Pronoun Production: Word or World Knowledge?*

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Number agreement and grammatical gender agreement are susceptible to *attraction*, where characteristics of other sentence elements lead to agreement errors. Previous evidence and theories suggest that attraction happens as a syntactic or lexical process (i.e., involving *word-knowledge*), rather than as a conceptual process (i.e., involving *world-knowledge*). The current paper presents data on a different type of agreement: agreement in *notional/conceptual* gender between genitive pronouns and their antecedents. We find that conceptual gender agreement is also susceptible to attraction, but unlike number or grammatical gender agreement, this attraction happens as a conceptual process, not a syntactic/lexical process.

1. Introduction

An important part of sentence production is the process of *agreement*. In the general case, agreement happens when the form of one word (the *target*) changes due to its relationship to another word (the *controller*). One function of agreement is to help tie together linguistic elements that are related in nonlinguistic thought (Bock 1995). Lying at the interface between meaning and syntax in this way, the processing mechanisms that underlie agreement are the subject of active investigation and debate. Though some evidence suggests that agreement production is primarily a syntactic process, other evidence suggests that conceptual or notional representations play an important role (for recent reviews, see Eberhard, Cutting and Bock 2005, and Vigliocco and Hartsuiker 2002). The present paper aims to further muddy the waters by investigating a type of agreement that has received little previous experimental attention: notional gender agreement (also called conceptual or biological gender agreement) on genitive pronouns.

The role of grammatical and notional properties in the production of agreement is related to a broader distinction between the grammatical and notional properties of language, sometimes called the difference between *word-*

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knowledge and *world-knowledge*. Word-knowledge consists of the relatively immutable meanings of words (and the relationships between words)—the core meaning that a word (hypothetically) brings with it from situation to situation. Because this core meaning is immutable in this fashion, it is a likely candidate to be directly encoded into the linguistic system at some level of semantics. In contrast, world-knowledge is the additional situation-specific information that contributes to meaning. Because such situation-specific meaning is typically inferred from world conditions rather than being part of a word's immutable meaning, it is a likely candidate to lie outside the sentence itself, and could be characterized as including discourse and pragmatic factors, general knowledge about the world, and so forth. There is reason to think of these types of knowledge as separable components of both language production (Levelt 1989) and comprehension (Clark and Clark 1977).

Of course, these types of knowledge might not be entirely distinct, given evidence that comprehension makes use of both word- and world-knowledge at the same time, and in equivalent ways (e.g., Hagoort, Hald, Bastiaansen and Petersson 2004). Nevertheless, an important question in the study of agreement processes has been how word-knowledge (usually referred to as *syntactic* or *lexical* information) and world-knowledge (usually referred to as *notional* or *conceptual* information) influence agreement.

1.1 Attraction errors in agreement

Many psycholinguistic investigations of agreement have relied on speakers' agreement errors, and one of the most common ways to induce errors in agreement is through *attraction* (Bock and Miller 1991). Attraction happens when an element agrees not with its intended controller, but with some other nearby element that suggests a different form. For example, a speaker might accidentally choose plural agreement for the verb in a sentence like (1) because the intervening plural noun *games* attracted the error.

(1) The time for fun and games *are* over. (Bock and Miller 1991)

This general principle of attraction has been used to investigate number agreement (between both subjects and verbs and subjects and pronouns; e.g., Bock 1995), grammatical gender agreement (e.g., Vigliocco and Franck 2001), and agreement between determiners and nouns (e.g., Alario and Caramazza 2002).

Early work on attraction of agreement errors suggested that agreement processes are unaffected by semantic or notional information. For example, Bock and Miller (1991) used a sentence completion task to compare errors in number agreement following preambles with and without possible *distributive* readings. If conceptual information is relevant to agreement processes, one might expect more number agreement errors in sentences like *The label on the bottles <u>are</u>*, where there are conceptually several labels (one on each bottle) than after preambles like *The baby on the blankets <u>are</u>*, where there is only one baby, both conceptually and syntactically. Bock and Miller (1991) found error rates in these conditions were equal, suggesting that notional plurality does not affect agreement processes.

However, it turns out that distributivity does affect number agreement in languages other than English (e.g., Vigliocco, Butterworth and Garrett 1996), and sometimes even in English (Eberhard 1999). Notional involvement has also been found in processes of grammatical gender agreement. In a series of experiments, Vigliocco and Franck (1999, 2001) investigated grammatical gender agreement in Italian and French by varying the congruence of notional and grammatical gender. They found that errors were least likely in cases where the controller had congruent notional and grammatical gender (e.g., in Italian, *la ragazza* 'the girl-FEM'), relatively more likely in cases where the controller had no notional gender (e.g., *la panchina* 'the bench-FEM'; Vigliocco and Franck 1999), and most likely in cases where notional and grammatical gender of the controller were incongruent (e.g., *la vittima* 'the victim-FEM' referring to a male victim; Vigliocco and Franck 2001).

This evidence suggests that world-knowledge (i.e., notional or conceptual properties) exerts some effect on the syntactic processes of subject-verb number agreement and grammatical gender agreement. One might expect world-knowledge to exert a greater effect on types of agreement that mark *semantic* relationships between elements rather than syntactic relationships; one such example might be pronoun number agreement.[1] Bock, Nicol and Cutting (1999) compared verb and pronoun number agreement with controllers that were notionally ambiguous with respect to number (collective nouns such as *fleet*, which are usually grammatically singular in American English) and found that pronouns are more likely to agree with notional number than are verbs. That is, speakers were more likely to say sentences like *The fleet with the distinctive flag surrendered, didn't <u>they</u>?* than sentences like *The fleet with the distinctive flag <u>were</u> in port*. Based on this finding, Bock et al. (1999) suggested that number agreement is controlled by notional number for pronouns, but by grammatical number for verbs.

However, there are also striking similarities between verb and pronoun number agreement (Bock, Eberhard and Cutting 2004). Particularly relevant to the present paper, although notional number of the *controller* affects pronoun agreement, Bock et al. (2004) found that notional *attraction* is nonexistent for pronouns as well as for verbs. That is, number agreement errors on pronouns (e.g., *The condition of the ship/ships/fleet worsened, didn't <u>they</u>?*) and on verbs (e.g., *The condition of the ship/ships/fleet <u>were</u> terrible*) were relatively common when the attractor was grammatically plural (*ships*), but were equally unlikely with notionally plural (*fleet*) and notionally singular (*ship*) attractors. This finding holds for grammatical gender too, in that the notional gender of attracting local nouns does not affect agreement errors, but the grammatical gender of attracting nouns does (Vigliocco and Franck 1999).

[1] What we here call "pronoun number agreement" is, more precisely, *concord* between a pronoun and its antecedent; i.e., is due to a coreference relationship rather than to syntactic control. Following Bock and colleagues (e.g., Eberhard et al. 2005) we use *agreement* to refer to both types of relationships.

1.2 Marking and morphing

Gathering all this evidence (and more), Bock and colleagues (Bock, Eberhard, Cutting, Meyer and Schriefers 2001; Eberhard, Cutting and Bock 2005) proposed a theory of number agreement that unifies verb and pronoun agreement processes. In this model, agreement is claimed to result from two processes: *marking*, which essentially corresponds to notional agreement, and *morphing*, which essentially corresponds to grammatical agreement. Under this model, verb number agreement arises through syntactic processes, whereas pronoun number is inherent in the pronoun's lexical entry. This explains why pronouns are more susceptible to notional influences than are verbs.

Importantly for the present discussion, attraction happens during the morphing process. This might seem to suggest that pronouns should not be vulnerable to attraction, since agreement information for pronouns is assigned during the marking stage. However, the marking and morphing theory proposes that the morphing process also reconciles the number of a pronoun with the grammatical number of its antecedent (so long as that antecedent is sufficiently accessible). Because attraction happens during morphing, it is expected that notional information from an attractor does not influence agreement—during the morphing process, notional information is irrelevant.

1.3 Errors in notional gender agreement

One type of agreement production that has not been directly investigated is *notional* gender agreement (also called *conceptual* or *biological* gender agreement). An example of this is that genitive pronouns in English (e.g., *his*/*her*) must agree in gender with their antecedent. Importantly, the agreement of these pronouns with their controller relies on a conceptual relationship rather than a grammatical one. Might this type of agreement also be susceptible to attraction processes, leading speakers to erroneously produce sentences with genitive pronouns that do not correctly agree with their antecedent, as in (2)?

(2) Bob$_i$ shipped a gift to *her*$_i$ sister.

If such errors are influenced by attraction, are they based entirely on the fact that the attractor (here, *sister*) is conceptually feminine, or are they based on the feminine information carried by the word itself? According to the marking and morphing model of number agreement (Bock et al. 2001; Eberhard et al. 2005), attraction occurs during grammatical processes (i.e., during morphing). This suggests that only the lexical/syntactic (word-knowledge) information of an attracting local noun is relevant to number agreement. Extending this model to notional gender agreement predicts that one should only see attraction to nouns like *sister*, and not to nouns that are conceptually, but not lexically, female (e.g., *cousin* who happens to be female).

On the other hand, the choice between *his* and *her* is, at least intuitively, based on the notional/conceptual gender of *Bob*, not on some syntactic property of *Bob*. Because of this, notional gender agreement might be equally susceptible to attraction from any entity of conflicting notional gender, even if the word used to refer to that entity does not include gender information. That is, Bob's female cousin might attract errors as well as Bob's sister.

The current paper addresses these two issues. Section 2 presents an experiment designed to determine if conceptual gender agreement processes are susceptible to attraction from other elements in the sentence. Section 3 compares these attraction errors, if they actually occur (as we valiantly try to keep the reader in suspense), when attractors represent gender both in word- and world-knowledge (e.g., *sister*) versus when attractors represent gender only in world-knowledge (e.g., *cousin*).

2. Does notional gender attract notional agreement errors?

Though attraction has been used to elicit errors in number agreement and in grammatical gender agreement, no work has addressed error production in notional gender agreement. To address this issue, we conducted two experiments[2] using attraction to elicit errors in notional gender agreement. Speakers described dative-eliciting pictures in which the subject and direct object matched or mismatched in gender, resulting in sentences like (3):

(3) Victoria/Victor carried a package to his/her granddaughter.

The initial goal of the experiments was simply to determine if the gender of the indirect object noun could attract gender agreement errors, leading to more errors like *Victor carried a package to <u>her</u> granddaughter* than errors like *Victoria carried a package to <u>his</u> granddaughter*.

2.1 Methods

Twenty-four dative-eliciting pictures were created in which the subject had a stereotypically male or female name, and the goal argument (i.e., the indirect object) was labeled with a term suggesting a relationship to the subject (most often a familial relationship, e.g., *daughter*) to encourage the production of the genitive pronouns *his* or *her*. Examples of the stimuli are presented in Figure 1.

Just over half of the pictures had goal arguments with "intrinsic" semantic gender (e.g., *daughter* and *son*; see Figures 1a and 1b). That is, for these items the gender of the (potential) attractor was part of both world and word knowledge. In the remaining pictures, the gender of the goal argument was not part of word knowledge, but only of world knowledge (e.g., *cousin* paired with a stick figure wearing a skirt; see Figures 1c and 1d). The comparison of attraction errors to these different types of goal arguments will be discussed in Section 3.

[2] Because the difference between these experiments is not relevant to the present discussion, and because the experiments used essentially the same items, only combined data from both experiments are presented here.

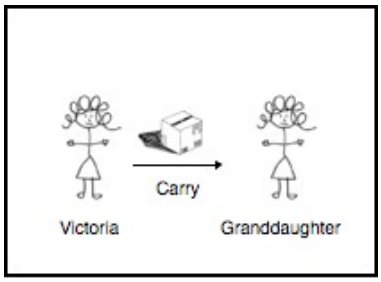

Figure 1a

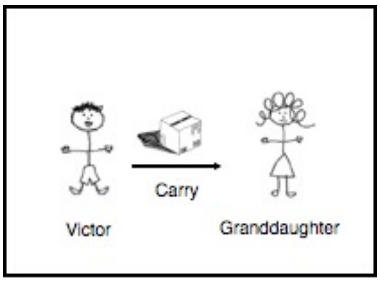

Figure 1b

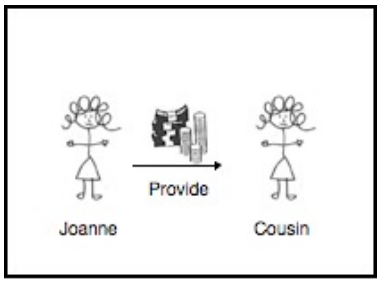

Figure 1c

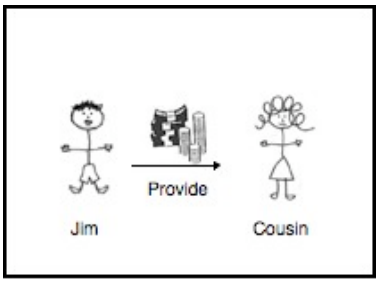

Figure 1d

Figure 1
Examples of the stimuli in the matching (1a and 1c) and mismatching (1b and 1d) condition
(Goal arguments had either lexically intrinsic (1a and 1b) or non-intrinsic (1c and 1d) gender.)

Speakers (82 in total) were instructed to say a sentence describing what was depicted in each picture, using the names and the verb provided, as quickly as possible. Each picture appeared after a brief (500 ms) fixation cross. To make the task more difficult, and thus to encourage the production of errors, the pictures disappeared at the onset of speakers' sentences. Speakers were allowed 2.5 seconds to complete their sentence, at which point the next fixation cross appeared. The matching and mismatching conditions were counterbalanced across both speakers and items, and each speaker saw all 24 items three times each, in separate blocks (and so provided 72 total sentences). Speakers' descriptions were recorded for later transcription and coding.

2.2 Attraction of conceptual gender agreement errors

Trials where speakers did not produce a dative sentence, did not produce a genitive pronoun, or where it was unclear which pronoun was produced were excluded from analysis; this led to the exclusion of 14% of all trials. For the re-

maining data, the proportion of gender agreement errors for each speaker was calculated in each condition.[3]

Speakers were three times more likely to produce agreement errors when the gender of the subject and indirect object mismatched (5.1% errors like *Victor… her sister*) than when the genders matched (1.7% errors like *Victoria… his sister*), as can be seen in Figure 2. This difference was supported by statistical tests, showing that the 3.4% difference was significant by both subjects and items ($F_1(1, 80) = 10.41$, CI = ±2.7%; $F_2(1, 22) = 8.34$, CI = ±4.3%).

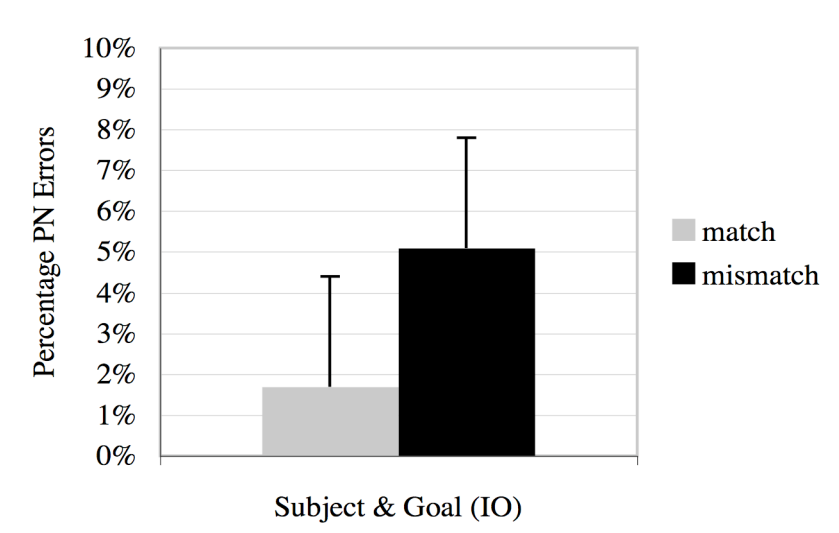

Figure 2
Errors in pronoun gender agreement in sentences with matching and mismatching genders of subject and goal arguments
(Error bars indicate the 95% confidence interval.)

These data show that notional gender agreement, like other sorts of agreement, is susceptible to attraction from other elements. Now that this type of error has been demonstrated experimentally, we can ask if this attraction is happening at the level of word-knowledge or world-knowledge.

3. Notional gender agreement: Word- or world-knowledge?

The experiment described above found that agreement between a genitive pronoun and its controller is influenced by other elements in the sentence, just as has been found with number and grammatical gender agreement. An interesting question is whether this effect was driven entirely by attraction to nouns where gender is specified both lexically and conceptually (e.g., *sister*), as might be

[3] Because proportions are not normally distributed, analyses were also conducted on arcsine-transformed proportions. Analyses conducted on arcsine-transformed proportions were similar to those conducted on raw proportions, so for readability only analyses conducted on raw proportions are reported and proportions are reported as percentages.

predicted from the marking and morphing account of number agreement (Bock et al. 2001; Eberhard et al. 2005).

As mentioned above, many of the items in these experiments (14/24) had goal arguments like *sister*, which potentially represent femaleness in both world- and word-knowledge. However, the other 10 items were male or female only in terms of world-knowledge (e.g., *cousin*)—the gender associated with these arguments came only from the associated stick figure having either a moustache or a skirt (see Figures 1c and 1d). If the attraction process for notional gender agreement happens during the grammatical process of morphing (Bock et al. 2001; Eberhard et al. 2005), then gender agreement errors should be likely only when the attractor represents gender lexically (e.g., *sister*). On the other hand, if notional gender agreement occurs at a conceptual or world-knowledge level (as might be expected if pronouns are particularly susceptible to notional number, e.g. Bock et al. 1999), then errors should be equally likely when the controller and attractor differ in conceptual gender, irrespective of whether gender information is also represented lexically (i.e., *sister* and *cousin* [who happens to be female] should be equally good attractors).

The results are presented in Figure 3. As mentioned in Section 2, speakers were more likely to produce the incorrect genitive pronoun when the genders of the subject and indirect object mismatched than when they matched (see Figure 2). Importantly, this was equally true when the attractor's gender was part of both word- and world-knowledge (e.g., *daughter* with a skirt) and when the gender was not part of word-knowledge (e.g., *cousin* with a skirt). If anything, the difference between the matching and mismatching conditions was numerically larger for pictures with non-intrinsic gendered goals (a 4.2% difference) than for pictures with intrinsic gendered goals (a 2.6% difference), although the difference in the size of these differences was not statistically reliable ($F_1(1, 80) = 1.02$; CI = ±2.8%; $F_2(1, 22) = 2.05$, CI = ±8.8%).[4]

[4] It is possible that, just as English has gender-distinct terms for most kinship relations (like *sister*), it also represents *male-cousin* and *female-cousin* with separate lexical entries that happen to sound exactly the same. This may not be a concern for the present set of stimuli because most of the items with non-intrinsic gender (8 of 10) were not kinship terms, but were words like *neighbor* and *client*, which seem less likely to have separate lexical representations for each gender. Note also that within the non-intrinsic gender condition, the attraction effect was of similar size for the two kinship terms (4.3%) as it was for the eight non-kinship terms (4.2%).

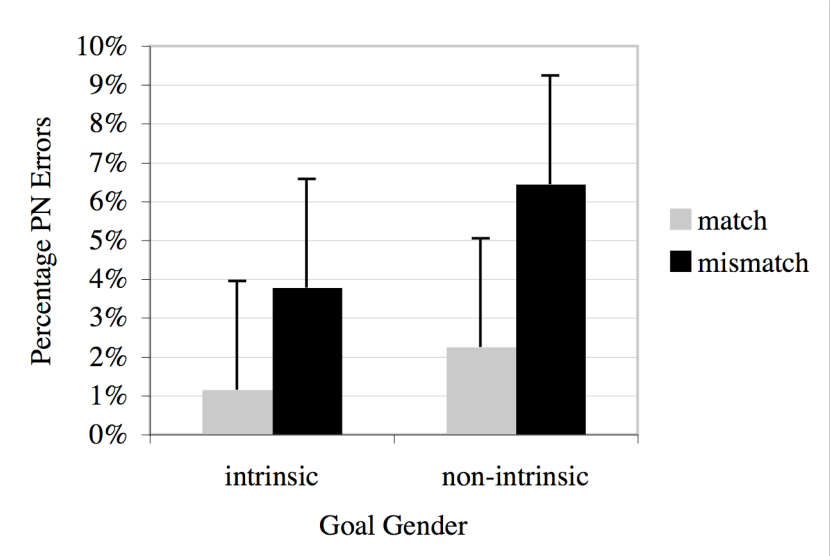

Figure 3
Errors in pronoun gender agreement in sentences with matching and mismatching genders of subject and goal arguments, for goal arguments with intrinsic gender (e.g., *sister*) and non-intrinsic gender (e.g., *cousin*)
(Error bars indicate the 95% confidence interval of the (*ns*) interaction.)

4. General discussion

The data reported here show that the phenomenon of attraction (Bock and Miller 1991), which has been used to investigate number and grammatical gender agreement, can also be used to investigate notional/conceptual gender agreement such as that between genitive pronouns (*his*/*her*) and their antecedents. In these experiments, speakers were more likely to produce the wrong genitive pronoun when the pronoun's antecedent and another element in the sentence (specifically, the noun in the indirect object) were of opposite genders, presumably because the gender of the indirect object attracted the error. Surprisingly, this was true both for attractors that represent gender information intrinsically (i.e., as part of word-knowledge) like *sister*, and for attractors that had only notional gender such as *cousin*.

This pattern is unexpected in light of data from studies of number agreement and of grammatical gender agreement showing that only lexical (i.e., syntactic) characteristics, and not notional characteristics, of attractors attract errors. That this is not true of attraction in notional gender agreement may be problematic for the marking-and-morphing account of agreement (Bock et al. 2001; Eberhard et al. 2005), as it claims that attraction errors occur during the syntactically based morphing stage. These data show that attraction errors in notional gender agreement are not syntactically based, suggesting that notional gender agreement in English is not a syntactic process.

The possibility that gender agreement in English happens notionally is, perhaps, a surprising claim as there are good reasons to think that pronoun agreement *is* a syntactic process. After all, the distribution of English pronouns is constrained syntactically in other ways (e.g., as reflected in the binding principles; Chomsky 1981), and pronouns agree in gender syntactically in other languages. Furthermore, errors in notional pronoun gender agreement (e.g., *The aunt*$_i$ *heard that he*$_i$ *had won the lottery*) elicit electrophysiological responses characteristic of syntactic processing in English comprehension. That is, such sentences elicit a P600 waveform—typically found in response to syntactic violations—when compared to *The aunt*$_i$ *heard that she*$_i$ *had won the lottery*, suggesting that the comprehension process treats this like a syntactic error (Osterhout and Mobley 1995).[5]

Despite these reasons to think that notional gender agreement could be a syntactic process, this appears to not be the case. This may imply that, in English, gender may not be a grammatical property of words at all. Given that number representation in many languages (including English) is grammatical, and gender representation in a wide range of languages is grammatical (Corbett 1991), why might it be that gender representation in English is not grammatical? One explanation begins by considering number in English, which maps meaning to form only quasi-systematically; though notionally singular entities (e.g., one domestic feline) are usually also grammatically singular (*cat*), and notionally plural entities (e.g., multiple domestic felines) are usually also grammatically plural (*cats*), there are exceptions. For example, a type of clothing worn on the lower half of the body, though grammatically plural (*pants*), is nonetheless conceived of as notionally singular (Bock et al. 2001). Similarly, gender in languages with grammatical gender systems (like Italian) is also only quasi-systematic. In contrast, gender in English may be perfectly systematic, at least for most speakers of the language. All things female are referred to with female pronouns and all things male are referred to with male pronouns. For the most part, the reverse mapping is equally systematic, in that all female pronouns refer to female entities and all male pronouns refer to male entities. The only possible exception to this is the infrequent (and at least to some, affected) tendency to refer to entities such as ships and countries with pronouns ("Ah, she's a fine ship"), but it is unclear how widespread such usage is, if it is a consciously unusual practice, and whether the convention actually reflects thinking of the notional entities (ships, countries) as possessing the attributed gender (consider the term *motherland*). So, the interesting possibility is that whereas quasi-systematic (or unsystematic) meaning-to-form correspondences become grammaticized, highly systematic meaning-to-form correspondences resist becoming part of a langauge's grammar.

This observation might explain an intriguing mystery concerning language representation generally. Specifically, why do grammatical systems tolerate quasi-systematic mappings at all? Given that linguistic devices, though at

[5] Although Osterhout and Mobley's (1995) finding might seem to contradict the claims presented here, it is worth noting that the electrophysiological syntactic effect they observe probably does not reflect agreement processes per se, but rather reflects an attempt to make sense of the error (i.e., an attempt to find a reasonable antecedent for the pronoun; Kaan, Harris, Gibson and Holcomb 2000).

least partially arbitrary in their form, serve the function of conveying features of meaning, why do the grammars of languages not more strictly enforce systematic mappings between meaning and form (e.g., why does English tolerate *pants* as a plural)? In part, the answer may be that exceptions to a meaning-to-form mapping enable the representations that underlie that mapping to become grammaticized. Specifically, it may be that exceptionless mappings resist being grammaticized through a phenomenon akin to *blocking* in the psychological literature (Kamin 1969), such that if one kind of representation (i.e., a conceptual one) can accurately underlie performance, another kind of representation (i.e., a grammatical one) is difficult or impossible to acquire. By introducing some critical number of exceptions, production mechanisms can (and indeed, probably must for accurate performance) split off a separate, meaning-independent representational system, the operation of which will exist for linguistic processing specifically. This "splitting off" for linguistic purposes can be naturally seen as a process (either synchronically or diachronically) of grammaticization.

Of course, this analysis begs a question: Why should a system aim to grammaticize features at all, if ungrammaticized conceptual features could have done the job, and have also maintained easier-to-understand meaning-to-form correspondences to boot? Here, the answer may come from the framework proposed by Bock (1982). In essence, representations that are grammaticized (or *syntactic*, in Bock 1982) can be processed more automatically than representations that are conceptual (see Bock 1982, for the full argument). And so the reason that linguistic systems may tolerate quasi-systematic mappings is that such mappings come with an important benefit: more automatic (i.e., easier) processing of the representations that underlie the use of the grammaticized linguistic form. Supporting this claim, grammatical gender systems with a strict form-to-meaning mapping are typologically quite rare (Corbett 1991), suggesting that grammaticized features are beneficial.

Of course, another (far less interesting) explanation for our experimental observations is that English words like *sister* may not be grammatically female in the first place, even if English does represent gender syntactically in other cases (e.g., on pronouns). This still leaves us with the surprising observation that purely notional information can attract agreement errors, though it is possible that words that do carry grammatical gender would exert a stronger effect. This could be tested by comparing attraction to gender-marked pronouns (e.g., *her* in a sentence like (4)) to attraction to non-gender marked pronouns (e.g., *them* in a sentence like (5)). If our failure to find different attraction patterns to *sister* and *cousin* occurred because *sister* is not grammatically female, then we should see considerably more attraction errors in (4) than in (5). However, finding similar patterns of attraction errors in (4) and (5) would replicate the results reported here, further suggesting that notional gender agreement in English is a conceptual, not syntactic, process.

(4) Liane$_i$ needed cash, so John$_j$ gave *her*$_i$ his/her$_j$ ATM card.

(5) [Liane and Claire]$_i$ needed cash, so John$_j$ gave *them*$_i$ his/her$_j$ ATM card.

If the genitive-pronoun agreement explored above is indeed an entirely notional process, it may be explained by a model of pronoun production pro-

posed by Schmitt, Meyer and Levelt (1999). Essentially, Schmitt et al. claim that the production of a pronoun requires reactivation of its antecedent, and while this presumably happens at a lexical level of representation, it may also involve conceptual reactivation. If so, then because speakers must plan to produce upcoming words, the conceptual reactivation of the pronoun's antecedent in a sentence like (2) might be temporally close to the conceptual activation of the immediately following word. When the relevant conceptual properties of the antecedent (in (2), the notional gender of Bob) and of the immediately following concept (the notional gender of Bob's sister or Bob's cousin) are different, speakers might then be relatively more likely to erroneously select the gender feature from the upcoming argument in the selection of the genitive pronoun.

This account could be tested by directly comparing attraction errors in grammatical and notional agreement (perhaps by using words where grammatical and notional gender can be dissociated, e.g., the nouns used by Vigliocco and Franck (2001)), as this account predicts a double dissociation between the types of attractors that lead to grammatical and notional agreement errors. Specifically, elements lexically (but not notionally) incongruent with a controller should attract errors in grammatical gender agreement, whereas elements notionally (but not lexically) incongruent with a controller should attract notional gender agreement errors. This pattern of results would suggest that notional gender agreement is processed in a different way from grammatical gender agreement.

In sum, conceptual gender agreement is vulnerable to attraction from other elements with different genders, and this attraction occurs at a conceptual level. This suggests that, unlike the more syntactically circumscribed processes of number agreement and grammatical gender agreement (which may operate via the marking and morphing account of Bock et al. 2001 and Eberhard et al. 2005), conceptual gender agreement relies on world-knowledge, not word-knowledge.

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