

The miscellaneous responses were examined to see how grammatical and notional number influenced agreement patterns when the preambles were reproduced incorrectly. Because some of these responses changed the number of the head or local noun in the preambles, agreement was evaluated relative to the grammatical and notional numbers of the heads and local nouns that were actually produced. Of the 81 responses, 9 contained no audible verb and 12 contained number-ambiguous verbs (13 of these 21 responses were in the condition with individual local nouns). The verbs in the remaining 60 responses (representing 31 individual-local-noun and 29 collective-local-noun preambles) were scored as singular or plural. After individual local nouns, 77.4% of the responses contained verbs that matched the grammatical number of the head nouns and 22.6% contained verbs that mismatched the grammatical number of the head. Of the latter, all but one were plural verbs after preambles with plural local nouns and singular heads; the other was a singular verb after a preamble with a plural head and a plural local noun. After collective local nouns, 79.3% of the verbs matched the

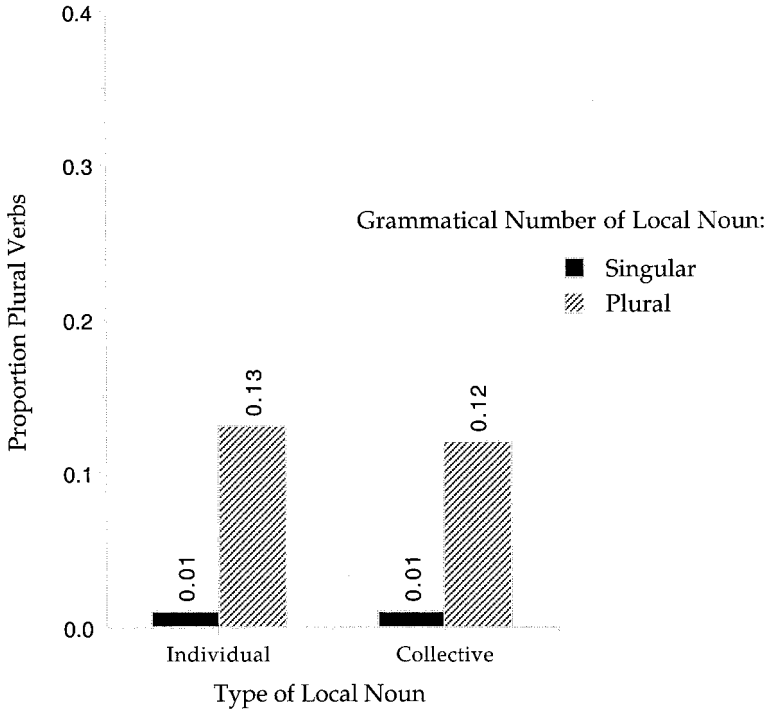

FIG. 4. Proportions of plural verbs in Experiment 3 following grammatically singular English subject noun phrases with individual or collective local nouns in both singular and plural versions.

grammatical number of the head nouns, and all the rest were plural verbs after preambles with plural local nouns and singular heads. In short, the miscellaneous responses offered no evidence for an effect of local notional plurality on verb number.

Discussion

The results suggest that grammatically singular collective nouns have no greater ability to attract plural verb agreement than grammatically singular individual nouns. Likewise, grammatically plural collectives elicited no more plural-agreeing verbs than grammatically plural individual nouns did. The same pattern held among responses to preambles that were incorrectly reproduced, offering no evidence for an effect on subject verb agreement of the local noun's notional number. This strengthens the argument that the notional numbers of the invariant plurals in Experiments 1 and 2 were not responsible for reducing plural attraction relative to the variable-plural local nouns.

EXPERIMENT 4

Experiment 4 extended Experiment 3 using Dutch speakers and materials, with the aim of testing the influence of a local noun when its notional number is made more salient. Eberhard (1999) showed that notional plurality was more likely to influence verb agreement when the situation denoted by the subject noun phrase was more concrete or when it was made concrete by illustrating it for English speakers. Eberhard's experiments involved emphasizing the distributive (plural) construals of phrases such as *the label on the bottles* by depicting multiple wine bottles, each with the same label. When accompanied by a picture, preambles like this were more likely to elicit plural verbs, despite the grammatical singularity of the head noun.

In order to highlight the notional plurality of local nouns, one set of participants in Experiment 4 heard preambles while viewing a picture that contained multiple objects corresponding to the local noun (e.g., *the bowl with the fruit* was accompanied by the picture with several apples in Fig. 5). The same picture accompanied preambles with grammatically plural local nouns, while a picture with a single object (e.g., the bowl with just one apple in Fig. 5) accompanied preambles with grammatically and notionally singular local nouns. If the notional plurality of a local noun is more likely to influence verb agreement when it is emphasized by an accompanying picture, one might expect to see attraction when pictures were presented along with the preambles, but not when the preambles were presented alone. In addition, Dutch speakers may be more sensitive to variations in notional number than English speakers are (Vigliocco, Hartsuiker et al., 1996), increasing the likelihood of a contrast with the results of Experiment 3.

One subsidiary comparison was incorporated into the study. It involved two different types of notional plurals, collectives and mass nouns. Dutch collectives and mass nouns are analogous in their properties to English collectives and mass nouns in that both types of nouns can be notionally plural,

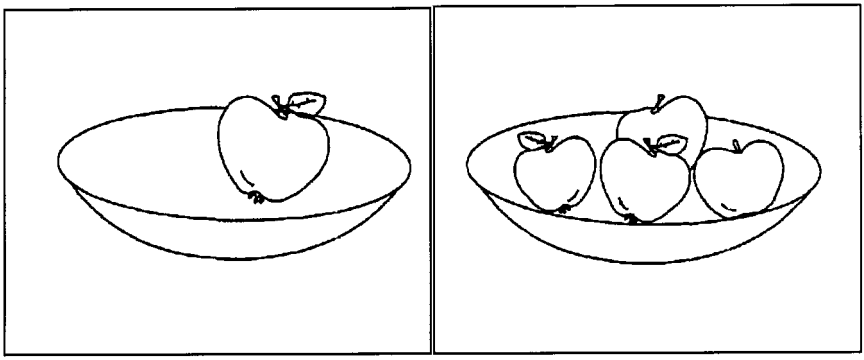

FIG. 5. Example pictures from Experiment 4.

TABLE 8
A Sample Item from Experiment 4

Local-noun condition	Example	English translation
Singular individual	De foto van de leerling	The photo of the pupil
Plural individual	De foto van de leerlingen	The photo of the pupils
Singular collective/mass	De foto van de klas	The photo of the class

but mass nouns differ from collectives in their grammatical properties. As described in the introduction, collectives are count nouns and exhibit normal alternations between singular and plural forms (*army*/*armies*), whereas mass nouns are in most instances obligatorily singular (*fog*/**fogs*). If the possibility of plural inflection is relevant to the effect of a singular local noun on verb agreement, mass nouns might differ from collectives in the amount of attraction that they induce.

Method

Participants. There were 54 participants, all native speakers of Dutch, recruited from the subject pool of the Max Planck Institute for Psycholinguistics or by newspaper advertisements in the Nijmegen area. They received a small payment in return for their participation.

Materials. The experimental materials in the no-picture conditions consisted of 35 items in Dutch. All had singular head nouns and three types of local nouns, to create three versions of each item.[5] The three local-noun types were singular individual nouns, plural individual nouns, and singular collective or mass nouns. The collective nouns were comparable to the English collectives in representing groups of people or objects. Most of the mass nouns also represented collections of objects but, unlike the collectives, had no grammatically plural counterpart (for example, the Dutch mass noun *bagage*, like its English cognate *baggage*, has no natural plural form except in its type sense). Table 8 shows a sample item with a collective local noun; the Appendix lists the complete item set with translations.

The preambles in the picture condition were a subset of 27 of the original items. The selected items were ones that could be readily depicted in the two versions corresponding to the two different interpretations of the preambles (see Fig. 5). The pictures were created as black-on-white line drawings and digitized for presentation in the experiment.

The 36 fillers had the same structure as the experimental items, except that all of them had plural head nouns. The local noun was plural in 18 of the fillers and singular in 18 others. In addition, there were 12 practice items, again with the same structure as the experimental items, but with both singular and plural head nouns (3 and 9, respectively) and singular and plural local nouns. All of the practice items with plural head nouns had singular local nouns. The same filler and practice items were used for all participants in all conditions.

Procedure. Participants were tested individually. In the no-picture condition, the participants heard the preambles over headphones while fixating an asterisk centered on a computer monitor. In the picture condition, the participants viewed a picture appropriate to the interpretation of the preamble (single objects in the singular local-noun condition, and multiple objects in the plural- and collective-local-noun conditions) while the preambles were played. In both

[5] A fourth type of preamble was used, which had two or more plural nouns after the subject noun. Because the results for these preambles were the same as for the preambles with only one plural local noun, we have omitted them from the discussion.

TABLE 9
Percentages of Responses in Three Scoring Categories by Local-Noun Condition in Experiment 4

Local-noun condition	Response percentages: Preambles with pictures	Response percentages: Preambles without pictures
	Singular-inflected verbs	
Singular	30.9 (150)	29.6 (280)
Plural	30.5 (148)	28.8 (272)
Collective mass	30.7 (149)	31.1 (294)
	Plural-inflected verbs	
Singular	0.0 (0)	0.2 (2)
Plural	0.6 (3)	1.9 (18)
Collective mass	0.0 (0)	0.0 (0)
	Miscellaneous responses	
Singular	2.5 (12)	3.5 (33)
Plural	2.3 (11)	2.6 (25)
Collective mass	2.7 (13)	2.2 (21)

Note. Raw numbers of responses are given in parentheses.

conditions, the participants repeated and completed the preambles as full sentences, with instructions to respond as rapidly and fluently as possible.

The practice block preceded the experimental list, with a short pause in between. The instructions for the practice block were to focus less on speed and more on producing fluent responses.

Design, scoring, and analyses. The experimental design for participants included a between-participants factor of picture presentation (with or without picture) and a within-participants factor of local-noun type (singular, plural, or collective mass). There were 36 participants in the no-picture condition and 18 in the picture condition. All of the participants in the picture condition received 9 items of each local-noun type. The participants in the no-picture condition received either 8 or 9 items of each type; across participants, every item was presented equally often in each of its three forms. The design for items included the picture-presentation factor crossed with local-noun type, so that each form of every item was presented to 9 participants in the picture condition and to 8 participants in the no-picture condition.

Responses were scored as in the Dutch condition of Experiment 1. There were 1293 singular-verb responses (constituting 92% of the responses in the picture condition and 91% in the no-picture condition), 23 plural-verb responses (1% of the responses in the picture condition and 2% in the no-picture condition), and 121 miscellaneous responses (7 and 9% of the responses in the picture and no-picture conditions, respectively).

The near-complete absence of plural verbs in the singular and notional-plural local-noun conditions made statistical analyses meaningless, and so none are reported. Descriptive statistics for the conditions with and without pictures are found in Table 9.

Results

Table 9 shows the distribution of responses across the three local-noun conditions when the preambles were accompanied and unaccompanied by

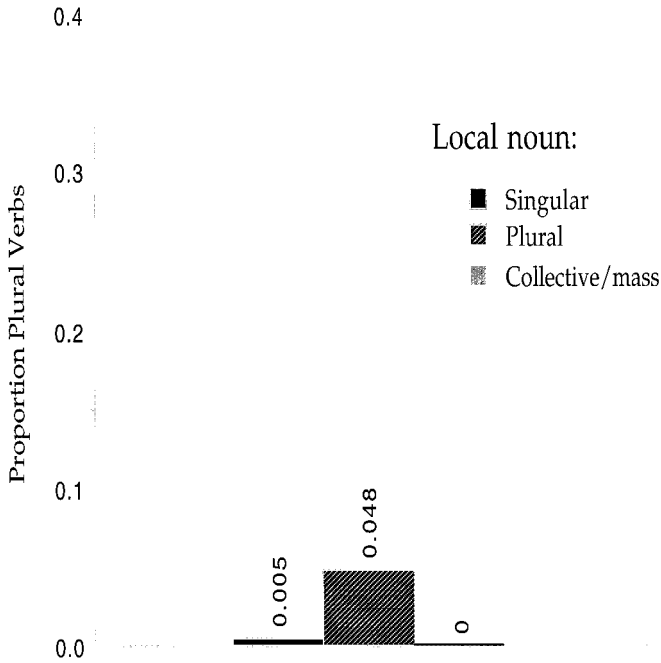

FIG. 6. Proportions of plural verbs in Experiment 4 after grammatically singular Dutch subject noun phrases with singular, plural, or collective/mass local nouns.

pictures, and Fig. 6 displays the overall proportions of plural verbs. Apart from two plural verbs that appeared after singular local nouns that were both notionally and grammatically singular, the only discernable tendency to produce plural verbs occurred after grammatically plural local nouns. This tendency was clearest when the preambles were unaccompanied by pictures, when the rate of attraction (1.9%) was roughly triple what it was when a picture of the referent situation accompanied the preambles (.6%).

There were no plural verbs at all after collective or mass local nouns, in either the picture or the no-picture condition. To evaluate whether collective and mass local nouns were associated with different rates of producing singular verbs, we compared the singular-verb responses in the collective-mass condition for the two noun types, omitting one item whose local noun could not be reliably classified as mass or count by native Dutch speakers. For the items with collective local nouns, 31.0% of all responses were singular verbs; for the items with mass local nouns, 31.2% of the responses were singular verbs. For the unclassified item, 26.7% of the responses were singular verbs.

Discussion

The results revealed no tendency for notionally plural local nouns to elicit plural verbs. Regardless of whether the speakers' utterances had collective

or mass local nouns, or were accompanied or unaccompanied by a picture of an objectively numerous referent for the local noun, the Dutch speakers in Experiment 4 produced no plural verbs at all in the collective-mass local-noun condition. Almost all of the plural verbs (over 90%) followed morphologically plural local nouns.

The absence of notional effects on agreement is in striking contrast to other results for Dutch. For distributive subject noun phrases (all of which ended in grammatically plural local nouns), Vigliocco, Hartsuiker et al., (1996) found vastly more plural agreement than for nondistributive subject noun phrases (which also ended in grammatically plural local nouns). In one experiment there was eight times as much plural agreement for distributives as for nondistributives, and in another there was six times as much. With similar materials, Hartsuiker, Huinck, and Kolk (1999) found twice as much. This suggests that Dutch speakers are exquisitely sensitive to notional number. The critical difference is in where the variation in notional number resides: When the entire subject noun phrase was notionally plural (as in Vigliocco, Hartsuiker et al., 1996; and Hartsuiker et al., 1999), the effects of notional number were unmistakable; when only the local noun was notionally plural (as in the present experiments), it was nonexistent. We account for this in terms of differences in the mechanisms of number marking and number morphing.

In addition to being confined to grammatically plural local nouns, attraction in the present experiment was more likely to occur when the preambles were presented without pictures. It may be that the difficulty of understanding or remembering the preambles in the absence of the pictures increased the incidence of attraction. In a similar vein, Fayol et al. (1994) showed that a memory load during preamble completion yielded higher attraction rates, but these increased attraction rates do not appear to be accompanied by changes in the general distribution of attraction effects.

GENERAL DISCUSSION

These experiments offered clear support for a morphological account of verbal attraction. Experiments 1 and 2 showed that invariable plural local nouns in English created attraction regardless of whether their notional number was singular (as for the summation plurals in Experiment 1) or plural (as for the other pluralia tantum in Experiment 2). To the extent that invariable plurals with singular notional number are plural only in their grammatical properties, these findings suggest that notional plurality is not necessary for the occurrence of attraction. Experiments 3 and 4 provided evidence that notional plurality on its own cannot cause attraction: Neither collective nouns (in both experiments) nor mass nouns (in Experiment 4) provoked attraction, despite their underlying notional plurality, perceptual support for notional plurality, and the use of Dutch (a language which Vigliocco, Hartsuiker et

al., 1996, showed to be more likely to reflect notional number). In the same circumstances, and in Experiment 4 with identical referents, grammatical number did elicit attraction. In short, the results argue that notional number is neither necessary nor sufficient for attraction to occur, whereas grammatical number is both necessary and sufficient.

The contrasts between English and Dutch that were possible in Experiment 1 and less directly, in Experiments 3 and 4, provided evidence that the mechanisms of attraction are likely to be the same in both languages. This is not surprising, given the wide-ranging similarities of English and Dutch, but it is noteworthy in two respects. First, it buttresses the conclusion that the bipartite-object concepts denoted by summation plurals are underlyingly singular in both Dutch and English, despite the grammatical plurality of the English words. The ratings of notional number established that in each language the bipartites were judged as being roughly the same as their normal singular controls, but different from their normal plural controls. This finding runs counter to hypotheses about strong influences of language on thinking (see Lucy, 1992 for review).

Second, Dutch verbs are unlike English verbs in a couple of important respects. Regular English verbs do not carry overt number marking in their most frequent form (the past tense) and the marking of number on the one regular verb form that is reliably marked is paradoxical: The morphology of the singular third-person present for verbs (*she* ***runs***) is homophonous with the morphology of the *plural* for nouns (*home* ***runs***) and likewise for the plural verb (*they* ***run***) and singular noun forms (*one* ***run***). Such oddities could be responsible for some of the features of attraction in English (though see Bock & Eberhard, 1993, for a test and disconfirmation of one of the most obvious hypotheses). However, Dutch does not have either of these properties: Virtually all Dutch verbs are marked for plurality, and plural verb number is normally homophonous with plural noun number. Yet when attraction occurred in Dutch, the same factors were responsible for it as in English. In both languages, grammatically plural local nouns elicited attraction and notionally plural local nouns did not, unless they were also grammatically plural.

There was one major difference between the languages in the overall incidence of attraction. Compared to the English speakers in Experiment 1, attraction was rare among the Dutch speakers. One might imagine that, by virtue of the number-marking regularity of Dutch, agreement is simply easier to implement and more reliably implemented in Dutch than in English. Though this may be true, we suspect something else is also at work. As a natural but reputedly illogical by-product of the mechanisms of agreement, attraction has long been the bane of prescriptive grammarians, and prescriptivist instruction in grammar (that is, the kind of instruction provided in elementary and secondary schools) typically includes drills designed to stamp it out. The more of this instruction students receive and the more of it they

retain, the less frequent attraction may be in their speech. Consistent with this speculation, attraction occurs less often among students from more selective universities.[6] In identical experiments, we found lower rates of attraction in verb agreement for English-speaking students enrolled at Cambridge University in England than at the University of Illinois (respectively, .02 compared to .09 for plural verbs after plural local nouns in Bock, Humphreys et al., 1999) and lower rates at Illinois than at Michigan State University (respectively, .28 compared to .34 for plural verbs after plural local nouns in the replication of Experiment 1 and in Experiment 1). The Dutch students in Experiment 1 (.10 for plural verbs after plural local nouns) are the product of a rigorous and selective system whose practices are more on a par with British than American secondary education.

Returning to the main point, the findings of the present experiments offer support for the view that there is a component of sentence production that is sensitive to the morphological properties of words and which uses those properties (along with the notionally designated number of the subject noun phrase) during the implementation of agreement. In the next sections we elaborate some of the implications of our results for the account of agreement proposed in the introduction.

The Marking and Morphing of Agreement Features in Sentence Production

In terms of the framework shown in Fig. 1, our findings offer more evidence that one component of the implementation of agreement is an active morphological process that affects number features on constituents that normally agree. The data indicate that this morphing process is insensitive to the variations in notional information that prompt the valuation and marking of number features during the mapping between messages and lexical-grammatical representations.

This account readily explains the absence of notional influences from local nouns in other results (Barker et al., 1999; Bock & Miller, 1991; Bock & Eberhard, 1993). Because number marking and number morphing have different domains, the effect of notional number on morphing is minimal: Notional number affects marking directly, but morphing only indirectly, by way of the number value of the subject noun phrase. Morphemes with a specified number feature can change the value of the phrase in the case of a conflict; in English, this most often means that a plural morpheme takes over the phrase's number value (Eberhard, 1997). When the source of a feature is a constituent other than the normal agreement controller, the consequence is attraction.

[6] Enforcing this connection, some of the most difficult items on the Scholastic Aptitude Test of Standard Written English evaluate students' ability to detect and correct errors of attraction (The College Board, 1990).

Tying attraction to the constituent assembly process helps to explain not only why notional information is limited in its impact on attraction but also why it is limited in scope. The amount of material that is immediately accessible to constituent assembly is roughly a clause, and attraction is more powerful within clauses than across them (Bock & Cutting, 1992; Meyer & Bock, 1999). It also begins to make sense of a puzzling finding from a study of verb and pronoun number agreement in English (Bock, Nicol, & Cutting, 1999). The main result of the study was that when sentence subjects were collective, there was a larger effect of notional number on pronouns than on verbs. For example, with the subject noun phrase *The cast in the soap opera* the modal tendency was to produce sentences with plural pronouns (e.g., *The cast in the soap opera watched* ***themselves***) but singular verbs (e.g., *The cast in the soap opera* ***was*** *mediocre*). This suggests that pronouns are more sensitive to notional number than verbs are. The puzzle is that collective local nouns do not attract plural pronoun agreement (Bock, Eberhard, & Cutting, 1992), although grammatically plural local nouns attract as much plural pronoun agreement as they do plural verb agreement (Bock, Nicol, & Cutting, 1999). This pattern of results can be explained if, during morphing, the number of a pronoun can be influenced by the grammatical number of a same-sentence noun phrase; since the notional number of a collective has no impact at this point, notional attraction cannot occur. The notional-number sensitivity of pronouns is a consequence of pronouns being selected, like other words, directly from the message (as Bock, Nicol, and Cutting argued) so that their number naturally reflects notional properties.

More generally, the marking-and-morphing framework offers a new account of the notional influences that have been reported for verb agreement. These influences include plural agreement with distributive subjects (Eberhard, 1999; Hartsuiker et al., 1999; Vigliocco et al., 1995; Vigliocco, Butterworth, & Garrett, 1996; Vigliocco, Hartsuiker et al., 1996) and plural agreement with collective subjects (Bock, Nicol, & Cutting, 1999). For example, Humphreys and Bock (1999) found that more plural verbs were used in sentences with subjects such as *The gang on the motorcycles* compared to sentences with subjects such as *The gang near the motorcycles.* One interpretation of such results might be that there is more attraction in the presence of more salient notional plurality, since *The gang on the motorcycles* emphasizes multipleness by distributing gang members over motorcycles. The alternative we propose is that rather than being more likely to create attraction, distributive subjects are simply more likely to have been marked as plurals during number marking. That is, if the message components underlying the subject are notionally plural, the entire subject noun phrase will be marked as plural and will transmit its plural number to the verb in the normal course of agreement implementation.

Phrases that allow a distributive reading nonetheless take singular agreement in many cases. As noted above, this follows from the prevalence of

nondistributive construals for potentially distributive situations, along with variation in speakers' willingness or ability to view things distributively across different states of affairs (Eberhard, 1999; Humphreys & Bock, 1999), dialects of English (Bock, Humphreys et al., 1999), and languages (Hartsuiker et al., 1999; Vigliocco et al., 1995; Vigliocco, Butterworth, & Garrett, 1996; Vigliocco, Hartsuiker et al., 1996). The key to some of this variation may lie in the processes of conceptualization and their consequences for number marking rather than in the linguistic processes of agreement. This kind of variation may explain why Bock and Miller (1991) failed to find plural agreement with distributive subjects when the distributive information was relatively abstract, whereas Eberhard (1999) found plural agreement with distributive subjects when they were more concrete. One's language or dialect may also predispose the kinds of conceptualizations that yield plural marking and plural verb agreement with distributive subjects; Vigliocco, Butterworth, and Garrett (1996) replicated Bock and Miller's results for English speakers but not for speakers of Spanish.

Whether because of conceptual or language-processing deficits, the ability to carry out number marking is likewise vulnerable to developmental impairments (Leonard, 1998) and adult aphasia. In the latter category, Hartsuiker et al. (1999a) found that Dutch-speaking Broca's aphasics showed little of the distributive, notional number-based agreement that normal Dutch speakers displayed with the same materials. In light of the problems of agrammatism that are diagnostic of Broca's aphasia, this result can be seen as a reflection of difficulties in marking or maintaining a number feature on sentence subjects.

Attraction during sentence production (and comprehension; Nicol, Forster, & Veres, 1997; Pearlmutter, Garnsey, & Bock, 1999) is not limited to number features. It also occurs for grammatical gender features in those languages that require gender agreement between nouns and pronouns (Meyer & Bock, 1999) or between nouns and verb or adjective forms (Kuminiak & Badecker, 1998; Vigliocco et al., 1995; Vigliocco & Franck, 1999). However, gender differs from number in ways that might be expected to affect the distribution and magnitude of the phenomenon. First, for inanimate singular nouns in most gender-marking languages, gender is an inherent grammatical property rather than a morphological feature. It must be specified during lexical selection, where it affects the processes of function assignment. In this respect, gender is similar to number subcategories such as mass and count. Second, because the genders of inanimate nouns are haphazardly related to conceptual properties, phrases containing these nouns have no message-based feature-marking process of the sort that we have hypothesized for number. Third, those animate nouns whose grammatical gender is rooted in a conceptual gender feature (regardless of whether the gender is explicitly marked) may be involved in notional gender effects when they are in head position (Vigliocco & Franck, 1999, Experiments 1 and 2), but should create

only grammatically based gender attraction effects in local-noun position (cf. Vigliocco & Franck, 1999, Experiment 2), paralleling the behavior of collectives in our experiment. Finally, animate nouns whose forms change depending on conceptual gender [as in Italian, where many animate nouns have the same stem but different suffixes depending on whether they are masculine or feminine, like ragazzo (*boy*) and ragazza (*girl*)] should produce greater attraction than comparable inanimates, if grammatical gender in other languages behaves in way that is consistent with our findings about the role of inflection in number attraction. We consider these findings in more detail in the next section.

An Inflectional Component of Attraction?

One important addition to the proposed marking-and-morphing framework grows out of the evidence for an inflectional contribution to the number-morphing process. We originally supposed that any grammatically plural element could create attraction. And in fact, in Experiments 1 and 2, invariant grammatically plural local nouns (like *scissors* or *suds*) in the structural vicinity of a verb did trigger plural attraction, regardless of whether the invariant plural was notionally singular (*scissors*) or notionally plural (*suds*). Comparing across experiments, the invariant grammatical plurals were more likely to attract plural agreement than the notionally plural but grammatical singular local nouns in Experiments 3 and 4. But the results of Experiments 1 and 2 also revealed major differences among plural-marked forms. Relative to the invariant plurals, the probability of attraction was substantially greater for plurals (like *razors* and *bubbles*) that have singular counterparts (*razor* and *bubble*).

Apparently, the occurrence of a plural inflection, distinct from the occurrence of a plural feature, changes the morphing processes involved in attraction (and presumably, in agreement). This was unexpected. The potential power of the effect can be seen in its absence for the two items in Experiment 1 whose invariant plural local nouns have polysemes with regular singular counterparts (e.g., *magnifying* ***glass*** and *shoulder* ***brace***). The effect was likewise absent for the same items in the replication of Experiment 1, where the proportion of plural verbs with *glasses* and *braces* as the local nouns was .22 compared to .21 for their normal plural controls. For the remaining items the proportions were .15 and .30 for the invariants and plural controls, respectively.

It is instructive to consider these results in company with others that point to the presence or absence of specific morphological effects on attraction. Inflection is presumably not required for invariant grammatical plurals such as *scissors* (or *people* or *cattle*), although it operates in some form for any noun with a plural alternative, including irregular plurals like *mice* and *feet:* Bock and Eberhard (1993, Experiment 3) found that irregular plurals cause as much attraction as regular plurals. Even more impressive, Vigliocco et

al. (1995, Experiment 3) found that local nouns that serve as both singulars and plurals (zero plurals comparable to English *sheep*) led to as much plural attraction when they were plural (indicated by an accompanying plural determiner) as normally inflected plurals. Clearly, it is not just the surface manifestation of inflection that matters; it is the existence of forms that can play both singular and plural parts.

Inflectional homophony of the kind exemplified by zero plurals may have drawbacks, however, not only for comprehension but also for production. Hartsuiker, Schriefers et al. (1999; see also Schriefers & van Kampen, 1993; Kuminiak & Badecker, 1998) found that plural attraction was more frequent in Dutch and German when the determiners of singular local nouns were homophonous with plural determiners (like English *the*) and when the case of an accusative singular local noun was homophonous with the nominative plural. So, when the morphological or inflectional features of a singular local noun or its determiner included an optional plural specification or included features that normally allow it to control agreement (i.e., an optional nominative-case specification), plural attraction was more likely to occur. The implication is that inflectional morphemes with multiple specifications may not have separate representations for each of their roles. Instead, each morphological form may bear the features relevant to each of its functions. For example, English *the* may carry a plural as well as a singular specification. When bound to a position in a phrasal frame, a morpheme's retinue of features may be capable of entering into and influencing the outcome of morphing and agreement processes.

Two different accounts can be entertained for inflectional effects on attraction and agreement. One rests on an assumption that morphologically unspecified forms (like singular nouns) have to undergo an inflectional adjustment during production to make them plural, whereas specified forms (like invariant plural nouns) do not. If so, the operation of locating, creating, or resolving the plural form for a noun might promote the assignment of verb number in agreement. In normal agreement, this can be conceived of as an activation boost from the plural feature that accompanies the inflection. In attraction, when the head noun is singular and the local noun plural, inflection of the local noun would create a corresponding boost that enhances its probability of morphing the number of the subject noun phrase to plural.

An alternative account involves lexical retrieval mechanisms. If plural and singular forms (as well as the members of other inflectional paradigms) are all represented in the lexicon (Seidenberg & McClelland, 1989), their retrieval may be accompanied by events that affect the determination of verb number. For example, if there is mutual inhibition and competition between singular and plural noun forms, the retrieval of the plural form might be difficult enough to disrupt the normal retrieval of an appropriate verb form. The absence of a singular alternative for invariable plurals would render them less likely to affect the verb in this way.

It is not possible to decide between these hypotheses on the basis of existing data, although there are a few relevant results from experiments that explored how differences in the relative frequencies of singular and plural local nouns affected attraction. Bock and Eberhard (1993, Experiment 3) looked at plural attraction for regular and irregular plural local nouns as well as singular attraction for the singular counterparts of the regulars and irregulars. Since irregular plurals tend to remain irregular because they are more frequent than their singular forms (Tiersma, 1982), whereas regular plurals tend to be lower in frequency than singulars, the retrieval hypothesis might predict that regular plurals engage in more vigorous competition against their higher frequency singular alternatives in order to be selected; irregular plurals, in contrast, should have little competition from their lower frequency singular counterparts. On the argument that disruptions in agreement arise when there are problems in resolving the selection of a singular or plural form, regular plurals would induce more plural attraction than irregular plurals, and the singular forms of irregular plurals would induce more attraction than regular singulars. Bock and Eberhard's results were weakly consistent with the second of these predictions, and weakly inconsistent with the first: Irregular singulars were a little more likely to attract singular verb number than regular singulars, but irregular plurals were a little more likely to cause attraction than regular plurals. Neither difference was significant.

Similarly, Barker and Nicol (1999), using a whole-sentence reading task, found no reliable differences in reading times for sentences with plural local nouns that were either higher or lower in frequency as plurals relative to their singular forms. Although the direction of the difference was consistent with the prediction of the retrieval hypothesis, an agreement elicitation task yielded no comparable effect (Barker, Nicol, & Garrett, 1999).

The present results make it clear that these issues warrant further investigation. In addition to their relevance for an account of the mechanisms of agreement, they have implications for the ongoing debate about the nature of the lexicon and the status of inflectional rules (Pinker, 1991, 1999; McClelland & Seidenberg, 2000; Seidenberg, 1997). If specific inflectional procedures (as opposed to competitions between existing singular and plural forms in the lexicon, for example) contribute to the resolution of conflicting number features in agreement, it would argue for the existence and importance of general structural computations during language processing. Finally, to the extent that structural computations contribute to the normal implementation of agreement, and therefore to the production of most utterances in most languages, theories of language production (and comprehension, too) require accounts that go beyond how lexical information is retrieved and assembled to explanations of how words are modified in structural contexts.

The proposed model of attraction and agreement is a small step in this direction. By integrating structural with lexical and inflectional computations (along the lines sketched in Bock, 1995b, elaborating proposals by Garrett,

1980, 1988), it offers an alternative account of notional effects on agreement. More speculatively, it could also provide a means for explaining the robust attraction results that have been attributed to the influence of morphophonology (Vigliocco, Anton-Mendes, Franck, & Collina, 1999; Hartsuiker et al., 1999). But because so little is known about how syntactic processes modulate or are coordinated with lexical processes, or about whether and how the temporal dynamics of lexical processing are tempered by concurrent syntactic processing, it remains entirely feasible that natural interactivity within the lexicon influences the retrieval of the morphological information used in normal (and abnormal) agreement.

Summary and Conclusions

The results of this series of experiments indicate that the primary cause of attraction in subject–verb number agreement is the grammatically marked number of a nonsubject noun in the structural vicinity of the verb. This implies that the agreement process is sensitive to grammatical number at a point in processing when notional number information is less accessible. Obviously, this does not mean that notional number is irrelevant to agreement: As in all production processes, agreement originates in features of meaning, and the feature-marking process ensures that the marking of number is sensitive to the relevant facets of the speaker's message. Beyond this, however, we have proposed that the implementation of agreement includes a process that manipulates the morphological features of words within particular structural configurations. The normal workings of this process create attraction.

APPENDIX

Experiment 1 materials

English preambles with singular control/ plural control/bipartite	Dutch preambles with singular control/ plural control/bipartite
The view through the telescope/telescopes/ binoculars	Het uitzicht door de telescoop/de telescopen/de verrekijker
The advertisement for the razor/razors/scissors	De reclame voor het scheermes/de scheermessen/de schaar
The crack in the lens/lenses/glasses	De barst in de lens/de lenzen/de bril
The handle of the shovel/shovels/tongs	Het handvat van de schop/de schoppen/de tang
The length of the needle/needles/tweezers	De lengte van de naald/de naalden/het pincet
The fabric for the nightgown/nightgowns/ pajamas	De stof voor het nachthemd/de nachthemden/de pyjama
The girl in the jacket/jackets/jeans	Het meisje in de jas/de jassen/de spijkerbroek
The color of the blazer/blazers/bermudas	De kleur van de blazer/de blazers/de bermuda

The style of the suit/suits/trousers	Het model van het pak/de pakken/de pantalon
The manufacturer of the lawnmower/lawnmowers/pruning shears	De fabrikant van de grasmaaier/de grasmaaiers/de snoeischaar
The size of the shirt/shirts/pants	De maat van het hemd/de hemden/de broek
The plastic in the helmet/helmets/goggles	Het plastic in de helm/de helmen/de duikbril
The stain on the apron/aprons/overalls	De vlek op de schort/de schorten/de overal
The price of the hammer/hammers/pliers	De prijs van de hamer/de hamers/de nijptang
The discount on the undershirt/undershirts/underpants	De korting op het onderhemd/de onderhemden/de onderbroek
The theft of the corset/corsets/panties	De diefstal van het corset/de corsetten/het slipje
The boy with the earring/earrings/braces	De jongen met de oorbel/de oorbellen/de beugel
The hole in the stocking/stockings/tights	Het gaatje in de kous/de kouzen/de maillot

Experiment 2 materials

Preambles with singular/plural/pluralia tantum local nouns

The color of the soap bubble/bubbles/suds
The reason for the big profit/profits/earnings
The actor with the good script/scripts/looks
The theme of the party/parties/festivities
The salesman with the inferior product/products/goods
The traveller with the hotel reservation/reservations/accommodations
The smell of the coffee bean/beans/grounds
The safe with the diamond/diamonds/valuables
The contestant with the prize/prizes/winnings
The discussion in the office/offices/headquarters
The taste of the boiled egg/eggs/grits
The mutiny in the fort/forts/barracks
The discount on the shirt/shirts/clothes
The harshness of the climate/climates/surroundings
The danger of the river/rivers/rapids
The analysis of the plan/plans/logistics
The search through the Russian history/histories/annals
The increase in the fee/fees/dues

Experiment 3 materials:

Preambles with singular individual/plural individual/singular collective/plural collective local nouns

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The strength of the soldier/soldiers/army/armies
The sight of the house/houses/village/villages
The time for the student/students/assembly/assemblies
The purpose of the delinquent/delinquents/gang/gangs
The jealousy of the relative/relatives/clan/clans
The location of the tree/trees/forest/forests
The job for the singer/singers/choir/choirs
The support from the deputy/deputies/posse/posses
The need for the member/members/committee/committees
The function of the judge/judges/jury/juries

The view of the spectator/spectators/audience/audiences
The disappearance of the politician/politicians/minority/minorities
The record of the player/players/team/teams
The type of individual/individuals/group/groups
The noise from the cow/cows/herd/herds
The condition of the ship/ships/fleet/fleets

Experiment 4 materials

Dutch preambles with singular individual/plural individual/singular mass-collective local nouns

Preamble	English translation
De tafel met het beeldje/de beeldjes/het aardwerk	The table with the figurine/figurines/pottery
De aanrecht met het bord/de borden/de afwas	The kitchen counter with the dish/dishes/dirty dishes [singular]
Het wagentje met de koffer/de koffers/de bagage	The cart with the suitcase/suitcases/baggage
De toonbank met de taart/de taarten/het banket	The showcase with the tart/tarts/pastry
De kast met het laken/de lakens/het beddegoed	The cupboard with the sheet/sheets/bedding
*De la met het mes/de messen/het bestek	The drawer with the knife/knives/silverware
De vaas met de bloem/de bloemen/het boeket	The vase with the flower/flowers/bouquet
De schaal met de appel/de appels/het fruit	The bowl with the apple/apples/fruit
De trommel voor het koekje/de koekjes/het gebak	The cookie jar for the cookie/cookies/baked goods
*De kist met de bijl/de bijlen/het gereedschaap	The cabinet with the axe/axes/equipment
De kruiwagen met de plank/de planken/het hout	The wheelbarrow with the board/boards/wood
Het doosje met het schakeltje/de schakeltjes/de ketting	The packet with the link/links/chain
De foto van de leerling/de leerlingen/de klas	The photo of the pupil/the pupils/the class
*De kapstok met het mutsje/de mutsjes/de kleding	The coatrack with the cap/caps/clothing
Het podium met de zanger/de zangers/het koor	The podium with the singer/singers/chorus
De wei met het schaap/de schapen/de kudde	The meadow with the sheep [singular]/sheep [plural]/herd
Het slagveld met de soldaat/de soldaten/het leger	The battlefield with the soldier/the soldiers/the army
De etalage met de beha/de beha's/de lingerie	The store window with the brassiere/the brassieres/the lingerie
De tak met het blad/de bladeren/het loof	The branch with the leaf/the leaves/the foliage
*De kamer met het bed/de bedden/het meubilair	The room with the bed/the beds/the suite of furniture
*De stoel met het hemd/de hemden/het ondergoed	The chair with the shirt/the shirts/the underwear

*De optocht met de muzikant/de muzikanten/het orkest	The parade with the musician/the musicians/the orchestra
Het rekje met de schoen/de schoenen/het schoeisel	The shoerack with the shoe/the shoes/the footwear
Het dienblad met het kopje/de kopjes/het servies	The tray with the cup/the cups/the china
*De kuil met het bot/de botten/het skelet	The pit with the bone/the bones/the skeleton
De zak met de lollie/de lollies/de snoep	The bag with the lollipop/the lollipops/the candy
De hoek met de pop/ de poppen/het speelgoed	The corner with the doll/the dolls/the playthings [singular]
De loper op de trede/de treden/de trap	The walker on the stair/the stairs/the stairway
De straat met de auto/de auto's/het verkeer	The street with the car/the cars/the traffic
Het plein met de lantaarn/de lantaarns/de verlichting	The square with the streetlight/the streetlights/the lighting
De weg naar het huis/de huizen/het dorp	The way to the house/houses/village
De tas met het blikje/de blikjes/de drank	The bag with the can/the cans/the liquor
De haven met het schip/de schepen/de vloot	The port with the ship/the ships/the fleet
*De mand met het stokbrood/de stokbroden/het voedsel	The basket with the loaf of French bread/ the loaves of French bread/the food
Het hol met het konijn/de konijnen/het wild	The den with the rabbit/the rabbits/the game

* Omitted from the picture condition in Experiment 4.

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