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Reaching agreement

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Abstract In addition to the major linguistic components of language use, theories of language production must explain how utterances grow out of communicative intentions. In ordinary circumstances, utterances are rooted in meanings. The question addressed in this paper is whether the mechanisms of a core syntactic process, number agreement, depend in any important way on the conceptual underpinnings of number. We critically examine research that points to a role for number semantics in the agreement process, and consider alternative psycholinguistic accounts of agreement in the context of issues about how number meaning infiltrates or informs the structural components of language production.

Keywords Number agreement · Agreement attraction · Language production · Psycholinguistics

1 Introduction

Most speakers, most of the time, talk because they have something they want to say. What they want to say rarely has anything directly to do with number meaning. Occasionally, people do say things like "I'll have three of those," but the occasions are comparatively rare. They are especially rare relative to the frequency with which speakers draw on number indirectly, for purposes of grammatical agreement. Even in English, with its impoverished agreement system, speakers use number-inflected

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verbs or pronouns more than once every five seconds in running speech, on average. English is of course not alone in using number this way. In this paper, we ask whether the manifestations of number in the agreement systems of languages in some way reflect number as it is represented in the communicative intentions that initiate the language production process.

We begin with a frankly speculative argument about number as a readily accessible referential device that languages, language learners, and language users can call on to create the syntax of grammatical agreement. We call the kind of number information that is relevant to these functions *notional number*, numerosity as represented in a speaker's mental model of what is to be communicated. Then, drawing on well-established findings about the workings of number perception, we trace some of the links between number cognition and number grammar within the psycholinguistic mechanisms of agreement in language production. Finally, we consider current psycholinguistic views about how speakers implement agreement and assess the merits of alternative accounts.

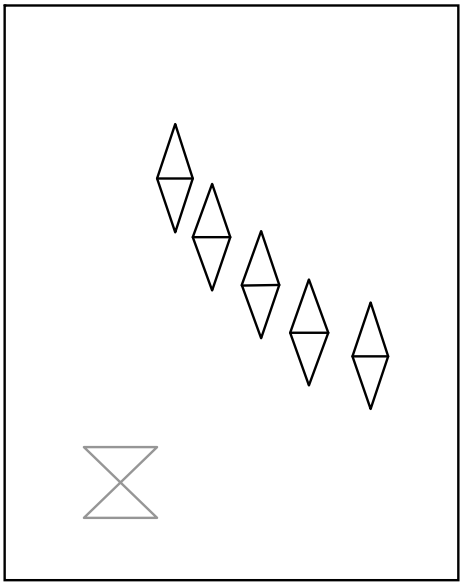
2 Notional number and grammatical number

The usefulness of notional number as a referential device stems from its ability to separate individuals from groups. It allows a speaker to restrict predications to a single person or thing, reducing ambiguity about the topic of an utterance. The importance of this function is readily appreciated in the context of pronominal distinctions. When a language uses number systematically in the grammar, its minimal manifestation is in pronouns. Presumably, for purposes of communication, speakers and listeners find it useful to distinguish individuals in terms of singletons and aggregates, to refer to oneself alone or as a member of a group, as in *I* and *we*, or to others alone or in a group, as in *he*, *she*, and *they*. The extensive quantification systems of language are another facet of the importance of number to referential functions.

A second function of number as a referential device stems from its utility in distinguishing and categorizing objects in the world, extending the referential power conferred by number in pronominal systems to objects irrespective of their roles in dialogue. Among other things, this implies that number distinctions can support the acquisition of new categories and new vocabulary. Consider the two types of nonsense shapes in Fig. 1. Suppose they represent pieces for a new board game, which someone introduces by saying "first, you take the *meeps* and I get the *bep*." The plural/singular number specification on its own accomplishes three things, distinguishing the objects, categorizing them, and pairing names with their referents. Other languages incorporate duals and trials in addition to a singular/plural distinction, allowing discriminations of up to three things relative to larger groups. For indeterminate quantities, languages may also use paucals or "big plurals" for small and large collections, respectively. When the grammar of a language requires such number distinctions to be made regardless of their immediate relevance, the grammar enforces a minimal condition on communication: speakers reliably convey number information and listeners get it for free, without deliberate efforts to establish common ground.

Grammatical number probably originates in pronominal systems (Givón 1976), where its referential function is clear. Yet the generalization of number inflection from

Fig. 1 The meeps and the bep



pronouns into verb morphology may serve no referential function at all, especially when verb number is redundant with a nominal or pronominal inflection. What the grammaticalization of number does do, unequivocally, is enable number as a device for tying together linguistically what belongs together mentally ("Behaghel's First Law", Vennemann 1973). When there is enough syntactic complexity in a language to separate linguistically what belongs together mentally, communication benefits from overt signals of what is being predicated of what. A continuation of *The owner of the slaves who was* is going to say something about the owner; *The owner of the slaves who were* is going to say something about the slaves. This linking ability has nothing at all to do with number-for-number's-sake, but it serves a preeminent function of syntax.

One mystery is why so many languages use number in these ways. After all, color could be equally useful, yet color is grammaticalized in no known languages. What makes number systems ubiquitous in grammars could be number's link to a phylogenetically and ontogenetically primitive ability that pigeons, rats, and human infants possess (for reviews see Butterworth 1999; Dehaene 1997; Feigenson et al. 2004; Nieder 2005). The ability is found in a perceptual capacity to automatically enumerate between one and three objects; beyond three (sometimes four in adults) judgments of numerosity depend on effortful individuation or counting. When counting is unavailable for enumerating larger quantities, judgments of relative numerosity still occur automatically in terms of approximate magnitudes (Hyde and Spelke 2009). The existence of these two different systems for number cognition means that it may be no coincidence that determinate grammatical number systems in known languages do not extend beyond trials (Corbett 2006). That is, languages may have distinctions between singulars and plurals, or between singulars and duals and plurals, or between singulars, duals, trials, and plurals, but that is the extent of the determinate-number

inventory. Differentiations in terms of relative magnitude (e.g., paucals and "big plurals") make no commitment to exact numerosity.

Of course, even without having number in the grammar, languages call upon numerosity variations to denote and distinguish objects in the world. The difference between number used explicitly for number's sake and number in grammar is that number-for-number's-sake expressly communicates precise information about number: expressions like *one boy*, *two boys*, *four boys* are unlikely unless the exact numerosity of the group is important. In contrast, a plural like *boys* can be used flexibly as a referential device, without a commitment to a specific number of more-than-one-boy. But this flexibility comes at a cost: Speakers are forced into number specification, regardless of its referential relevance.

Slobin (1996) calls the potential cognitive consequences of this coercion "thinking for speaking." If a language's grammar demands number specification whether or not number is directly relevant to a communicative intention, speakers must learn to attend to, encode, or decide numerosity as a part of message formation. So, speakers of languages like English must do this; languages like Chinese make no such demands. Consequently, English speakers are unrelentingly forced to bring their natural enumeration capacity to bear in the course of talking and communicating.

These considerations make the link between notional number and psycholinguistic issues of language production straightforward: perceptions and conceptions are where speakers begin. There is a natural perceptual basis for number—at least for small sets—that languages can exploit syntactically (Bock and Kahn 2009), not only for purposes of reference but for purposes of structural linking. The upshot is that number has one foot in nonlinguistic cognition and another in syntax, offering a means for tracing the transition from thought to language for a perceptually, semantically, and syntactically important kind of information.

3 Meaning in number agreement

The role of meaning in syntax, in general, is a source of longstanding controversy. Contemporary views often call on constructs like thematic roles, logical form, and the lexicon to develop accounts of the interface between conceptual structure and grammar (Culicover and Jackendoff 2005), with the goal of explaining syntax as a system whose fundamental workings do not change with cross-linguistic variations in the interface. Views of agreement within such accounts are historically diverse. In 1965, Chomsky formulated agreement as the rewriting of terminal symbols, treating agreement rules as analogous to rules of assimilation in phonology and thereby allocating agreement to a minor role in the syntax. But in other accounts, agreement-like mechanisms (e.g., feature-passing and unification) constitute the core of syntax (Gazdar et al. 1985; Pollard and Sag 1994).

To relate the several kinds of formal systems in linguistics to issues in psycholinguistics, we divide the approaches roughly into what we call *control* accounts and *constraint* accounts, corresponding to the asymmetrical and symmetrical approaches summarized in den Dikken (2003). Control (asymmetrical) accounts treat agreement in terms of the transmission of features within syntactic structures. For example, verb

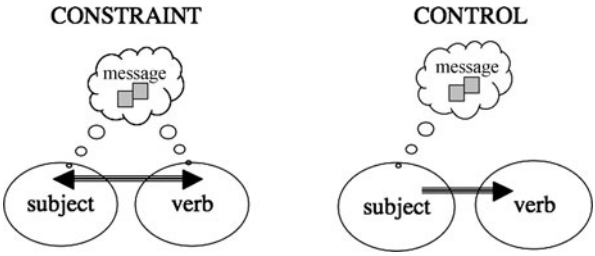


Fig. 2 Two accounts of the relationship between numerosity (as represented in a speaker's message) and subject-verb number agreement in language production

number arises under the control of subject number, with number features transmitted to the verb (the agreement target) from the subject (the agreement controller) without any extra-syntactic mediation. Constraint (symmetrical) accounts treat subject number and verb number as parallel products of the same kinds of information. For instance, a number feature that is rooted in semantic structures may be realized on the subject and on the verb in tandem, so that the semantics of number is relevant to both the subject and the verb. The argument, then, is that verb number is determined by meaning in the same way as subject number.

Figure 2 caricatures the control and constraint views from a psycholinguistic perspective. In both panels of the figure, the speaker's message is shown as the origin of notional number, and in the depicted message, the notional number is two. Control, in the right-hand panel, creates verb number through the mediation of subject number: There is no direct connection between the speaker's message and verb number. If the referent of the subject noun phrase is plural, the subject may be grammatically plural, and this grammatical plurality is transmitted to the verb, sometimes via a hypothesized movement operation that transports subject-number features to the verb. So, any impact of number meaning on the verb occurs within the syntax. The plural *are* after a subject like *The boys* arises because the plural subject confers plurality on the verb.

The constraint view, shown on the left side of Fig. 2, allows notional number to directly affect the inflection of both the subject and the verb. There is a direct connection between the speaker's message and verb number, so that a plural referent of a subject selects a plural noun phrase and a plural verb. Notional number retrieves the subject inflection and the verb inflection separately, but under the guidance of the same information. A plural *are* after a subject like *The boys* arises because the same notionally plural referent confers plurality on the subject and on the verb. In the event that the resulting number features differ, a reconciliation mechanism takes over (e.g., unification, represented as the bidirectional arrow in Fig. 2) to bring the differing features into alignment.

The control and constraint views are represented in both linguistic and psycholinguistic approaches to agreement. In linguistics, control mechanisms are part of the mainstream tradition in generative grammar, from its inception to the present day (see den Dikken 2003). The precise rules have changed as theories have changed, but all of them posit that subject features determine verb features. On the other hand, there are formal constraint mechanisms for agreement. Pollard and Sag (1994) proposed that indices on subjects and verbs carry independent values constrained by referential number, with agreement being the result of reconciliation between the values of the

indices. From this perspective, then, agreement is the product of multiple incursions of number semantics into the agreement process, and not the derivative of a structural relationship in which the source of meaning-related features is tightly circumscribed (viz., to an agreement controller like the subject noun phrase).

In psycholinguistics, there are parallel positions about how agreement works in language production. A control model is detailed in a theory called Marking and Morphing (Eberhard et al. 2005), discussed below. In the model, only some types of noun phrases (including subject noun phrases and pronoun phrases) carry number values that can be set by nonlinguistic information. Verbs, in particular, do not carry independent notionally determined agreement features, but gain their features from controllers. The constraint position has been staked out and experimentally tested by Haskell and MacDonald (2003), and Thornton and MacDonald (2003). Vigliocco and Hartsuiker (2002, 2005; see also Vigliocco and Franck 1999, 2001) endorse a related view under the heading of Maximalism. The Maximalist contention is that meaning pervades the agreement process, with the implication that all of the linguistic elements that enter into agreement relationships carry notionally freighted features. Reid (1991, 2011) takes the Maximalist argument a step further, with independent selection of linguistic features based on underlying number meanings.

Obviously, there would be little debate over control and constraint approaches if number meaning were conclusively shown to be irrelevant to number agreement. In that event, only a control approach would be viable. However, the arguments and empirical evidence for an effect of notional number on agreement are hard to dismiss. We briefly review the linguistic and psycholinguistic arguments in turn.

3.1 Linguistic arguments for notional effects on agreement

The existence of notional agreement is acknowledged in standard grammars of English (Biber et al. 1999; Quirk et al. 1985), motivated by a broad array of observations that are consistent with notional effects. For instance, a conjunction may be singular or plural depending on the numerosity of its referent: in *His brother and best friend were at the funeral*, the plural *were* is used if the brother and best friend are different people. But when brother and best friend are one and the same, the verb will be singular (*His brother and best friend was at the funeral*; Morgan 1972, 1984; Pollard and Sag 1994). This phenomenon even piqued the interest of the *Car Talk* hosts on National Public Radio. In March 2004, the weekly Puzzler was not an automotive mystery, but an agreement mystery: When can conjunctions be followed by *singular* verbs? The answer was that conjoined subjects take singular agreement when the conjunction refers to one thing. For instance, *Car Talk*'s (apocryphal) law firm, Dewey, Cheetham, and Howe, is singular and not plural.

There are even occasional efforts to reduce number agreement entirely to semantics (cf. Dowty and Jacobson 1988). Although the approach has acknowledged weaknesses (see Pollard and Sag 1994, for a description of some of them), there are staunch advocates of meaning-based accounts of agreement. Reid (1991, 2011) sets out examples of the arguments and the data that motivate meaning-based accounts, calling on observations of notional-number use in spontaneous speech and writing. One of the frustrations of arguments of these kinds is that there is in fact relatively little data

Table 1 Experimental procedures for eliciting verb number agreement (Bock and Miller 1991)

Experimental Trial Event	Examples of possible responses	Response scoring
1. Preamble presented auditorily:  *the key to the cabinets*		
2. Speaker repeats preamble and completes as a full sentence:	*"The key to the cabinets was missing"*	Singular
	"The key to the cabinets were missing"	Plural
	"The key to the cabinets dropped"	Ambiguous number
	"The key to the cabinet was rusty"	Miscellaneous error [preamble repetition error]

that can decide for or against the notional position. Because most grammatical plurals are also notional plurals, almost all uses of plurals are consistent with both positions. To make a convincing case for notional effects and for the pervasiveness of notional effects, controlled comparisons are essential. That is where psycholinguistic evidence comes in.

3.2 Psycholinguistic evidence for notional effects

Considerable attention has been given to the topic of notional agreement in the psycholinguistic literature. The goal in this research is to gauge variations in agreement under conditions in which the hypothesized notional factors are manipulated. The usual experimental paradigm is a simple sentence completion task of the sort sketched in Table 1.

The completion task is designed to elicit a phenomenon called *attraction*. Attraction is a familiar pattern in which a verb agrees in number with a noun phrase that is not the subject of a sentence, often a noun phrase that occurs within the subject noun phrase but not as its head. For instance, in *the key to the cabinets were missing*, the plural *were* seems to agree spuriously with *cabinets*. Strictly speaking, attraction is a grammatical error. However, there is a kind of notional agreement that can create the same pattern. Consider the phrase *the picture on the postcards*. This phrase, and others like it, is usually taken to refer to a situation in which tokens of the same picture appear on multiple postcards. If agreement can be notionally driven, plural agreement with subject noun phrases like *the picture on the postcards* would be expected to be more frequent than plural agreement with subject noun phrases like *the key to the cabinets*. The sentence-completion paradigm serves as a tool to increase the general incidence of plural agreement, enhancing any tendency for notional plurality to drive plural verb agreement. This enhancement magnifies and makes it easier to observe what could otherwise be a very weak effect.

Using the sentence-completion task or variants of it, experiments have in fact disclosed the existence of notional effects on agreement in several languages (in Dutch:

Vigliocco et al. 1996b; in English: Bock et al. 1999; Eberhard 1999; Humphreys and Bock 2005; in French: Vigliocco et al. 1996a; in Hebrew: Deutsch and Dank 2009; in Italian: Vigliocco et al. 1995; in Russian: Lorimor et al. 2008; and in Spanish: Bock et al. in press; Foote and Bock in press; and Vigliocco et al. 1996a). However, the effects are limited. To pinpoint the nature and magnitude of the notional influence, Middleton et al. (2010) examined the incidence of notional number agreement as a function of objective ratings of referential plurality. The results established a clear, graded relationship between increases in referential plurality and the likelihood of plural verb agreement with grammatically singular subjects. But the Middleton et al. results also revealed the weakness of notional forces: the rate of grammatical agreement was about seven times the rate of notional agreement.

What these findings suggest is that notional number intrudes on agreement processes in English and other languages, though its effects are small. Furthermore, the effects become progressively smaller as the richness of verbal morphology increases (Foote and Bock in press; Lorimor et al. 2008). Still, regardless of magnitude, the presence of such influences indicates that number meaning somehow affects the implementation of agreement in language production. In the next section, we examine efforts to explain how the effects come about.

4 Explaining notional effects on number agreement

On its face, notional agreement is more compatible with constraint-based, maximalist approaches than with control approaches to grammatical agreement in language production. Clearly, agreement is sensitive to variations in notional number and it reflects the variations in graded ways. Constraint-based views emphasize the role that meaning plays in language processes, treating number semantics as one of many kinds of information that interact with grammatical mechanisms in establishing agreement. Fundamental to the constraint view is that the scope of semantic/syntactic interaction is fairly wide. From a maximalist perspective, the reliable occurrence of notional agreement is a likely and easily explained consequence of number meaning pervading the formulation of sentence structure, affecting in parallel the number of the subject and the verb. The fact that notional effects are small can be interpreted to mean simply that differences in conceptualizations of numerosity (such as collectivity and distributivity) are subtle, particularly when conceptualization interacts with verb number inflection to distinguish singulars from plurals.

Still, it is not especially hard for control views to explain notional agreement. Recall that the simple control account sketched above puts the subject noun phrase into a relationship with the verb in which the subject's number features fully determine the verb's number. If the number features of subject noun phrases depend probabilistically on valuations of notional number, and if these number features in turn control verb number, then verb number will reflect the same notional number valuations as the subject. The crucial issues are not whether there are notional effects on agreement or whether the effects are graded. Instead, the issue is whether number features can be traced to number meaning for the subject alone (or to number features that may

originate in semantic properties but are posted on the subject by syntactic mechanisms like Quantifier Raising, den Dikken 2001) with transmission to the verb as a structural, syntactic process.

Thus, a key to evaluating the merits of constraint and control accounts is whether the impact of number meaning is the same for verbs as for other types of number agreement, such as agreement between pronouns and their antecedents. In constraint accounts, the mechanisms of subject-verb number agreement and pronoun-antecedent number agreement should be the same: both involve the reconciliation of referential indices (Pollard and Sag 1994). This leads to the expectation that these two kinds of number agreement will pattern in similar ways. In contrast, control accounts tend to treat the principles, operations, and domains of verb agreement and pronoun agreement differently, with the consequence that number inflections for verbs and pronouns diverge in important ways (see Corbett 2006 for an overview).

With respect to pronoun number, existing psycholinguistic evidence suggests that the source of pronoun number is not typically in linguistic representations but in discourse representations (like mental models or other types of conceptual contexts, Garnham 2001; below we return to the question of whether this generalization applies to all types of pronouns). For instance, Gernsbacher (1991) and Oakhill et al. (1992) found a preference for pronoun variations that mirrored notional rather than grammatical number. With collective antecedents, plural pronouns (e.g., *Last night we went to hear a new jazz band. **They** played for more than five hours*) were rated as more acceptable and comprehended faster than singular pronouns (*Last night we went to hear a new jazz band. **It** played for more than five hours*). Pronouns can even be introduced and readily understood in the absence of explicit antecedents (Greene et al. 1994). If singular and plural verbs exhibit tendencies similar to those of pronouns, the predictions of constraint accounts would be upheld.

Of course, verbs and pronouns differ in many ways that could explain apparent variations in their number properties, apart from the mechanisms of agreement themselves. One prominent difference is in their distribution: pronouns often occur in different clauses from their antecedents, whereas verbs have to occur in the same clause. This seriously complicates the interpretation of disparities in verb and pronoun number. To sidestep this problem and compare the effects of grammatical and notional number on verb and pronoun agreement, a level playing field is needed. The next section reviews the results from efforts to do this in controlled settings.

5 Verb and pronoun number

To evaluate the determinants of verb and pronoun number under equivalent conditions, the verb elicitation task described above has been used in concert with a similar task for tag and reflexive pronoun elicitation. Table 2 illustrates the experimental paradigm for tag pronoun elicitation, with the procedure used for verbs shown again for easy comparison. For verb elicitation, speakers are asked to complete preambles as full sentences; for tag and reflexive pronouns, they are asked to complete the preambles with tag questions or reflexive pronouns, respectively.

The critical feature of this paradigm is that the subject noun phrase *The actor in the soap operas* is identical for verb and pronoun items. So, the agreement controllers

Table 2 Experimental procedures for eliciting verb and pronoun number agreement (Bock et al. 1999)

Experimental Trial Event	Example preamble		Sample responses		Scoring category	
	Verb elicitation	Pronoun elicitation	Verb	Pronoun	Verb scoring	Pronoun scoring
1. Preamble presented auditorily 	*The actor in the soap operas*	*The actor in the soap operas rehearsed*				
2. Speaker repeats preamble and completes			*"The actor in the soap operas was replaced"*	*"The actor in the soap operas rehearsed, didn't he?"*	Singular	Singular
			"The actor in the soap operas were replaced"	*"The actor in the soap operas rehearsed, didn't they?"*	Plural	Plural
			"The actor in the soap operas died"	Not applicable	Ambiguous number	Not applicable
			"The actor in the soap opera was replaced"	*"The actor in the soap opera rehearsed, didn't he?"*	Miscellaneous [preamble repetition error]	Miscellaneous [preamble repetition error]

are the same in verb and pronoun elicitation, with the only difference between the preambles being that the pronoun versions contain a number-neutral, regular past-tense verb after the subject noun phrase.

To elicit pronouns, participants receive examples of tag or reflexive constructions and a few practice trials to ensure their understanding of the experimental procedure. To increase variety in the materials that are presented, the majority of the preambles are fillers with different structures (e.g., simple noun phrases). The speakers' completions (verbs or pronouns) are categorized in terms of their major properties, with singular and plural targets being the categories used in the primary analyses.

Using these methods, variations between verb and pronoun agreement have been examined with materials that create differences in the notional properties of subject noun phrases. The comparisons in notional agreement that have been made between verbs and pronouns involve notional singularity and collectivity (e.g., *The actor in the soap operas/The cast in the soap operas*; Bock et al. 1999, 2004, 2006), and notional singularity and distributivity (e.g., *the warning from the experts/the mistake in the programs*; Bock et al. 2004). The contrast between notional singularity and distributivity was created with preambles in which the referent of the subject noun phrase is normally construed as a single token (*the warning from the experts* tends to be interpreted as one warning issued jointly by several experts) or as multiple tokens

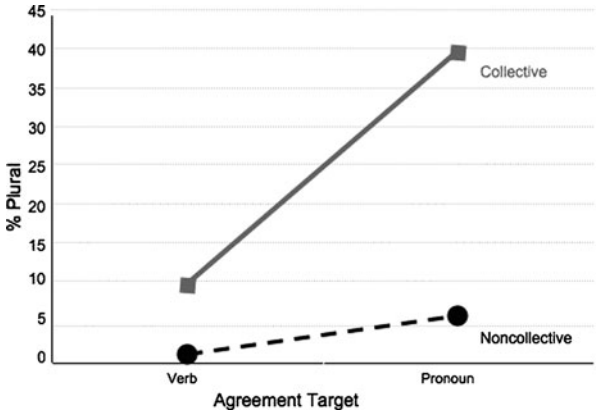


Fig. 3 Averaged rates of plural agreement for verbs and pronouns after grammatically singular but notionally plural (collective) or notionally singular (noncollective) subjects or antecedents

of the same type (*the mistake in the programs* tends to be interpreted as tokens of the same mistake replicated across several programs).

The results of these studies are easy to summarize. In all cases, the sensitivity of pronouns to notional plurality in the subject noun phrase is large in comparison to the sensitivity of verbs. Although there is a detectable verb effect, reflecting the same trend as in Middleton et al. (2010), the pronoun effect is about four times larger. Figure 3 illustrates and summarizes the results for subjects with noncollective (such as *actor*) and collective (such as *cast*) heads.

Other research on English illustrates how these differences play out. Bock et al. (2006) compared British and American English with respect to the verb number variations in agreement with collective heads, with the goal of identifying the source of the well-known grammatical difference between the two English varieties (compare the British *Management **are** not responsible* and the American *Management **is** not responsible*). One step toward this goal was to elicit verbs and pronouns from native speakers of British and American English, using the same experimental materials. As expected, for verbs, there was a substantial difference between British and American in plural number agreement, which was evident in experimental as well as corpus data (for Britons, the overall rate of plural verb agreement was .32 compared to .11 for Americans).

To assess the role of notional number in this contrast, pronoun agreement was examined using the paradigm above. The striking result was that for pronouns, there was little difference between the varieties in the rates of plural number agreement (.53 of the instances in British vs. .56 in American). Simply stated, pronoun number agreement did not display the variations seen in verb agreement, despite massive notional effects on pronoun number. This is a problem for existing constraint accounts, where the verb and pronoun effects would be expected to vary together.

There is an alternative interpretation of these results that has to be addressed. Conceivably, identical mechanisms could operate in verb and pronoun number agreement, consistent with constraint accounts, but with differences in the stability or sensitivity of agreement targets under the pressure of the same notional variations. For instance, pronoun number might be much more easily swayed than verb number by any number variations in a speaker's mental model. The logic works like this: assume that

pronoun and verb number are both triggered directly by notional number representations, without mediation by a controller. In the presence of a notional plural (e.g., the mental representation of an army), a plural pronoun (*they*) might be triggered more strongly, with a higher probability, than a plural verb inflection (*were*), perhaps because of stronger associations between plural notions and plural pronouns than between plural notions and plural verb inflections. This would make verb forms more recalcitrant to notional pressures than pronouns, not because of a qualitative difference in how verb and pronoun number are controlled, but because of a quantitative difference in how strongly verb and pronoun number are constrained.

To evaluate this alternative, Bock et al. (2004) used the phenomenon of attraction to examine the vulnerability of verbs and pronouns to notional number variation. Recall that in attraction, verbs display sensitivity to the grammatical number of a noun phrase (hereafter, the attractor) that is not the expected controller, but lies in the vicinity of the controller. For instance, in *I'm not sure how meaningful the idea of pronunciation rules are*, the plural prepositional object (*pronunciation rules*) seems to attract verb number, yielding the plural *are* instead of the singular *is* that would be expected in agreement with the singular subject (*the idea*). Pronouns undergo attraction too. In the self-repaired utterance *the breaking of relations in themselves... in itself...*, the plural prepositional object (*relations*) attracts pronoun number, initially yielding the plural *themselves* rather than the intended and ensuing singular *itself*. As these examples suggest, attraction can be described as invasion of the controller's number features by an attractor's features (with the mechanism behind the invasion a matter of current debate, reviewed below).

There are three features of attraction that are relevant to evaluating the sensitivity of pronouns to notional number. First, attraction is much more likely to occur when an attractor is plural than when it is singular (the singular/plural asymmetry; Bock and Miller 1991). Second, verbs and pronouns both exhibit this singular-plural asymmetry (Bock et al. 1999). Third, for verbs, attraction occurs from grammatical plurality but not notional plurality (Bock and Eberhard 1993; Bock et al. 2001): plural attraction is no more likely after the collective attractor *choir* in the subject noun phrase *The job for the choir* than after a noncollective attractor like *singer* in *The job for the singer*.

So, to assess whether pronouns are more sensitive than verbs to notional number variations, the notional properties of attractors can be manipulated separately from their grammatical properties. For instance, *soldier* and *army* differ in notional plurality, as determined from notional-number ratings and confirmed in the large differences between verbs and pronouns in the rates of plural agreement with collective heads. If the difference between verbs and pronouns is due to a general sensitivity on the part of pronouns to notional variations, the same sensitivity should be apparent in pronoun attraction after subject-antecedent noun phrases such as *The strength of the soldier* and *The strength of the army*. The "general sensitivity" prediction is shown in Fig. 4.

Bock et al. (2004; Experiments 2 and 3) tested the general sensitivity hypothesis, using the same set of collective nouns alternately as heads and as attractors. As heads, singular collectives yielded the typical large difference between verbs and pronouns in plural agreement that was sketched in Fig. 3. But as attractors, singular collectives had no impact for either verbs or pronouns, as shown in Fig. 5. Only when the

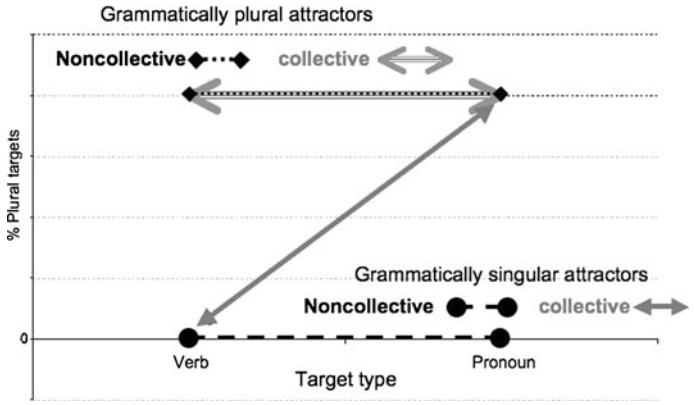


Fig. 4 Prediction of a general sensitivity (constraint-like) account of verb and pronoun attraction (*y* axis in arbitrary units)

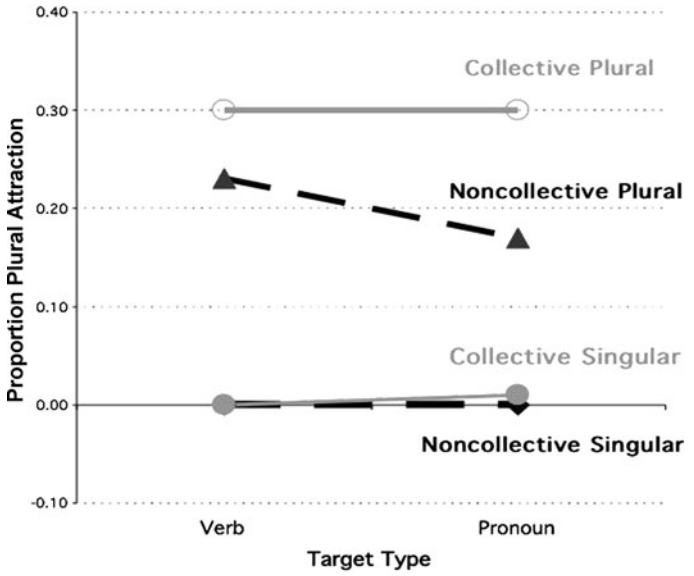


Fig. 5 Verb and pronoun attraction after grammatically singular and grammatically plural collective and noncollective local nouns

attractors were grammatically plural (e.g., *soldiers*, *armies*) did verbs and pronouns both exhibit attraction. (Oddly, grammatically plural collectives yielded more attraction overall than did grammatically plural noncollectives. This difference remains to be satisfactorily explained, but is accounted for in the Marking and Morphing model as an effect of the low frequency of plural collectives. The critical point here is that verbs and pronouns were similarly influenced by whatever factor was in play.) These attraction results, together with the agreement outcomes, support a psycholinguistic control account of verb agreement: Verbs and pronouns display large differences

in number agreement that cannot be explained as mere differences in sensitivity to notional number.

So, verbs and pronouns are similarly sensitive to grammatical number variations in attractors and similarly insensitive to notional number variations in attractors. The implication is that pronouns carry no more sensitivity to ambient notional number than verbs do. Instead, it seems likely that the mechanisms for pronoun and verb agreement differ in some way.

6 The production mechanisms behind number agreement

To account for the observed patterns of variation in English verb- and pronoun-number agreement, Eberhard et al. (2005) developed a computational model of agreement processes. The model, dubbed *Marking and Morphing*, serves to test the viability of a theory about the production of number agreement in which the major variations to be explained include the following:

(1) In agreement, verb number predominantly reflects the grammatical number of its controller, the subject noun phrase, in American as well as British English (where the grammatical number of many collectives is plural; Bock et al. 2006);
(2) Pronoun number predominantly reflects the notional number of its antecedent (even when the antecedent is a subject noun phrase);
(3) There is a small but systematic effect on verb agreement of the controller's notional number;
(4) Variations in number attraction are due to grammatical but not notional number properties of the attractor.

As part of a uniform account for these patterns, the theory posits three determinants of subject/antecedent number. The first is a notionally sanctioned number feature on the subject noun phrase. The feature is rooted in the message representation for an upcoming utterance, and serves as a syntactically relevant referential categorization. The process by which the feature comes into play is called *marking* in the model. Its conceptual-syntactic interface properties make it analogous to a phi feature in formal syntax.

The second determinant of subject/antecedent number is the so-called grammatical number of the head of the subject noun phrase and its dependents (determiners, quantifiers, etc.). Grammatical number is a product of morphological number specifications, taken to be part of the lexical representation of words and other morphemes. Among the morphemes that carry privative number specifications, most are plural. A few (e.g., *a*, *one*, *each*, and all singular pronouns) have privative singular specifications. When a morpheme carries no number specification, it is unspecified for number. In the model, the values of the specifications are set to correspond to conventional grammatical number ($+1$ = plural; -1 = singular; 0 = unspecified).

The third determinant of subject/antecedent number is attraction. The model covers the workings of two factors with known effects on attraction: (a) the grammatical number specifications of the morphemes integrated into the structural representation of an utterance (just as for head nouns), but outside the immediate head noun phrase;

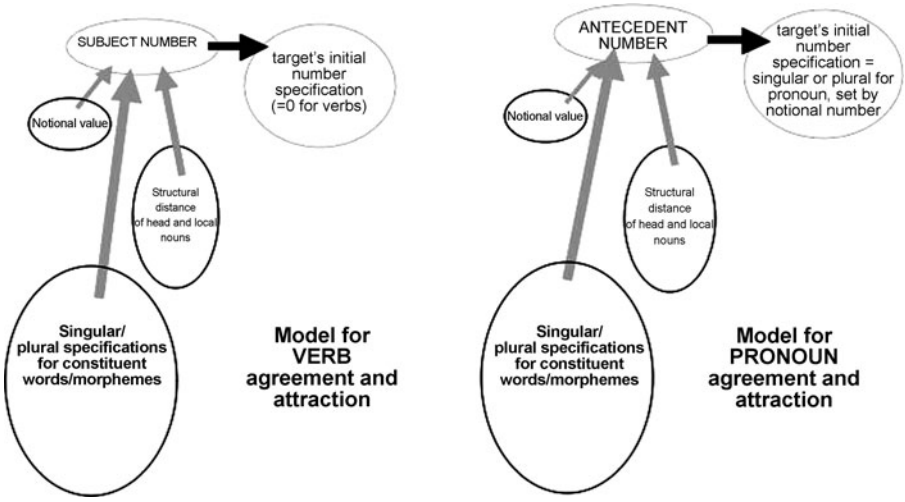


Fig. 6 Schematic depiction of variables contributing to subject number for verbs (*left panel*) and antecedent number for pronouns (*right panel*) in Marking and Morphing model of agreement (*ellipse sizes* indicate relative weights of contributions to final value)

and (b) the hierarchical distances from these morphemes to the root of the subject noun phrase (or to the root of the entire sentence). Hierarchical distance is based on simple assumptions about phrase structure configurations.

Figure 6 schematically illustrates the convergence of the three number determinants on the root of the subject or antecedent noun phrase. The model's estimate of the relative impact of each factor is represented in terms of the size of the corresponding ellipse linked to the controller. The estimates are derived from linguistically based values of structural and morphological factors along with experimentally based values from a meta-analysis of the literature on notional, lexical, and attraction effects. As noted above, the major structural modulator is the distance of a head or attractor from the root of the controlling phrase and the major morphological modulators are the number specifications of nouns and pronouns within phrases.

Morphological specifications carry the greatest weight in number determination, which is psycholinguistically justifiable in terms of the timing of their entry into agreement implementation. In the model, the recruitment of morphological specifications occurs at the interface between marking and *morphing*, with morphing comprising several processes by which inflectional morphemes are retrieved and their values reconciled with the notionally sanctioned features. Because the morphological specifications enter into implementation later than notional features, in company with lexical retrieval processes, they may be active in working memory at a point when feature transmission to agreement targets (another of the morphing mechanisms in Marking and Morphing) occurs. However, the timing of these processes (about which virtually nothing is known) is not directly represented in the model.

The final (or reconciled) number feature of the controller is a simple linear combination of the weighted factors. Because the factors and their weighted values are identical in the verb and pronoun models, the reconciled number feature will also

have equivalent values for verbs and pronouns when the referents, the syntactic structures, and the lexical contents of the controllers are the same. So, if a subject noun phrase and an antecedent noun phrase in different sentences happen to be the same (e.g., *the picture on the postcards*), their feature values will be the same.

The only difference between the verb and pronoun models is in the initial value of the agreement target, the verb or pronoun itself. Verbs have no initial number value, with their final values being fully determined by the value of the subject noun phrase. That is, verb number is completely controlled by subject number. The model thus relies on control mechanisms for verb agreement. Pronouns, however, enter the agreement process with a morphological specification, the grammatical number value of the pronoun's lexical entry. Initial pronoun selection occurs not under linguistic control from the antecedent, but under the influence of the same notional number that contributes to its antecedent's feature value, given that the pronoun and its antecedent have the same referent.

For a pronoun target, all of this means that its number value is a product of notional number and the number specification of the selected pronoun, combined with the number feature of the antecedent phrase (if the feature remains active in working memory). That is, pronoun selection is influenced but not controlled by antecedent number (compare this to a proposal of Kayne's (2002), in which all pronouns originate together with their antecedents in the same constituent, seemingly in a control relationship). The bulk of the difference between verb and pronoun number is determined by the number specification of the pronoun itself. Because the antecedent and pronoun are coreferential, and because the selection of the pronoun is determined by the same notional value that affects the antecedent's number, the major relationship between antecedent and pronoun number is one of constraint. This constitutes the difference in the mechanisms for pronoun agreement and verb agreement.

The parsimonious account of variations in verb and pronoun agreement due to the strength of notional effects is one of the most notable features of the model. Comparing the left and right panels of Fig. 6, the similarities in the processes are easily seen. The number features on an antecedent phrase can be invaded by the feature values of an attractor under the same conditions for verbs and pronouns. According to the model, the result is that verb attraction and pronoun attraction should pattern in the same way. And they do, despite other differences in the mechanisms behind verb and pronoun number features.

The experimental finding that makes this account particularly persuasive is the absence of any differences between pronouns and verbs in sensitivity to notional number in attraction. In fact, by incorporating a control component for pronouns, the Marking and Morphing model describes pronoun attraction in the same way as verb attraction, and explains their equivalence. Whether the processing mechanism for structural feature-sharing between pronouns and antecedents is in fact the same as the control mechanism for subjects and verbs remains to be firmly established, but the outcomes for pronoun and verb number are alike.

Where antecedent-pronoun agreement differs from subject-verb agreement, according to the model, is in the inherent number specification for pronouns and the inherent absence of number specification for verbs. Verbs enter the agreement process devoid of syntactically relevant number features, so that verb number is entirely

controlled by the final, reconciled number feature of the subject noun phrase. Pronoun number is likewise affected by the number of the antecedent (e.g., a subject noun phrase of a previous or current clause), but only weakly, because of the strength of the constraint that comes from coreferentiality between pronouns and their antecedents.

Remaining to be discussed is one surprising result from the experiments that compared verb and pronoun agreement (Bock et al. 1999, 2006). The two types of pronouns that were tested, reflexive and tag pronouns, were expected to differ in vulnerability to grammatical and notional factors. Reflexive pronouns, in the same clauses as their co-referential antecedents, should be more accessible to the grammatical number properties of their antecedents than tag pronouns. In more formal terms, Chomsky (1986) proposed that reflexives raise to inflectional head positions in the course of the syntactic derivation, establishing a Spec-Head relationship that should make reflexive-antecedent agreement behave like subject-verb agreement. Conversely, tag pronouns should be less accessible to an antecedent's grammatical properties, given the general observation that notional features (particular gender features in languages with grammatical gender) tend to become more prominent when a pronoun's antecedent occurs in a different clause. The sharp distinction between reflexives and other pronouns in Binding Theory (Chomsky 1981) also raises an anticipation of differences (though there are alternative analyses that make other predictions; Kayne 2002; Zwart 2002).

The actual experimental outcome was that number attraction for reflexives and tag pronouns patterned in the same way. Relative to verbs, pronouns of both kinds showed similarly strong effects of the antecedent's notional number, and both were equivalent to verbs with respect to their sensitivity and insensitivity to the grammatical and notional numbers of attractors, respectively. One interpretation of the systematic notional effect is that pronoun number, regardless of pronoun type or structural relation to the antecedent, may be uniformly influenced by the speaker's awareness of coreference. That is, a pronoun's singularity (*it* or *itself*) or plurality (*they* or *themselves*) could originate in the referent's notional number. The structural conditions on pronouns and reflexives summarized in Binding Theory come into play not in determining number, but in determining morphological form (e.g., whether the pronoun is *it* or *itself*; Joseph 1979).

Taken together, the array of experimental results for verb and pronoun agreement point to three important conclusions about the mechanisms of agreement in language production. First, verb and pronoun agreement both exhibit the effects of notional number. Second, for verb number agreement, the process is one of control by the number of the subject noun phrase: Verbs make no independent contribution to the implementation of verb number agreement. Spelled out, this means (a) that verb number inflection is not the product of a meaning-driven morphological process, but of a grammatical, structurally regulated mechanism; and (b) that notional effects on verb number originate in the subject noun phrase's number features, which are partly a product of notional valuations. Third, pronoun number is the joint product of a control process and a constraint process that involves co-indexation. The control process makes a contribution to pronoun number that reflects the same combination of marking and morphing as for verbs, and yields pronoun attraction. The constraint process

involves co-indexation, and adds a notional influence to pronoun number that is created by meaning-driven lexical selection of the pronoun itself.

7 Agreement and attraction in other languages

Another strength of Marking and Morphing is its ability to account for and predict agreement and attraction in other languages and language varieties. The apparent differences in how agreement works across languages lead to an expectation that the psycholinguistic mechanisms of production could vary widely. Such variations could in turn have implications for how speakers use the notional and linguistic resources that are needed for agreement, potentially requiring different organizations of psycholinguistic processes.

Consider pro-drop languages and languages in which verbs commonly precede their subjects, where many utterances lack overt or immediate controllers for the number morphology carried on the verb. Vigliocco et al. (1995) proposed that speakers of such languages might make more immediate or direct use of notional information than speakers of languages in which controllers and their attendant morphology are consistently expressed prior to verbs. In a related vein, Vigliocco et al. (1996a) and Vigliocco et al. (1996b) suggested that morphological processes in languages with rich morphology may be more likely to call on notional information for morphological selection than languages in which morphology is sparse and variably expressed. In all of these cases, the implication is that speakers of such languages could deploy production processes that interact with meaning-based information in a way that differs from languages with different morphological characteristics. Slobin's (1996) characterization of such differences in terms of "thinking for speaking" is apt: some languages force their speakers to "think differently" or more selectively than others.

Consistent with these ideas, Vigliocco et al. (1996a) reported larger distributivity effects in Spanish than in English, which they ascribed to either the difference between Spanish and English in the use of pro-drop or the richer morphology of Spanish. To arbitrate between the pro-drop and rich morphology hypotheses, Vigliocco et al. (1996b) tested speakers of Dutch and French, which are not pro-drop languages but do have rich morphology. The impact of distributivity in Dutch and French was just as large as in Spanish, pointing at morphological richness as the vehicle of the semantic effect.

Based on these and related results, Vigliocco and Franck (1999, 2001) and Vigliocco and Hartsuiker (2002) argued for a constraint-based production system in which meaning pervades the agreement process, with the pervasiveness of meaning effects being a function of variations in the richness and regularity of morphological systems. In terms of number, the richer the number morphology, the stronger the impact of number meaning on number agreement.

There are theoretical as well as empirical challenges to the hypothesized role of morphology in meaning-mediated agreement. Theoretically, Marking and Morphing predicts a diametrically opposed pattern: the richer the morphology, the weaker the impact of meaning on agreement. The basis of this prediction is in the model's mechanism for introducing morphology and its weighting of morphological contributions

to number agreement. Because the notional marking of a phrase and the morphological specifications of the lexical contents make separable contributions to the number of a controlling phrase, and because morphological specifications have more sway in the number computation, the specifications tend to filter (block or overrule) the marking values.

The empirical challenge to the meaning-driven morphology hypothesis comes from experiments that confirm the opposing relationship between morphological richness and notional effects. Experiments on Russian (Lorimor et al. 2008) and two different varieties of Spanish that differ in morphological elaboration (Dominican and Mexican Spanish, Foote and Bock in press) disclosed *weaker* effects of number meaning on agreement in the languages with richer morphology. Relative to English and a wide array of other languages with smaller inventories of inflectional morphology, the impact of notional variations on Russian number agreement were negligible, consistent with the elaborate Russian morphological system.

The comparison of Dominican and Mexican Spanish is even more revealing. Toribio (2000) argued that Dominican Spanish, relative to other varieties of Latin American Spanish, is undergoing a shift toward reduced morphological expression. The reduction is exhibited in an erosion of verbal morphology with a concomitant decrease in word-order flexibility and pronoun dropping. Capitalizing on this trend, Foote and Bock (in press) directly compared the effects of notional number on agreement production in Dominican and Mexican, using matched materials with overt subjects. As predicted, there were considerably stronger effects in Dominican than in Mexican Spanish.

The most illuminating evidence against the idea that rich morphology promotes notional agreement came from a test of local variations in morphological expression *within* the Spanish varieties. The Marking and Morphing theory predicts that increases in the impact of notional number should accompany local, contextually dependent reductions in agreement morphology. For example, the absence of subject-pronoun number morphology when pronouns are dropped (e.g., *Es amarilla* '(it) is yellow'; *Son amarillas* '(they) are yellow') should allow distributive construals to exert stronger effects. Imagine a picture showing a yellow label on several bottles. Speakers instructed explicitly to name the labels' color would be expected to say *Es amarilla* '(it) is yellow'). However, if the plural notional number of the yellow labels creates an unexpressed plural subject (due to distributivity), the production of *Son amarillas* '(they) are yellow') should increase in probability. These increases in notional effects ought to be the same in both Spanish varieties, because morphological reduction is the same in both varieties.

Exactly this result was obtained in a second experiment (Foote and Bock in press, Experiment 2). In the course of the experiment, native speakers of Mexican or Dominican Spanish heard noun phrases like *La etiqueta en las botellas* 'the label on the bottles' accompanying a pictured display in which the same label appeared on several bottles. The phrase was followed by a question such as *¿De qué color?* 'What color?', to which speakers responded with a pro-drop construction containing the answer. So, the answer might be either the grammatically expected *Es amarilla* or the notionally driven *Son amarillas.* The propensity of speakers to use the plural *Son amarillas* when a distributive construal was possible was compared to the separately measured

propensity to use the plural when the subject noun phrase was overtly expressed (i.e., *La etiqueta en las botellas son amarillas*). Recall that with overt subjects, Dominican speakers were more likely to use notionally driven plural verbs than Mexican speakers. However, when producing pro-drop constructions, speakers of both varieties exhibited increases in the use of notional plurals. Relative to the baseline rates of notional agreement in each variety, these increases were the same in size. (There is an objection to this result that is easily countered. The objection is that speakers could have ignored the captioning phrase [e.g., *La etiqueta en las botellas*], using only the picture to generate the utterance. But if this were so, speakers should have made gender errors, too, and they did not. Across the experimental materials, there were different pictures with correspondingly different head nouns of different genders. The gender inflections on adjectives agreed almost perfectly with the head nouns.)

The implication is that general differences in morphological richness between languages do not create general, language-wide differences in speakers' reliance on notional number in the production of verb-number agreement. Consistent with Marking and Morphing, morphological filtering systematically regulates the sway of notional number, regardless of language-wide variations in inflectional morphology.

One interesting twist on this variation comes from work on morphological ambiguity. In Russian, German, and many other case-marking languages, there are inflections that are ambiguous with respect to case. So, in German, subject nouns with feminine and neuter genders are ambiguous between nominative and accusative (e.g., *die Frau* can be either nominative or accusative case). A plausible consequence of this ambiguity is a sparse or unstable feature set when such nouns serve as agreement controllers. In the Marking and Morphing framework, this would induce competition between the (intended) nominative and (uninvited but consorting) accusative. In turn, competition increases the likelihood of attraction, which arises when the morphological specifications of an attractor occupy the feature set of the controller. At the extreme, attraction in English arises almost exclusively when a controller's feature set is empty (due to the presence of an unmarked and unspecified singular head).

Extrapolating to German, when a controller's feature set has an inherent feature conflict, interference or time or both may increase the likelihood of an extraneous morphological feature (e.g., a plural feature) invading the feature set. This result is reported in experiments by Hartsuiker et al. (2003) on German (using case ambiguity in the local noun) and Dutch (using a number ambiguity in Dutch definite determiners). Attraction in the absence of morphological ambiguity in the local noun phrase was nearly undetectable; in the presence of ambiguous morphology, attraction was relatively common. In German, for example, the dative feminine plural *den Demonstrationen* in:

Die	*Stellungnahme*	*zu*	*den*	*Demonstrationen*
The	position	on	the	demonstrations

is unambiguously dative, whereas the accusative feminine plural *die Demonstrationen* in:

Die	*Stellungnahme*	*gegen*	*die*	*Demonstrationen*
The	position	against	the	demonstrations

is homophonous with the nominative feminine plural. Almost all of the number attraction observed with subject noun-phrase pairs like these, matched for their heads and local nouns, occurred after the morphologically ambiguous accusative feminine plurals. (See Franck et al. 2008, for a review and report of similar results for gender agreement, and for a model with substantial similarities to the morphing components of Marking and Morphing.)

In short, to the extent that a controller's feature set is sparse or unstable, the more the controller is open to the effects of other, externally motivated features. These external features can come from the mechanisms of either marking (i.e., from features motivated by the notional number of a referent) or morphing (i.e., from features motivated by the morphological number specifications of an attractor's inflections).

Other evidence for the cross-linguistic validity of marking and morphing processes, as well as their separability, comes from Hebrew. Hebrew is a rich-morphology language in a different family from other languages that have been tested. Deutsch and Dank (2009) showed that the same nouns behaved quite differently in head and local position, with notional number and gender effects prominent for head nouns but absent for local nouns. For number, mass nouns led to substantial plural agreement when they occurred in head position, but not when they were in local position. For gender, animate head nouns were more powerful agreement controllers than inanimates, reducing the incidence of gender attraction to local nouns. But when there was an animacy contrast between attractors, with the gender of the head noun held constant, animate and inanimate nouns were comparable in their ability to attract agreement. Again, heads bearing a notionally driven (but syntactically realized) number or gender feature play a different role in agreement than the same nouns as attractors. In attraction, it is the grammatical features of words that matter most.

The Marking and Morphing approach to the psycholinguistics of grammatical agreement thus accounts for an array of agreement facts about verb and pronoun number agreement, verb and pronoun number attraction, number agreement and attraction in several languages and language varieties, and morphologically motivated variations in agreement and attraction. An important question is whether other approaches to agreement fare as well. To address this, the next section outlines alternative psycholinguistic accounts of agreement production and their explanatory adequacy.

8 The psycholinguistics of grammatical agreement from contrasting perspectives

Apart from the Marking and Morphing framework, there are currently four psycholinguistic accounts of agreement and attraction that have been developed to varying degrees. These four accounts are the constraint view evaluated above, a semantic integration hypothesis proposed by Solomon and Pearlmutter (2004), an approach in which the psycholinguistic processes of agreement are worked out in terms of formal grammatical mechanisms (Franck et al. 2006), and a memory retrieval view (Badecker and Kuminiak 2007). Respectively, we call the four accounts Constraint, Semantic Integration, Production Syntax, and Memory Retrieval.

The strengths and weaknesses of these accounts can be evaluated relative to their success in accounting for the range of accepted facts and experimental results on agreement and attraction in language production. The major experimental results that have to be addressed include the evidence for notional contributions to agreement, for the occurrence of attraction, for the absence of notional contributions to attraction, for similarities and differences in verb and pronoun agreement with respect to notional effects, and for morphological filtering. To situate the accounts within a viable theory of language production, each account can also be assessed in terms of how successfully it deals with the general relationship between agreement and aberrations in agreement (such as attraction) and with the processing characteristics of spoken language production.

8.1 Agreement as constraint satisfaction

The claims of constraint-based views and the problems with them have been introduced already, so we confine the discussion here to a brief review and summary of the adequacy of the approach. Following Pollard and Sag (1994), the distinctive claim in Constraint approaches is that agreeing elements enter into a relationship in which both elements call on information about reference and, in the case of number agreement, notional number. In den Dikken's (2003) terms, this makes the approach symmetric.

A clear strength of the Constraint view is that it predicts effects of notional number on agreement. These effects can be subtle, but are evident in famous examples given by Morgan (1972, 1984) and Pollard and Sag (1994) and in carefully controlled tests. Notably, it is possible to discern notional effects in verb number agreement, consistent with the Constraint claim that verbs make use of notional information. For pronoun agreement, the symmetry claim makes considerable sense and provides a partial account of how pronoun agreement works in psycholinguistic tests.

Another advantage of the Constraint view is that it is in principle open to explaining agreement and variations in agreement (such as attraction) within the same framework. Canonical agreement arises when the constraints on agreement, both semantic and grammatical constraints, operate within the ranges typically observed for normal agreement situations in terms of meaning, structural distances, and morphological cues. When the semantic, structural, or morphological constraints fall outside the typical ranges, variations like attraction occur. For example, when notional values are strongly at odds with morphological constraints, notional values may take precedence in controlling agreement outcomes. The constraints themselves stay the same. (Note that Marking and Morphing has the same advantage of accounting for agreement and its variations in a uniform framework, although in a framework that differs from the Constraint approach.)

The challenges to the Constraint view come from the clear differences between verbs and pronouns in notional number agreement, and from evidence that the differences emerge from two separate types of mechanisms. As documented above, only one of the mechanisms has constraint-like characteristics in which notional number directly affects the selection of word forms, without mediation from the structural configurations in which agreement arises. The constraint-like mechanism operates in

the selection of pronouns, but not in the selection of verb inflections. Instead, the selection of verb inflections appears to occur under syntactic control from the subject noun phrase.

At present, there is no detailed theory or model of agreement production in terms of constraint satisfaction. It could be fairly easy to develop a model that embraces the kinds of factors that are important to the Marking and Morphing account, but organized in different ways to capture the disparate syntactic and semantic effects on verb and pronoun agreement. However, if such a model is developed, it is important that it make predictions that differ qualitatively, and not just qualitatively, from a two-mechanism model like Marking and Morphing. Otherwise, the models would be functionally equivalent.

8.2 Semantic integration

Solomon and Pearlmutter (2004) offered a unique account for semantic effects on agreement that calls on a construct of semantic integration. In Solomon and Pearlmutter's terms, semantic integration (hereafter, integration) has to do with the extent to which an expression contains elements that are tightly linked to one another. Consider the phrases *the bracelet made of silver* and *the ketchup or the mustard*. The former is judged as integrated, due to the close referential connection between *bracelet* and *silver*, but the latter is not. Solomon and Pearlmutter gathered independent ratings of integration from students who received these example phrases and a definition of integration according to which integrated phrases "provide [a] close connection between the words" in an expression (like *bracelet made of silver*), regardless of whether the words themselves are related in meaning (like *ketchup or mustard*).

In agreement elicitation experiments, Solomon and Pearlmutter (2004) showed that well-integrated subjects were more likely to create attraction, eliciting more noncanonical plural verb agreement than less integrated subjects. So, subject noun phrases like *The drawing of the flowers* and *The pizza with the yummy toppings* attracted plural agreement more often than *The drawing with the flowers* and *The pizza with the tasty beverages*. To account for this highly consistent pattern, Solomon and Pearlmutter proposed that the more integrated a subject phrase is, the greater the likelihood that its lexical components will be prepared in parallel and compete with one another for control of the verb (or for specifying the features of the subject noun phrase). So, in more integrated subjects, plural attractors are more effective in taking control of verb number, leading to plural agreement. Conversely, less integrated subject noun phrases are predicted to be less likely to display attraction, because the attractor is less likely to be in play when the subject is formulated.

A strong point in this proposal is its incorporation of time as a crucial element in the production of agreement. Speed of formulation (often measured in terms of speech rates) is an important variable in many accounts of speech errors of all kinds, with higher rates of speech typically associated with more errors (cf. Dell 1986). Solomon and Pearlmutter's account brings this pattern into the realm of agreement in a plausible, intriguing way. Although the timing predictions have yet to be directly tested, the hypothesis has considerable appeal.

The shortcomings in the approach, as a general agreement-production framework, have to do with the absence of an account of how integration is coordinated with

the structural and syntactic components of formulation. To be fair, the account is not aimed at providing such a framework. Instead, it aims at complementing more general theories and, from this standpoint, it sits comfortably with the Marking and Morphing model. Like Marking and Morphing, Semantic Integration assumes an asymmetric control process, inasmuch as the formulation of subject noun phrases takes precedence in agreement. There is no explicit, directly bestowed semantic contribution to verb number.

Integration thus offers a new view of the process of notional valuation and how notional factors could affect structural processing. For instance, integration could lead to a general speed-up in processing from marking through structural elaboration. However, more details are needed to explain how faster processing increases the likelihood of attraction, in terms of either fractured structural representations or interference between heads and attractors that is mediated by (say) weaker attachment of morphemes—terminal elements—to structural positions.

Another aspect of the integration account that has to be clarified is the precise nature of the relationship between semantic integration and notional number. The emphasis in the integration account as currently formulated is on lexical linkages. It is easy to suppose that such linkages stem from referential coherence: *Pizza with yummy toppings* is referentially more integrated than *Pizza with tasty beverages*. Put this way, though, the obtained results are the opposite of what notional valuations would predict. Intuitively, one imagines a pizza and its toppings as a single, spatially holistic entity, while one imagines a pizza with beverages as multiple, spatially separated objects. These constitute notional singulars and notional plurals, respectively. Analogously, a nondistributive construal of a situation creates a notional singular (e.g., *pizza* in a single pie), while a distributed construal creates a notional plural (*pizza* in multiple slices). Yet in Solomon and Pearlmutter's work, semantic integration (notional singularity) yielded *plural* agreement, while the absence of integration (notional plurality) yielded singular agreement.

The paradox of more holistic representations being correlated with less singular agreement is heightened in the findings of Humphreys and Bock (2005). Humphreys and Bock obtained agreement patterns that reflected a contribution from distributivity that could not be accounted for in terms of integration. They compared subject noun phrases that differed in judged distributivity while keeping the head and attracting nouns constant, creating subject noun phrases like *The gang on the motorcycles* (distributive, and notionally plural) and *The gang by the motorcycles* (nondistributive, and notionally singular). As in previous research, the likelihood of plural agreement was higher for distributed subjects. However, the distributed subjects also tended to be rated as less integrated, presumably because of factors like spatial separation (a gang riding motorcycles is imagined to be spread out in a way that a gang beside motorcycles isn't). Since the prediction from semantic integration is more plural agreement with more integration, due to increased attraction, the finding of *less* plural agreement by Humphreys and Bock runs in exactly the opposite direction.

It may be that integration and distributivity are separable forces in agreement. If so, it is a high priority to identify the nature of their effects. If both are notional-semantic factors, they may reflect different dimensions of referential analysis. Alternatively, distributivity could be a notional factor and integration a linguistic factor related to

the assemblage of words and structures for conveying information about a referent. Solomon and Pearlmutter's proposal appears to be closer to the latter, given their emphasis on the increased likelihood of parallel lexical processing that arises in the presence of integration.

Semantic integration is obviously an important factor in agreement production, but one whose workings remain to be satisfactorily explained. In the Marking and Morphing model, integration is treated as a notional factor. As just noted, however, there are other ways to explain its effects that may (or may not) require an expanded account or an account of a different kind.

8.3 Production syntax

A groundbreaking effort to explain number agreement and attraction is embedded within the mechanisms of formal syntax, as set out in the Principles and Parameters and Minimalist frameworks (Chomsky 1995). Building on other evidence for structural constraints on agreement and attraction (Bock and Cutting 1992; Franck et al. 2002; Hartsuiker et al. 2001; Vigliocco and Nicol 1998), Franck et al. (2006) proposed a processing role for basic operations from formal syntax including MERGE (which integrates structures), MOVE (which displaces elements from one place to another in a structure), and AGREE (which creates agreement between subjects and verbs via feature-copying operations mediated by a functional node called AgrS).

Crucial to the account is the unfolding of structure in successive stages of derivation, with the basic operations in each stage building a complete functional structure (roughly, a clausal structure). Within each stage, features involved in AGREE assume different structural positions with respect to the subject and verb. In some languages, in some structures, the features separate the subject and verb in configurations that allow the verb to copy the features of an attractor instead of the subject. If derivations whose intermediate configurations are conducive to attraction (in terms of the positions of the features involved in agreement) in fact yield attraction more often than derivations with less conducive configurations, both the formal account of agreement and the processing extension of the account gain credence.

To test this, Franck et al. (2006) examined structures in Italian and French with properties that allowed the contribution of one operation, AGREE, to be evaluated experimentally. They first assessed the effects of linear precedence and structural dominance to attraction, and then explored whether AGREE made a further contribution. In all of their experiments, they used variants of the sentence fragment completion paradigm (described earlier) to elicit agreement.

In the first experiment, to evaluate the effect of linear precedence, they had speakers produce normal (subject-verb) and inverted subject (verb-subject) constructions in Italian, as in (1) and (2):

(1) Subject-verb: *L'amica dei vicini telefonerà*. (The friend of the neighbors will phone.)

(2) Verb-subject: *Telefonerà l'amica dei vicini*. (Will phone the friend of the neighbors.)

For both constructions, sentences were used in which the head (*amica*) and attractor (*vicini*) mismatched in number, with a singular head and plural local, or plural head and singular local.

To the degree that linear precedence matters, as it has in other work, the attraction rate should be higher in SV than in VS constructions. It was. Unusually, the effect was reliable only for plural subjects with singular attractors, with agreement errors consisting of the production of singular instead of plural verb forms. That is, errors involving singular verb forms increased in frequency in comparison to errors involving plural verbs forms. Put differently, there was more attraction to singular than to plural local nouns. This is a perplexing finding in comparison to other results, where the usual pattern is increased error from plural relative to singulars attractors (the singular/plural asymmetry). The magnitude of the asymmetry varies, but has never reversed in the way observed by Franck et al. Nonetheless, there was a linear precedence effect, albeit of an unusual sort.

The second experiment assessed the role of structural dominance, which affects attraction to English subjects like *the threat to the presidents of the company*, when compared to *the threat to the president of the companies*. Specifically, Franck et al. (2002) found that plurals that were structurally closer to the verb (*presidents*) were stronger attractors than plurals that were linearly closer to the verb (*companies*). In the 2006 experiment by Franck et al. (Experiment 2), French constructions were used in which plural attractors immediately preceded to-be-produced verbs, but differed in their structural distance from the verbs. In one condition, the plural attractor occurred in a prepositional phrase modifier (3) and in the other condition as a clitic pronoun (4):

(3) Modifier attractor: *Le professeur des élèves…* [*lit/*lisent*].
(The professor of the students reads/*read.)

(4) Clitic attractor: *Le professeur les…* [*lit/*lisent*].
(The professor them reads/*read.)

In (4), the plural clitic *les* (which is an inanimate direct object) is structurally closer to the verb than the plural prepositional object in (3). The outcome was that the rates of attraction were considerably higher when the clitic pronoun served as the attractor, consistent with the role of structural dominance in attraction.

The third experiment was the crucial one for testing the formal-operations predictions. In Experiment 3, again in French, object-extracted cleft constructions were used with either subject-verb order in the subordinate clause (5) or verb-subject order (6):

(5) Subject-verb order: *C'est les négociations que le ministre suspend…*

(6) Verb-subject order: *C'est les négociations que suspend le ministre…*

Both of these fragments mean that the minister stopped the negotiations, but in the verb-subject case, the typical word order is reversed. As in the first two experiments, the procedure involved presenting a sentence fragment and then a verb in its infinitive form; the speakers' task was to use the verb (in a normally inflected form) to fill in a

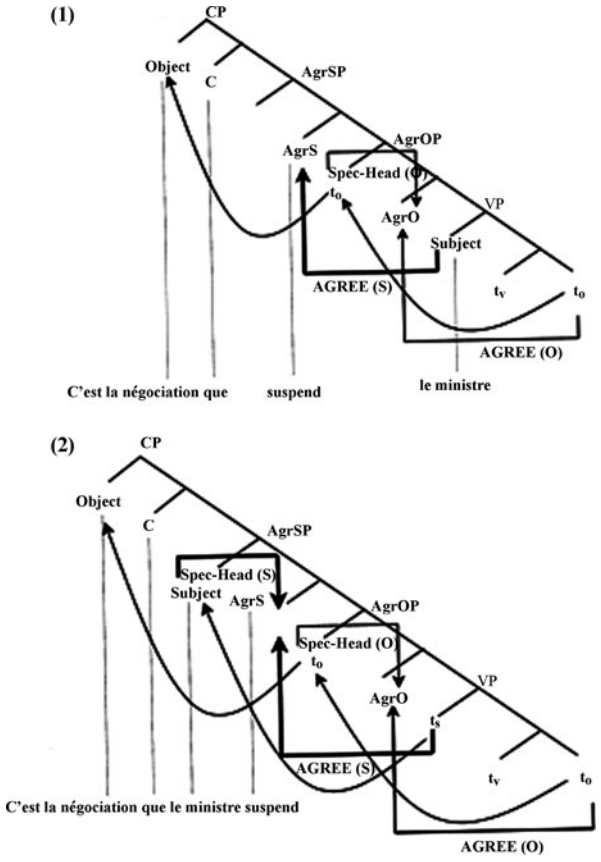


Fig. 7 Derivation of subject-verb agreement in object-initial cleft sentences with (*1*) verb-subject order and (*2*) subject-verb order (reproduced from Fig. 6 in Franck et al. 2006: 196)

gap in the fragments. For instance, given the verb *suspendre*, speakers were supposed to repeat and complete fragments presented as either

C'est les négociations que le ministre ___.
or
C'est les négociations que ___ *le ministre.*

Heads and local noun phrases matched in number (both singular or both plural) or mismatched (one singular and one plural, balanced for heads and locals).

The prediction was that attraction would occur in both kinds of sentences, despite the fact that *négociations* (for instance) neither immediately precedes nor structurally dominates the verb. The reasoning behind this prediction is that the plural *does* intervene between the head and the verb in an intermediate stage of derivation (see Fig. 7), assuming that features like plural are carried on the trace of the object as it moves (t_O in Fig. 7). Then, the key difference is between subject-verb and verb-subject order due to Spec-Head checking during the derivations. Checking reinforces agreement by validating agreement features on targets and controllers, thereby decreasing the likelihood of error. Since this checking occurs twice in the derivation of the subject-verb construction (once under Agree and once under Spec-Head agreement) but only

once in the derivation of the verb-subject construction (only under Agree), the predicted difference was that more attraction should occur for the verb-subject order.

The results aligned with the predictions: there was attraction for both structures, replicating other work that shows attraction across as well as within clauses (Bock and Cutting 1992), even when the attractor is an object that does not dominate the verb (Hartsuiker et al. 2001). Moreover, and most important, there was more attraction for verb-subject than subject-verb constructions.

Thus, the increased rate of attraction for the verb-subject order aligns with the derivational prediction. Unfortunately, it may do so for reasons that have nothing to do with derivational history. There were not only more agreement errors with verb-subject order, but also more errors of all kinds. There were more errors repeating the fragments and more miscellaneous errors (e.g., failure to produce a verb). Agreement errors even occurred in the match conditions for the verb-subject construction, meaning that speakers produced plural verbs in sentences with singular subjects and singular attractors, and singular verbs in sentences with plural subjects and plural attractors, where the potential for attraction was absent. In the subject-verb construction, in contrast, there were no errors at all in the match conditions. What these observations indicate is that the verb-subject construction was simply harder to deal with, for reasons unrelated to agreement.

What is the source of the difficulty? At least two specific problems with the verb-subject construction confronted the speakers. First, the verb-subject word order in the subordinate clause was probably harder to understand and harder to formulate agreement for than the canonical subject-verb constructions. The second problem lies in differences in the difficulty of the task for the two constructions. On the subject-verb trials, speakers had only to repeat a fragment in the order shown, in normal incremental fashion, and then append the correct form of an infinitive (which was presented after the fragment):

C'est les négociations que le ministre ___. [*suspendre*]

On the subject-verb trials, the presented materials were like:

C'est les négociations que ___ *le ministre.* [*suspendre*]

So, for the verb-subject trials, speakers had to repeat a part of the displayed fragment, interrupt the repetition to insert the verb form, and then continue on with the fragment. Intuitively, this is harder to do.

The upshot is that the experiment makes an unconvincing case for agreement mechanisms analogous to the formal operation of AGREE. There are simple alternative interpretations that do not require movement through stages of structural representations. (It should be noted that the first two experiments present other problems that put the conclusions in question and raise more general concerns about the results. The strong reversed asymmetry between singular and plural attraction in Experiment 1 is perplexing and needs to be replicated; in Experiment 2, disparate plural forms served as attractors, either clitic pronouns or full noun phrases, which have many differences other than plurality. Subsequent experiments by Franck et al. 2010 leave these concerns unaddressed and raise other misgivings.)

Regardless of the empirical shortcomings, what is notable about the experiments (as well as the interpretations and the perspective behind them) is that they take seriously the relevance of formal grammatical theory to explanations of the psycholinguistic mechanisms of agreement production. The approach offers a more explicit account of the linguistic details of agreement than other processing theories. In doing so, it complements den Dikken's (2000, 2001) arguments for the relevance of phenomena in agreement production (such as attraction) to formal grammar, and takes a significant step toward developing a specific area of research that can be profitably addressed from the theoretical perspectives of both linguistics and psycholinguistics. In work on language production, virtually nothing of this kind has been attempted since the quickly abandoned effort by Miller (1962) to cast the earliest versions of transformational grammar into an account of language performance (see Miller and McKean 1964, for an illustrative experiment on sentence production).

The problems inherent in this revived approach are nonetheless very similar to those that dogged Miller's efforts. Against a processing architecture in which complete structures are derived through movements that originate at the ends of sentences, or call on the phonological forms of words that are destined for the ends of sentences (Franck et al. 2010), there are barriers that include (a) the need to formulate utterances in real time; (b) the incremental nature of language production; (c) the unrelenting necessity of implementing agreement; and (d) the rates at which agreement can be realized. Even in laboratory tasks, number agreement can be completed in under 500 ms, an interval that also includes decision and motor response latencies as task overhead (Staub 2009).

Other reservations come from arguments and evidence that call into question a role for movement and traces of movement in language production (Bock and Loebell 1990; Bock et al. 1992; Pickering and Barry 1991; Staub 2009), though there remain intuitively persuasive observations that tend to favor their existence. One such observation is the blocking of *wanna*-contraction. Ferreira and Engelhardt (2006) called on related examples to discuss the phenomenon in the context of language production, observing that the full-vowel, citation form of *to* seems more likely in *They heard who he bequeathed the money* ***to*** *Thursday* than in *They heard that he postponed the meeting* ***to*** *Thursday*. The difference can be explained in terms of the presence of a structural trace of the object *who* after the *to* in the first sentence; in the second sentence, the object of *to* is overtly expressed. At the same time, Ferreira and Engelhardt comment on the lack of empirical evidence. Indeed, in an analysis of the Switchboard corpus of spoken English, Boas (2004) found instances of *wanna* before supposed traces, and suggested that the relevant conditioning factor is the formality of speech.

Returning to the Franck et al. account, there is another shortcoming that stems from the absence of direct accommodations for number meaning. Although the functional features relevant to agreement may flag the appropriate agreement values, no consideration is given to where the features come from or what they code. The upshot is that the Production Syntax view does not grapple with the role of factors such as distributivity or integration in number agreement, or with interactions between meaning features and grammatical features of number, or with the differences and similarities between verbs and pronouns in the role of number meaning in agreement and attraction.

The bottom line is that a Production Syntax perspective is attractive in offering an integration of linguistic theory with the psycholinguistics of sentence production, but it faces significant challenges. One is the need to firm up its empirical foundation. Beyond that, it lacks viable explanations for how production can proceed within the time constraints on normal speaking, how number meaning creates number features (and the meanings behind other functional features), and how notional and lexical sources of number information combine during the formulation of agreement.

8.4 Memory retrieval

The last account of agreement production that we review involves memory retrieval. Memory retrieval approaches concentrate on the agreement mechanism itself, setting aside the notional and featural questions addressed in the Marking and Morphing account. What is at issue is how the verb (more generally, the agreement target) gets its agreement features. In Marking and Morphing, the mechanism is analogous to copying, which could be driven in either a "forward" (from the subject to the verb, with the subject looking to spawn features) or "backward" direction (from the verb to the subject, with the verb looking for missing features). Memory retrieval accounts embrace the backward option, in which verbs look for features in a controller. The backward retrieval process could be set in motion for purposes of copying or for purposes of verification, which in turn correspond to control mechanisms (in which the verb lacks features) or constraint mechanisms (in which the verb gets an initial set of features, presumably from the message).

As currently formulated, memory retrieval accounts of agreement appear to adopt a version of the control option (i.e., copying), in which verbs search for their features in the subject noun phrase. Badecker and Kuminiak (2007) tested such an account in Slovak, capitalizing on its three genders (masculine, feminine, and neuter). In Slovak, gender agreement with subjects is expressed on first-person past-tense verbs and exhibits a markedness hierarchy in which feminine is the most marked and neuter the least, with masculine falling in between. The question addressed was whether these markedness rankings predicted asymmetries in attraction, such that feminine local nouns would be more likely to attract agreement than masculine, masculine more than neuter, and feminine more than neuter. Using a variant of the sentence fragment completion paradigm, Badecker and Kuminiak found evidence in favor of all three hypotheses. The implication is that attraction can arise in a system in which there are no default states (unlike the singular default in the singular/plural system), casting doubt on the mechanisms of spreading activation and percolation in other models (Eberhard et al. 2005; Franck et al. 2002; Vigliocco and Nicol 1998). The latter accounts rely on the absence of functional features on the subject noun phrase for those cases when agreement takes the singular as a nonspecified, default option. This is less plausible in a three-valued ranked system. Instead, the results lend support to mechanisms like memory retrieval, in which verbs seek the features of a controller and are drawn to more marked features.

Memory Retrieval proffers a familiar cognitive mechanism to explain how feature copying works in production, and how things go wrong when they do. It accounts for the agreement and attraction asymmetries that are ubiquitous in observations of

number agreement in terms of an independently motivated markedness hierarchy. It also provides a more explicit mechanism for what Marking and Morphing glosses as a copy operation. In doing away with percolation, it replaces a process that many cognitive psychologists regard as implausible with one that is compatible with current views of how memory works (McElree 2006). Not least, in calling on memory retrieval, the view fits comfortably with common-sense views of agreement production.

In short, a mechanism of memory retrieval could make a powerful and persuasive contribution to an account of agreement (in both comprehension and production; see Wagers et al. 2009). But like other approaches, it has its weaknesses and omissions. One of them is the absence of an explicit way to deal with the role that meaning plays in agreement. There is no obvious explanation of how modulations due to notional number (Humphreys and Bock 2005) or biological gender (Vigliocco and Franck 2001) arise: The increased incidence of plural agreement when distributive construals are possible has no straightforward treatment in terms of retrieval operations. Relatedly, reliance on retrieval mechanisms skirts the similarities and differences between verb and pronoun agreement. Lastly, some kinds of structural effects (like those reported by Bock and Cutting 1992 and Franck et al. 2002) are hard to handle in terms of memory retrieval alone.

An empirical limitation is that the account has so far been applied and tested only for gender agreement, using a paradigm that puts a premium on working memory. In Badecker and Kuminiak's (2007) experiments, speakers were required to perform a working memory task in conjunction with fragment completion. (Speakers heard a "fake acronym" to maintain in memory while receiving and completing the preamble. Afterwards, they recalled the acronym if possible.) Such memory tasks increase the rate of agreement errors (Fayol et al. 1994), which is otherwise negligible for gender agreement, but may artifactually increase reliance on memory.

For now, though, there is no good reason to think that the basic mechanisms of gender and number agreement differ. The Marking and Morphing and Memory Retrieval approaches both offer ways to explain gender and number agreement within a uniform framework, a state of affairs which demands competitive testing of the views across the domains and situations to which they have been applied.

8.5 How the theories stack up

There are several notable dimensions of similarity and difference among the five psycholinguistic accounts of agreement that are currently in play. The dimensions we consider here are the mechanisms of agreement (how features come to agree), the mechanisms of meaning infiltration, and the range of agreement systems addressed.

Regarding agreement mechanisms, four of the five accounts embrace a control process in which the number of an agreement controller determines the number of an agreement target. Only Constraint theories demur, embracing views in which features of agreeing elements can be formulated in parallel.

Among the control views, however, the mechanisms of control differ. The Marking and Morphing, and Semantic Integration models assume a direct copying operation in which verbs and other targets acquire subject features. Production Syntax also

incorporates a feature-copying operation, but the copying is indirect, via a functional node (AgrS) that mediates the transfer of subject features to a verb. With Memory Retrieval, verbs directly retrieve their features from subjects; subjects do not transmit their features to verbs (as the notion of copying may imply) and feature retrieval is direct rather than mediated by constructs like AgrS. Thus far, there is no evidence to discriminate among these proposals about control.

Another dimension of contrast is how (and even whether) the meanings correlated with agreement features affect their values. Three of the theories specifically address the question in terms of the mechanisms that guide feature selection under influence from meaning information. In the most detailed Constraint approaches, meaning matters to the selection of agreement morphology, with meaningful conceptual categorizations driving the retrieval of (for example) subject and verb morphology. In Marking and Morphing, meaning matters to subject-verb agreement only in the selection of features for the subject noun phrase. Verbs are agnostic with respect to the number information that they come to carry in their inflectional morphology. These views have been competitively evaluated, as reviewed earlier, with results that favor a Marking and Morphing type of account. In Semantic Integration, the impact of meaning is mediated by differences in the rates at which referentially related and unrelated notions are linked: better (and thus speedier) integration translates into a greater likelihood of agreement errors like attraction. However, the details of the transition from integration to agreement remain to be worked out.

Of the plethora of agreement systems within and between languages, only a miniscule fraction have been considered in any of the accounts. There have been a few efforts at cross-linguistic validation for Constraint and for Marking and Morphing, but the other two views have been tested only in single languages. The evidence for Memory Retrieval comes from Slovak, and the evidence for Production Syntax comes from French (the experiments reported by Franck et al. 2006 were done on both Italian and French, but only French was used in the critical Experiment 3).

Likewise, there has been comparatively little exploration of the commonalities and differences in how agreement features operate psycholinguistically. In some cases, the grounds for comparison are absent, at least for the time being: Nevins (2011) mentions that for person features, the mainstay psycholinguistic phenomenon of attraction simply does not exist. Apart from number, then, gender is the only feature that has received any sustained attention. Unsurprisingly, all of this work has been done in languages other than English, due to the absence from English of grammatical gender. The results align well with the findings for number. Badecker and Kuminiak (2007) observed grammatical gender attraction and attraction asymmetries in Slovak similar to those for number in other languages, with the twist of Slovak's three-valued gender system. Vigliocco and Franck (1999, 2001) observed gender attraction in French and Italian, although the attraction asymmetries were less prominent than for number.

Other research compares natural and grammatical gender to assess whether notional gender (like notional number) affects agreement. Deutsch and Dank (2009) found effects of natural and grammatical gender in Hebrew that parallel the results obtained for number, with natural gender boosting the power of grammatical gender for heads (as in Vigliocco and Franck's 1999, 2001 results from French and Italian) but not for attractors (replicating findings for French in Vigliocco and Franck 1999;

Experiment 2). Deutsch and Dank (2009) also obtained a good mathematical fit between their gender data and the Marking and Morphing model, which was originally developed on the basis of results for number agreement.

Comparisons between gender and number attraction are important for examining whether gender and number features work together or independently in the course of agreement implementation (a question linked to linguistic debates about the representation of number and gender features; cf. Picallo 1991; Ritter 1993). Standing solidly in the way of answering this question is the rarity of gender agreement errors: The rates of gender attraction are vanishingly low unless interference manipulations are added to the agreement task (Badecker and Kuminiak 2007). The only exception is reported by Antón-Méndez et al. (2002). Their findings suggested that number and gender are independently manipulated, in interesting contrast to the results for two types of number agreement (subject-verb and predicate-adjective), which patterned together. Given the importance of this question, it would be valuable to carry out these comparisons in other languages wherever possible.

The general difference between gender and number agreement in the rate of attraction remains to be explained. Within and across studies, gender attraction is almost always weaker than number attraction. There are at least two obvious culprits. Gender is often a lexical specification only, without direct support from gender meaning. As a result, gender comes into play relatively late in the process of sentence formulation, leaving little time for the interplay of features that may be essential for attraction to occur (see Dell 1986, who demonstrates the effect of temporal variables on interactions for other kinds of speech errors). Alternatively, the natural correlation between grammatical gender and morphological specification may reduce the rates of gender attraction: when information about gender is carried by a head as well as by a local noun phrase, in order for attraction to arise the local gender must displace the head's gender. Since the specifications of heads have more power to control agreement features (for reasons explained earlier), local specifications are less likely to displace head specifications than they are to replace default values. So, it is comparatively easy for a plural local to take over agreement when the head is singular by default, but hard for a masculine local to take over agreement from a feminine head, when both the head and the attractor carry gender specifications.

Despite their differences, there are ways in which alternative approaches to agreement are more complementary than conflicting. Assuming a rough decomposition of agreement into processes involved with meaning, with structure and lexicalization, and with feature sharing, each approach offers a slightly more detailed perspective than others on some components of agreement. Marking and Morphing suggests that the transition from notional to grammatical number occurs in the assignment of syntactic features that capture basic dimensions of number meaning from messages. Semantic Integration proposes an additional process that affects the transition from messages to structural representations, a process in which variations in referential coherence may lead to variations in agreement. Construed as a force within the process by which syntactic features come to be assigned, Semantic Integration enriches the account of the interface between messages and syntax. Constraint-based theories posit possible interactions among the components of agreement that may color agreement outcomes, and indeed offered the first evidence for meaning-based effects

on agreement (Vigliocco et al. 1995). Production Syntax and Memory Retrieval both address the nature of the process by which agreement features come to be shared between controllers and targets, proposing contrasting accounts of how agreement is implemented within structural representations. On the surface, the Production Syntax and Retrieval accounts are quite different, but the development of a plausible processing implementation could render the details of Production Syntax into an explanation of the processes by which agreement targets retrieve the features of their controllers.

The only unambiguous clash arises in a difference among the theories in the nature of the agreement control process, and whether it is symmetric or asymmetric (den Dikken 2003). Whereas Constraint arguments emphasize the parallel (i.e., symmetric) assignment of agreement features to constituents that stand in agreement relationships, the other views endorse control processes in which one element in a representation determines the features of another. This, then, is a key question in the debate.

9 Conclusion

The processes of grammatical agreement have become an important topic for psycholinguistic research. From the standpoint of theories of language production, the importance of agreement is clear. There are few domains in language where the bridges that link meaning, structure, morphology, and phonology are as heavily trafficked or as tractable to experimental investigation. As a consequence, all of these linkages have received attention in the psycholinguistic literature, yielding an unusually well documented (but still far from fully understood) area of language use.

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