

## Representations and Processes in the Production of Pronouns: Some Perspectives from Dutch

Antje S. Meyer

*Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands*

and

Kathryn Bock

*University of Illinois*

The production and interpretation of pronouns involves the identification of a mental referent and, in connected speech or text, a discourse antecedent. One of the few overt signals of the relationship between a pronoun and its antecedent is agreement in features such as number and grammatical gender. To examine how speakers create these signals, two experiments tested conceptual, lexical, and morphophonological accounts of pronoun production in Dutch. The experiments employed sentence completion and continuation tasks with materials containing noun phrases that conflicted or agreed in grammatical gender. The noun phrases served as the antecedents for demonstrative pronouns (in Experiment 1) and relative pronouns (in Experiment 2) that required gender marking. Gender errors were used to assess the nature of the processes that established the link between pronouns and antecedents. There were more gender errors when candidate antecedents conflicted in grammatical gender, counter to the predictions of a pure conceptual hypothesis. Gender marking on candidate antecedents did not change the magnitude of this interference effect, counter to the predictions of an overt-morphology hypothesis. Mirroring previous findings about pronoun comprehension, the results suggest that speakers of gender-marking languages call on specific linguistic information about antecedents in order to select pronouns and that the information consists of specifications of grammatical gender associated with the lemmas of words. © 1999 Academic Press

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Pronouns can be found in all languages of the world. In English and Dutch they are among the most commonly used words in print (Baayen, Piepenbrock, & van Rijn, 1993) and are probably even more frequent in speech. They are

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Address correspondence and reprint requests to Antje S. Meyer, Max Planck Institute for Psycholinguistics, Postbus 310, 6500 AH Nijmegen, The Netherlands (E-mail: [asmeyer@mpi.nl](mailto:asmeyer@mpi.nl)) or Kathryn Bock, Beckman Institute, University of Illinois, 405 N. Mathews, Urbana, IL 61801. E-mail: [kbock@s.psych.uiuc.edu](mailto:kbock@s.psych.uiuc.edu).

fundamental to both the structure and the function of language. They are nonetheless far from simple in their conditions of use, either linguistically or cognitively, in either comprehension or production. One testimonial to their cognitive complexity comes from language acquisition, where children's problems with pronouns may persist well past the point at which the use of common nouns is firmly established (Clark, 1978; Clark & Sengul, 1978).

For adult listeners, the challenges of interpreting pronouns have to do with identifying pronominal referents and antecedents from the minimal feature specifications that pronouns afford. In English, these features include little beyond number, natural gender, and animacy. Some languages add more features to the set, notably grammatical gender, but because the sparse meaning specifications of pronouns are

what sets them apart and gives them so much of their pragmatic value, they remain semantically impoverished.

For speakers, the cognitive challenges of pronouns are markedly different. Speakers know the referents of the personal pronouns they use, so they have no uncertainty about who or what the pronouns denote. Speakers are also the principal beneficiaries of the cognitive economics of pronouns. Relative to other words, pronouns are efficient: Being very frequent and very short, they are easily retrieved and easily articulated. The challenges they present to a speaker have much more to do with deciding when a pronoun can successfully be used to allow a particular listener at a particular place and time to pick out the referent that the speaker has in mind (Levelt, 1989). What remains once this hurdle is crossed is merely to select the appropriate pronoun from the lexicon.

Although pronoun selection is surely simple in comparison to what speakers must do to determine when a pronoun is felicitous, the specifics of the selection process are largely unexplored. These specifics are integral to theories of lexical encoding in language production and instructive for theories of pronoun interpretation in language comprehension. Accordingly, our focus in the present work was to develop and test alternative hypotheses about the processes of pronoun selection during language production. We begin with an overview of related work on the interpretation of pronouns before turning to the questions to be asked about their production.

#### THE COGNITIVE UNDERPINNINGS OF PRONOUN INTERPRETATION

One consistent finding about pronoun comprehension is that listeners and readers try to identify candidate antecedents when they encounter pronouns or other anaphoric expressions. In one of the first efforts to explore this process, Chang (1980) presented readers with sentences such as *John and Mary went to the grocery store and he bought a quart of milk* followed immediately by a probe word (e.g., *John*). The participants indicated as quickly as possible whether the probe word had occurred

in the sentence. Relative to control sentences for which the probe word *John* was not the antecedent of the pronoun in the second clause (e.g., *John and Mary went to the grocery store and she bought a quart of milk*), responses were faster when the probe represented the pronoun's antecedent. Subsequent work has shown that antecedent reactivation can follow promptly upon the occurrence of an anaphor (Dell, McKoon, & Ratcliff, 1983; McKoon, Gerrig, & Greene, 1996) without an intervening search or retrieval process.

Depending on the nature of the information that is reactivated in memory, facilitation of the response to a probe may be explained in different ways. The probe might make contact with a phonologically intact, verbatim trace of the antecedent referring expression, or with a more abstract lexical-semantic representation, or with a conceptual representation that incorporates features of the intended referent itself. For instance, in the sentence *After the psycholinguists sent their son to Princeton, they...* the occurrence of the pronoun *they* might prompt the reactivation of a morphophonological memory trace of the phrase or a lexical-semantic representation including information along the lines of "noun [plural]: denoting those who study language from a psychological perspective" or, if the listener grasps the real-world referent of the expression, a mental image of a couple who seem too young to be sending a son to college.

Some evidence that the representation of the antecedent for a pronoun is fairly close to a referential, mental-model based representation comes from work by Cloitre and Bever (1988) and Gernsbacher (1991). This kind of representation has been dubbed *conceptual*. We will assume that when comprehension and interpretation are successful, conceptual antecedents are eventually recovered during the resolution of pronominal anaphora (Bock & Brewer, 1985). However, conceptual antecedents may be less likely to form the representation that is immediately created upon first hearing or reading a pronoun. A variety of evidence suggests that initial processing makes use of the linguistic features of the context in which the pronoun appears (Cowart & Cairns, 1987; Murphy,

1985; Nicol, 1988). This kind of pronoun processing is commonly said to involve *surface anaphora*.

Languages with pronouns that mark grammatical gender allow strong competitive tests of surface and conceptual processing. In such languages, the grammatical features of nouns tend to be reflected in the forms of pronouns. In Dutch, for example, the grammatical gender of the noun *vrouwje* (little woman) is neuter, so that the pronouns for which it serves as an antecedent are likely to be neuter. At the same time, because *vrouwje* normally refers to females, the natural gender is different from the grammatical gender, allowing conceptual anaphors to differ from surface anaphors. In *Het oude vrouwje dat door het bos liep droeg een zware tas. Zij was. . .* (The little old lady that walked through the forest carried a heavy bag. She was . . .) the relative pronoun *dat* (that) is neuter, while the personal nominative pronoun introducing the next sentence, *zij* (she), is feminine. Accordingly, the antecedent of the relative pronoun in this instance is a word that shares its grammatical gender (a surface antecedent), while the antecedent of the nominative pronoun is a mental referent that shares its natural gender (a conceptual antecedent).

Exploiting a similar property in other gender-marking languages, Garnham, Oakhill, Ehrlich, and Carreiras (1995; see also Cacciari, Carreiras, & Cionini, 1997) examined reading and question-answering in Spanish and French. Their findings suggested that readers initially accessed a surface antecedent, but fairly quickly began to call on the properties of a conceptual antecedent that influenced the time taken to answer a question about the contents of the passages that they had read. Garnham et al. proposed two alternative accounts of these results. One preserves a distinction between the representations that surface and conceptual anaphors consult, along the lines implied above. A second, however, suggests that the two kinds of information are combined into a model of the discourse and can be drawn on interchangeably.

In support of this second suggestion, Garnham et al. (1995) noted a feature of pronominal reference in circumstances that require

the antecedent to be found from the shared mental or environmental common ground of the conversation rather than from the discourse context. This kind of reference can be termed *deictic*. The relevant property of deictic reference can be seen in an example from English. The word *pants* is grammatically plural, like other members of the class of summation plurals (*scissors*, *binoculars*, etc.). Yet the piece of clothing the word denotes is conceptually singular when there is only one item in question (forcing the peculiar locution “a pair of pants” to denote a singleton member of the category). Even in unheralded uses (in the sense of Green, Gerrig, McKoon, & Ratcliff, 1994) and in deictic uses, with no linguistic antecedents, the pronoun may be plural. Imagine a man trying on some new trousers, inspecting himself critically in a mirror and saying to the clerk “They’re too big, aren’t they?” Clearly, the plural pronoun need not come from discourse reference to the plural word *pants*.

Because these uses are natural and normal, Garnham et al. (1995) suggested that the selection of pronouns during language production calls on a representation in which grammatical gender is intimately connected with semantic properties. Accordingly, the surface expression of pronouns in production may be determined interchangeably by grammatical and semantic features. In turn, comprehension may call on a joint representation of surface grammatical and semantic properties to resolve anaphoric references.

#### SELECTING PRONOUNS FOR PRODUCTION

Our research was designed to explore the kinds of representations that speakers consult in order to determine the form of the pronoun they will use. We will assume that the conditions for using a pronoun have been met within a discourse context, where the pronoun’s antecedent is something previously mentioned. To specify the appropriate pronoun, speakers presumably begin with information about the conceptual referent that they intend to pick out. The relevant features for such a specification may include various pragmatic features as well as con-

ceptual features (such as natural gender, natural number, and so on). In addition to these conceptual features, speakers may also call on linguistic properties of the *default categorization* of the referent, as in the *pants* example above (Bosch, 1986; Garnham et al., 1995). This implies that speakers determine the conceptual category of the referent, access the grammatical features of the basic-level term for the category, and employ those features in selecting an appropriate pronoun. Because this route to pronoun selection requires no information about whether or how a referent was previously mentioned, it would serve for producing unheralded and deictic pronouns as well as offering a pure conceptually driven route for the production of anaphoric pronouns.

Alternatively, when proceeding beyond the conceptual representation of a referent, speakers may call directly or indirectly on the grammatical features of the referent's categorization as established within the discourse context. This would mean consulting a syntactically relevant representation of a word that has been used to denote the referent, relying on a memory record of the current discourse to do so. For instance, in a telephone conversation with a hotel clerk, a guest might introduce the topic of some missing suitcases. Subsequently the objects could be referred to as *they*, a plural pronoun appropriate to the number of the noun *suitcases*. On the other hand, if the same set of objects in the same conversation had initially been introduced as *baggage*, the guest might be more likely to employ the singular pronoun *it* in later references, using the pronoun appropriate to the singular grammatical number of the mass noun *baggage*.

Yet another possibility involves using the morphological features of specific words from the discourse. In Dutch, the definite determiners *de* and *het* mark nouns of different grammatical genders (called *common* and *neuter*, respectively). In consequence, any definitely determined singular noun phrase has a surface tag for its gender. When such a noun phrase serves as the antecedent of an anaphoric pronoun, the appropriate form of the pronoun can be formulated from the surface information that origi-

nally accompanied the antecedent: If the determiner was *de*, the pronoun options include the word *die*, but if the determiner was *het*, the pronominal options are different and include words like *dat*.

We will call these three respective hypotheses about pronoun selection the *conceptual* hypothesis, the *lexical* hypothesis, and the *tag* hypothesis. In terms of theories of the cognitive processes of language production (Bock & Levelt, 1994), the strong form of the conceptual hypothesis suggests that the speaker identifies the intended referent within a representation of the to-be-conveyed message, directly (i.e., directly from the concept) accesses the relevant features of a word that accurately denotes the referent, and uses only these features when selecting a pronoun. The lexical hypothesis implies that, in addition to identifying the intended referent, the speaker consults information about the prior discourse that incorporates grammatically relevant features of specific words used to introduce discourse referents. These features reflect the part of a lexical representation called a *lemma*, which includes information about syntactic properties like grammatical gender. The *tag* hypothesis assumes that, in addition to using conceptual and abstract lexical information about the antecedent, the speaker consults a memory record of the prior discourse that includes traces of words actually produced in their phonologically encoded forms. Strong forms of each of these hypotheses would argue for the exclusive use of the corresponding information, with little influence from other sources.

## THE GENDER SYSTEM OF DUTCH

To test these hypotheses, we devised a series of production experiments that exploited the gender system in Dutch. Normatively speaking, pronouns in Dutch agree with their noun antecedents in grammatical gender. There are only two genders in regular use, one neuter (comprising those nouns that take the definite determiner *het*, informally called *het* nouns) and the other common (comprising those nouns that take the definite determiner *de*, called *de* nouns). The class of common-gender nouns is a merger of what were historically the masculine

and feminine genders, which are all but obsolete in standard contemporary Dutch, as spoken in most of The Netherlands (van Berkum, 1996). The corresponding neuter- and common-gender pronouns include the singular demonstratives *dat* (for *het* nouns) and *die* (for *de* nouns). The same demonstratives serve to introduce relative clauses, analogous to English *that*, and when they do they carry the gender of the head noun, which the relative clause modifies (e.g., *de jongen die lang is* [the boy who is tall] or *het meisje dat lang is* [the girl who is tall]). To make these gender distinctions explicit for English readers, we will subscript the Dutch nouns and pronouns in our examples, as well as their English glosses, to indicate whether the word in question is a common-gender *de* word (e.g., *jongen<sub>v</sub>/boy<sub>v</sub>/die<sub>v</sub>*) or a neuter-gender *het* word (e.g., *meisje<sub>n</sub>/girl<sub>n</sub>/dat<sub>n</sub>*).

Although demonstratives and relatives are the only pronouns relevant to our research, the definite determiners *de* [the<sub>v</sub>] and *het* [the<sub>n</sub>], along with the indefinite determiner *een* [a], play an important part. The indefinite *een* can be used with *de* and *het* words alike, with no change in its form. However, if a noun introduced with *een* is later referred to with a pronoun, the pronoun may be expected to reflect the noun's grammatical gender, despite the absence of gender marking on the determiner. Because most Dutch nouns do not indicate gender overtly in their phonology, this offers a straightforward means of testing the tag hypothesis.

#### AN OVERVIEW OF THE EXPERIMENTS

In this research we used sentence completion tasks adapted from studies of grammatical agreement in English (Bock, 1995). On each trial in both experiments the participants heard a preamble sentence, e.g., “Kijk, daar ligt een aardappel<sub>v</sub> bij een badpak<sub>n</sub>” (Look, there's a potato<sub>v</sub> lying next to a swimsuit<sub>n</sub>). Shortly after the offset of the preamble, a printed adjective appeared on a computer screen and remained in view until the end of the trial (e.g., GAAR [cooked]). When the adjective appeared, the participant reproduced the preamble, appending a second sentence (in Experiment 1) or inserting

a relative clause (in Experiment 2) using the adjective displayed on the screen. This implicitly demanded the use of gender-marking pronouns. In Experiment 1 the pronouns were demonstratives [e.g., “Die<sub>v</sub> is gaar” (It<sub>v</sub> is cooked)] and in Experiment 2 they were relatives [e.g., “. . . die<sub>v</sub> gaar is . . .” (. . . that<sub>v</sub> is cooked . . .)]. Although the pronominal forms of demonstratives and relatives are the same in Dutch (as they are in English), their structural contexts differ. Specifically, demonstratives occurred in a different sentence from their antecedents, whereas relatives occurred in the same sentence as their antecedents.

The main questions were whether participants would normally use a pronoun whose gender is appropriate for the intended antecedent (the *de*-noun *potato<sub>v</sub>*, in the example above) and whether the choice of pronoun would be influenced by the gender of an interloper, a nonantecedent noun phrase in the immediate vicinity (the *het*-noun *swimsuit<sub>n</sub>*). Speakers may be more vulnerable to *gender interference* effects when the genders of the antecedent and the interloper mismatch, as they do in the example, than when they match. Gender interference occurs when a pronoun displays the gender of the interloper rather than the gender of the antecedent.

Gender interference can be used to diagnose the nature of the processes by which speakers access the relevant features of a pronoun's antecedent. Suppose a speaker says the Dutch equivalent of *Look, there's a potato<sub>v</sub> next to a swimsuit<sub>n</sub>. It<sub>n</sub> is cooked*. Assuming that the speaker means *it<sub>n</sub>* to refer to the potato (as the adjective *cooked* strongly implies), the gender of the pronoun is inappropriate. Should this kind of error occur reliably when the interloper in the preamble is the opposite of the intended gender, the implication would be that the features for pronoun selection are sought from a representation of lexical features associated with potential antecedents from the preceding discourse. Were gender features instead determined from a message representation of the antecedent supplemented with only a default categorization of the antecedent during production, it is less obvious why gender interference

should arise more often when the genders of the antecedent and interloper mismatch than when they match. This therefore constitutes a contrast between the conceptual hypothesis and the lexical hypothesis.

In addition to varying the genders of antecedents and interlopers, the experiments manipulated the types of determiners that accompanied them. All of the preambles had two versions, one with the ungendered indefinite determiner *een* (a) accompanying both the antecedent and the interloper and a second version that replaced the indefinite determiners with the gender-marking definite determiners *de* (the<sub>D</sub>) and *het* (the<sub>N</sub>). Whether gender interference occurs in the absence of the surface distinctions between antecedents and interlopers provided by the definite determiners and whether interference is selectively ameliorated or exacerbated by surface markers constitutes a contrast between the lexical and the tag hypotheses. Specifically, if gender is a property carried principally by gender tags (like determiners) rather than by the lexical entries of nouns, gender interference should be most evident in the overt-gender conditions.

Both of the experiments reported below examined the incidence and distribution of gender interference after preambles that contained nouns of uniform genders or contrasting genders and both compared preambles that had explicit gender tagging (overt gender) to preambles that lacked explicit tagging (covert gender). The first experiment used Dutch demonstrative pronouns, which had antecedents in a preceding sentence. In the second experiment we extended the findings to relative pronouns, whose antecedents were in the same sentence as the pronouns.

## EXPERIMENT 1

In Experiment 1, the participants had to create sentences that served as sequels to sentences they had just heard. The form of their task was such that the sequels naturally began with Dutch demonstrative pronouns, either the common-gender *die*<sub>D</sub> (it<sub>D</sub>) or the neuter-gender *dat*<sub>N</sub> (it<sub>N</sub>). For half of the participants the preamble nouns carried gender overtly, using definite determiners;

for the other half the gender of the nouns remained covert, using indefinite determiners. The nouns themselves carried no reliable gender cues (except in one instance), so that the appearance of gender interference in the covert-gender conditions could arise only from gender information retrieved from the lexical entry for a potential antecedent for the demonstrative pronoun.<sup>1</sup>

### Method

*Participants.* The main experiment was carried out with 48 native speakers of Dutch. They were undergraduate students at the University of Nijmegen and were paid for their participation. Thirty-two other students took part in validation studies carried out on the materials.

*Materials.* There were 96 experimental items (see Appendix). Each item consisted of a preamble sentence and a single adjective. The preamble was always of the form *Kijk, daar ligt een/de aardappel<sub>D</sub> bij een/het badpak<sub>N</sub>* (Look, there's a potato<sub>D</sub> lying next to a swimsuit<sub>N</sub>). Of the two nouns in each preamble, one was always an expected antecedent for the to-be-elicited demonstrative pronoun, and the other was the interloper. For each item, an adjective was selected [e.g., *gaar* (cooked)] that applied plausibly to only the expected antecedent and not to the interloper. The genders of the antecedent and the interloper, whether the genders matched or mismatched, and the positions of the antecedent (first noun or second noun) were varied orthogonally.

Two versions were created for each of these items. In one version, both nouns were accompanied by definite determiners (*de* or *het*), whereas in the other version, they were combined with indefinite determiners.

To validate our judgments about the plausibility of the adjective–noun combinations, 32 raters were given written lists of word triplets. The triplets included the two nouns from each preamble and the adjective. The raters were instructed to indicate whether the adjective was more likely to be a property of the first or the

<sup>1</sup> The exception was the noun *slipje* (pair of panties), No. 52 in the Appendix. The diminutive suffix *-je* flags the noun as neuter.

second noun. Half of the raters received the nouns in one order (the same order as in the preambles), and the other half in the reversed order. The raters showed a very strong preference (99.3% overall) for the intended antecedent as the noun most likely to be modified by the adjective. For 92 of the 96 items at most one rater failed to select the expected noun. Of the remaining four items, three showed a 90.6% bias (29 of 32 raters) and one had an 84.4% bias (27 out of 32 raters) toward the expected noun.

In addition to the experimental items, there were 72 fillers and 16 practice items. They were similar to the experimental items in length and complexity and also began with *kijk* (look), but they differed from the experimental preambles in syntactic structure. All of the fillers included a transitive verb, a direct object, and often an adverb.

*Procedure.* The experimental sentences and filler materials were digitally recorded by a female native speaker of Dutch for presentation during the experimental sessions. Recordings were made in a quiet room using a Sony DTC55 digital audio tape recorder and a Sennheiser ME40 microphone. Speech analysis software (waves/ESPS, Entropics Inc.) was used to determine the beginnings and ends of the preambles and to write them to individual speech files. The speech files were stored on the hard drive of a Hermac 386SX computer, which controlled the experiment.

Each session began with the practice items, followed by the experimental and filler items in random order, a different random order for each participant. The participants were tested individually in a quiet room. They were told that on each trial they would hear a sentence and then see a word on the computer screen. Their instructions were to listen to the entire sentence and then repeat it, adding a continuation sentence beginning with either "Die<sub>D</sub> is. . ." or "Dat<sub>H</sub> is. . ." and using the adjective provided, as in "Die<sub>D</sub> is mooi" (That<sub>D</sub> is beautiful).

Preambles were played at a comfortable listening amplitude over headphones (Sennheiser MD211N). Each preamble was followed 200 ms after its offset by the appearance of an adjective, in black lowercase letters on a gray

background, on a computer monitor (NEC Multisync30) in front of the participant. The participant repeated the preamble and then generated a continuation sentence. The repetition and continuation were digitally recorded for later analysis. Six seconds after the onset of the adjective, the next trial began.

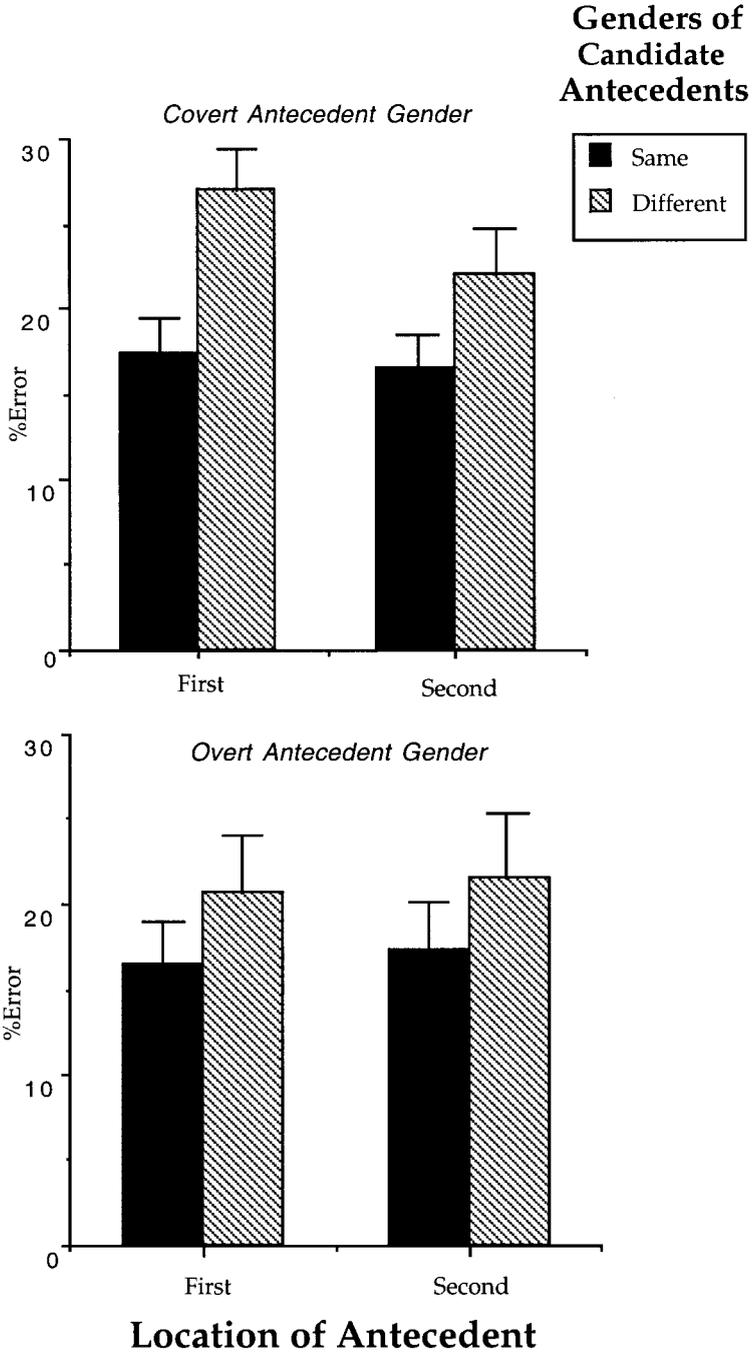
*Design.* Each speaker was tested on all 96 items. Every combination of antecedent position (first or second), grammatical gender (common or neuter), and match vs mismatch of antecedent and interloper gender was represented by 12 items. Half of the participants received the versions of the items with definite determiners, and half received the versions with indefinite determiners.

*Scoring and analyses.* The speakers' responses were evaluated for correct repetition of the preamble and for the type of demonstrative pronoun used. The data from one item were excluded because one of its nouns was incorrectly classified as neuter. On 3.4% of the experimental trials, speakers failed to repeat the preamble correctly or failed to provide a new sentence including a demonstrative pronoun and adjective. These trials were excluded from analysis. For the remaining trials, pronouns that agreed with the antecedent in gender were counted as correct and those that disagreed were counted as incorrect. Analyses of variance were performed on the percentages of incorrect pronouns produced in each cell of the experimental design. Except when noted, all reported effects were significant at or beyond the .05 level.

## Results

The main findings are shown in Fig. 1. Speakers made more pronoun-gender mistakes when antecedent and interloper differed in grammatical gender than when they had the same grammatical gender [22.8% vs 16.9% error;  $F_1(1, 46) = 31.7$ ;  $F_2(1, 91) = 4.6$ ). However, overt gender-marking had no significant impact on the error rate as either a main effect or interaction. The error rate was 20.8% when gender was covert and 19.0% when it was overt.

Table 1 shows the results broken down by the gender of the antecedent. There were fewer errors when the antecedent was a common noun



**FIG. 1.** Errors in grammatical gender in the production of Dutch demonstrative pronouns in Experiment 1. The error bars represent the standard errors of the means. The antecedent's gender was not explicitly marked (covert antecedent gender) when an indefinite determiner accompanied the antecedent and was explicitly marked (overt antecedent gender) when a definite determiner accompanied the antecedent. Pronouns occurred in a sentence that followed their antecedents.

TABLE 1

Percentages of Gender Errors on Demonstrative Pronouns with Gender-Unmarked and Gender-Marked Antecedents (Experiment 1)

Genders of candidate antecedents (first and second noun phrases)	Location of expected antecedent	
	First noun phrase	Second noun phrase
Gender covert (indefinite determiners)		
Common-common	9.2	10.2
Common-neuter	24.3	29.6
Neuter-neuter	25.5	22.9
Neuter-common	29.8	14.6
Gender overt (definite determiners)		
Common-common	8.6	13.4
Common-neuter	12.8	28.2
Neuter-neuter	24.4	21.2
Neuter-common	28.3	15.0

than when it was a neuter noun. Overall, the percentage of correct common-gender pronouns was 86.6%, compared to 73.8% correct neuter-gender pronouns [ $F_1(1, 46) = 15.3$ ;  $F_2(1, 91) = 27.7$ ]. In addition, the interference effects in the mismatch conditions were stronger when the interloper was a common noun than when it was a neuter noun [29.0% errors vs 16.7% errors;  $F_1(1, 46) = 31.3$ ;  $F_2(1, 91) = 5.6$ ].

### Discussion

The errors in producing the demonstrative pronouns suggest that the gender of the pronoun was influenced by the grammatical gender of the interloper. This pattern is consistent with a lexical hypothesis for pronoun-gender selection. According to the lexical hypothesis, when formulating an anaphoric pronoun, speakers try to access the grammatical features of lexical items that were previously used to denote the same referent in the active discourse context. The results are less compatible with a strong conceptual hypothesis, which attributes gender selection to a default categorization (such as a basic-level categorization of the referent) rather than an active categorization (the lexical instan-

tiation within the current discourse). Of course, the lexical and conceptual hypotheses both assume that speakers begin with a conceptual or message representation of the referent, but only the lexical hypothesis is straightforwardly compatible with evidence that the pronoun's form is influenced by a previously instantiated lexical specification of a nonantecedent referring expression.

Experiment 1 also tested the hypothesis that speakers rely on an antecedent's explicit markers of grammatical gender when selecting the gender of an anaphoric pronoun. According to this tag hypothesis, there should have been fewer gender errors on pronouns in the match condition when the antecedents carried gender-marked determiners and more gender interference in the mismatch condition from explicitly marked, nonantecedent interlopers. The results offered little support for these predictions. Although there were nonsignificant numerical trends in the predicted directions, there was nothing to suggest that speakers place heavy reliance on overt gender marking in formulating demonstrative pronouns.

The overall superiority for the demonstrative *die<sub>D</sub>* was unexpected, but has a possible explanation in terms of the distributions of *de* and *het* nouns in Dutch. Because of these distributions, *die<sub>D</sub>* is far more frequent. We return to this in the General Discussion.

### EXPERIMENT 2

The tag hypothesis assumes that information about the surface markings of gender is accessible at the time a pronoun is formulated. One well-known limitation on the availability of this kind of information is the fast decay of information about specific wording in human memory (Sachs, 1967), especially when a sentence boundary intervenes (Jarvella, 1971). The retrievability of pronoun antecedents during comprehension also shows discontinuities associated with clause or sentence boundaries (Clark & Sengul, 1979; Ehrlich & Rayner, 1983). Such facts about memory may help to shape the cognitive mechanisms that carry out agreement in gender-marking languages. Notably, the use of grammatical gender in gender-marking lan-

guages is sometimes seen to change systematically at sentence boundaries. German is well known for this phenomenon. If a pronoun has a grammatically neuter noun as an antecedent, but the referent of the neuter noun has biological (natural) gender [e.g., *das Mädchen* (girl) is grammatically neuter but biologically feminine], the biological rather than the grammatical gender may appear on the pronoun if it occurs in a different sentence than the antecedent. But if the antecedent is in the same sentence as the pronoun, the grammatical gender dominates (Drosdowski, 1984, p. 664). With the close relationship between German and Dutch, comparable patterns of gender usage might be expected among Dutch speakers.

If sentential bounds on grammatical gender agreement apply in Dutch and reflect in part the restrictions on the accessibility of overt gender markers in immediate memory, the conclusions from Experiment 1 may not generalize to within-sentence agreement processes. Specifically, the absence of evidence for the tag hypothesis in Experiment 1 may be a consequence of the restriction to cross-sentence anaphora in the experimental materials. The tag hypothesis could be more successful in predicting gender agreement and gender interference effects within sentences. Experiment 2 was run in order to find out.

Dutch speakers were asked to create relative clauses with the materials from Experiment 1. They were presented with a preamble and an adjective and asked to produce an utterance with a relative clause. The speakers were free to add the relative clause to either noun phrase, although the meaning of the adjective strongly constrained which of the choices would yield a sensible result. For example, given a preamble such as *een slot<sub>H</sub> in een tuin<sub>D</sub>* and the adjective *stuk*, speakers would be most likely to produce the utterance “*een slot<sub>H</sub> dat<sub>H</sub> stuk is in een tuin<sub>D</sub>*” (literally, a lock<sub>H</sub> that<sub>H</sub> broken is in a garden<sub>D</sub>). In contrast, given *een papier<sub>H</sub> op een trui<sub>D</sub>* and the adjective *warm*, the more likely utterance would be “*een papier<sub>H</sub> op een trui<sub>D</sub> die<sub>D</sub> warm is*” (literally, a piece of paper<sub>H</sub> on a sweater<sub>D</sub> that<sub>D</sub> warm is). The tag hypothesis predicts that relative pronouns (which are the same in form

as the demonstratives) should be marked more reliably for gender after definite than after indefinite determiners and should suffer more interference in the same circumstances.

### Method

*Participants.* The participants were 48 native speakers of Dutch from the same source as Experiment 1.

*Materials.* The materials were the same as in Experiment 1.

*Procedure.* The procedure duplicated that of previous experiment, except that the speakers were instructed by example to use the visually presented adjective to create a relative clause. They were permitted to append the relative clause to either the first or second noun phrase of the preamble as they wished.

*Design.* The experimental design was the same as in Experiment 1.

### Results

Speakers usually minimized the distance between the relative clause and its antecedent. Consequently, when the antecedent was the first noun, the relative clause was inserted into the preamble immediately after the first noun, and when the antecedent was the second noun, the relative clause was appended to the preamble immediately after the second noun. Speakers deviated from this pattern only 2.3% of the time when gender was covert in the preamble and 3.2% of the time when gender was overt. The deviant utterances (124 in total) were excluded from the analyses below. An additional 223 cases (4.8% of all responses) were missing because of preamble-repetition failures.

The percentages of relative-pronoun gender errors are shown in Table 2, with the data from one item (the same item as in Experiment 1) excluded because of an incorrect gender classification. Figure 2 summarizes the most important effects. Speakers made more errors when the antecedent and interloper differed in grammatical gender than when they had the same grammatical gender [10.0% errors in the mismatch condition vs 5.5% in the match condition;  $F_1(1, 46) = 39.9$ ;  $F_2(1, 91) = 9.0$ ] and when the antecedent was the second of the

TABLE 2

Percentages of Gender Errors on Relative Pronouns with Gender-Unmarked and Gender-Marked Antecedents (Experiment 2)

Genders of candidate antecedents (first and second noun phrases)	Location of expected antecedent	
	First noun phrase	Second noun phrase
Gender covert (indefinite determiners)		
Common-common	2.5	3.6
Common-neuter	8.9	22.3
Neuter-neuter	18.0	11.2
Neuter-common	18.9	11.3
Gender overt (definite determiners)		
Common-common	0.4	1.9
Common-neuter	2.1	7.1
Neuter-neuter	2.5	4.0
Neuter-common	2.3	7.3

candidate noun phrases [ $F_1(1, 46) = 4.7$ ], although this effect was not significant for items [ $F_2(1, 91) = 1.1, p > .1$ ]. Because the mismatch effect was larger when the antecedent was in second position, the interaction between gender match and position was also significant, though again only by subjects [ $F_1(1, 46) = 10.1; F_2(1, 91) = 2.0, p > .1$ ].

Gender marking on the antecedent noun phrases influenced the error rate, yielding more errors overall when marking was covert than when it was overt [12.1% vs 3.4%;  $F_1(1, 46) = 17.1; F_2(1, 91) = 60.2$ ]. A mismatch in gender between the candidate antecedents had a greater effect when gender was unmarked than when it was marked [ $F_1(1, 46) = 8.0$ ], and the position of the antecedent mattered less when gender was unmarked [ $F_1(1, 46) = 10.14$ ], although neither of these interactions achieved significance by items [ $F_2(1, 91) = 3.1, p > .05$  and  $F_2(1, 91) = 2.0, p > .1$ , respectively].

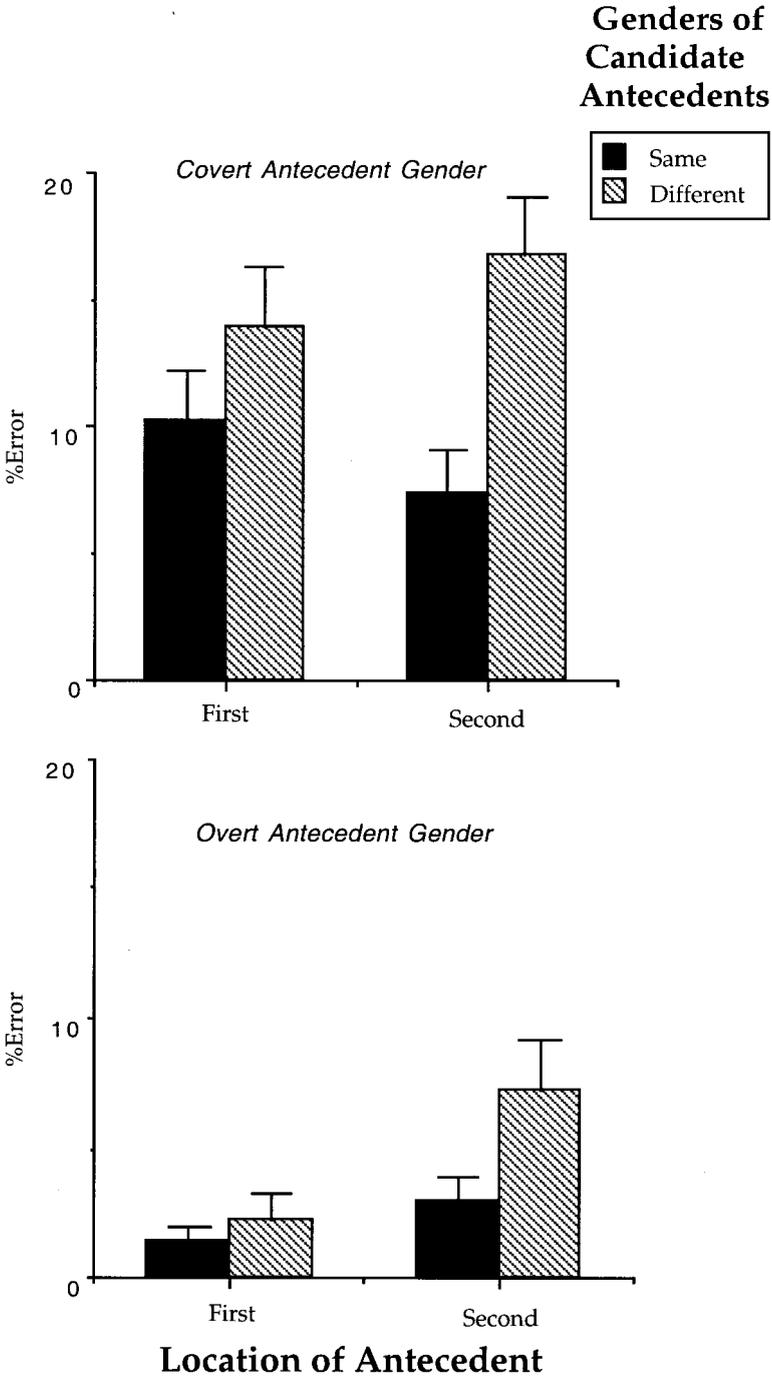
Once again, there were fewer errors when the antecedent was a common-gender noun than when it was neuter. This was clearest when gender was covert: There were 93.6% correct common-gender pronouns, compared to 82.4% correct neuter-gender pronouns. The corre-

sponding rates when gender was overt were 97.0 and 96.1%. Likewise, interference in the mismatch conditions was greater when the interloper was a common-gender noun than when the interloper was neuter (with covert gender, there were 20.7% errors in the mismatch condition after a common-gender interloper compared to 10.1% errors after a neuter-gender interloper; with overt gender, the error percentages were 4.7 and 5.1%, respectively). In subsidiary analyses including the gender of the antecedent as a factor, these trends yielded a significant main effect of gender [ $F_1(1, 46) = 6.2; F_2(1, 91) = 17.6$ ] and a significant interaction between gender and overt marking [ $F_1(1, 46) = 4.7; F_2(1, 91) = 26.4$ ]. The three-way interaction among these factors and gender match was not significant (both  $F_s < 1$ ).

### Discussion

Two of the findings from Experiment 2 merit discussion. One was the strong tendency for speakers to place the relative clauses immediately after the selected antecedent for the pronoun. This helps to solidify the interpretation of the results by providing an independent validation of the normative designations of the antecedents. Because the expected antecedents for the demonstrative pronouns in Experiment 1 were exactly the same as the expected antecedents for the relative pronouns in this experiment, we can be more confident that the speakers in both experiments generally intended the pronouns to be coreferential with the normative antecedents.

The most notable result in Experiment 2 was how gender marking on antecedent noun phrases affected the forms of coreferential pronouns in the same sentences. When the antecedent's gender was explicitly tagged by an accompanying article, erroneously gendered pronouns were significantly less likely than when the gender of the antecedent noun phrase was not explicitly indicated. Moreover, the magnitude of this difference was greater in Experiment 2 than in Experiment 1. Although a direct statistical comparison of the two experiments is compromised by differences in the forms of the utterances that were produced, it is defensible to



**FIG. 2.** Errors in grammatical gender in the production of Dutch relative pronouns in Experiment 2. The error bars represent the standard errors of the means. The antecedent's gender was not explicitly marked (covert antecedent gender) when an indefinite determiner accompanied the antecedent and was explicitly marked (overt antecedent gender) when a definite determiner accompanied the antecedent. Pronouns occurred in the same sentences as their antecedents.

contrast the results when the antecedent was in second position since, in both experiments, the pronoun immediately followed a second-position antecedent. An analysis of the data from the second-position conditions revealed that speakers made significantly fewer errors in selecting relative pronouns than demonstrative pronouns [8.5 vs 19.4% errors;  $F_1(1, 92) = 25.74$ ;  $F_2(1, 46) = 60.18$ ]. This reduction was most pronounced when gender was overt (19.4 vs 5.0% when overt, compared to 19.3 vs 12.0% when covert), although the interaction between pronoun type and gender tagging that reflects this reduction was marginal in the subject analysis [ $F_1(1, 92) = 3.02$ ,  $p < .10$ ;  $F_2(1, 46) = 13.65$ ].

This difference in pronoun accuracy offers support for the traditional view that grammatical gender is more reliably marked within than across sentence boundaries. Even so, the error pattern is not consistent with the predictions from a strong form of the tag hypothesis. A strong tag hypothesis implies that gender information is proprietarily conveyed by the marking of the determiner. The argument would be that gender information resides in the overt form of the determiner and that in the absence of this form gender must be inferred from the noun alone. Although this indeed predicts a reduction in pronoun errors when the genders of candidate antecedents match, it also predicts an increase in errors when the genders of the candidate antecedents mismatch. This did not occur: The reduction in errors when gender was overt, compared to when it was covert, was equivalent regardless of whether the antecedents were the same or different in gender.

This suggests that gender tagging provides redundant information about gender rather than privileged information: When an antecedent carries a gender-explicit determiner, the grammatical gender is carried by both the noun and the determiner rather than either one alone. The memory representation of a determiner's grammatical information may be more fragile than that of the noun (Koriat & Greenberg, 1994) and hence more vulnerable to disruption at sentence boundaries. This would account for the

nonsignificant impact of overt gender in Experiment 1.

In short, the results of Experiment 2 are more compatible with the lexical hypothesis of immediate antecedent recovery than with the tag hypothesis. The findings indicate that the identification of an antecedent takes place in a memory representation that contains lexically specific information about the grammatical privileges of words, but not information about their overt morphological forms.

## GENERAL DISCUSSION

Our results lend support to a lexical hypothesis for the selection of grammatical gender in pronoun production. To recapitulate, the results of both experiments indicated that gender selection calls on more information than is available solely from a conceptual or message-level representation of the intended referent or from the referent's default lexical categorization. Specifically, pronoun gender selection reflected the grammatical features of discourse-activated lexical information. This was shown in consistent interference from the mismatching grammatical gender of a nonantecedent noun, which should occur only if pronoun gender is influenced by memory representations that include earlier mentions of the intended referent.

The experiments further showed that gender selection is not controlled solely or strongly by overt markers of gender on definite determiners that accompanied the antecedents: Overt markers appeared to supplement the information carried by the noun but did not override it, as one would expect if gender-specific morphology were the only information or the primary information consulted during pronoun selection. This disconfirmed the tag hypothesis.

Consistent with the lexical hypothesis, in both experiments the accuracy of pronoun selection decreased when an interloper carried conflicting gender and decreased further when the interloper occupied the preferred position for the antecedent (sentence-initial position in Experiment 1) or when the interloper occupied a place in the current sentence representation (sentence-initial position in Experiment 2). All of these gender-interference effects point to-

ward a process involving a lexically specified representation of candidate antecedents for a pronoun in order to select the pronoun's form.

The results accord well with others in the psycholinguistic literature in indicating that specific linguistic information is used in the processing of pronouns in languages that mark grammatical gender. In comprehension tasks, Garnham et al. (1995) found that speakers of French and Spanish read sentences more quickly when pronouns carried unambiguous cues to the grammatical genders of their antecedents and that this effect was of the same magnitude for pronouns with inanimate-object antecedents (which have only grammatical gender) as it was for pronouns with human antecedents (which had matching grammatical and biological genders). This points to a role for grammatical gender in establishing pronominal antecedents. However, the effect of grammatical gender diminished rapidly: When a clause separated the pronoun from its antecedent, pronouns with human (i.e., biologically gendered) antecedents were understood more readily than pronouns with inanimate (i.e., only grammatically gendered) antecedents. Cacciari et al. (1997) found similar tendencies in Italian: Pronouns whose antecedents bore overt grammatical gender were understood more readily than pronouns without an explicitly gendered antecedent.

Of course, Romance languages (including Italian, Spanish, and French) tend to have reliable gender cues in their word forms. For example, Spanish nouns ending in *-o* are typically masculine, while those ending in *-a* are typically feminine. This makes it hard to determine whether it is overt morphophonological marking that mediates the effect of grammatical gender on pronoun resolution rather than a more abstract lexical classification of gender. Our results strongly suggest that in Dutch it is the latter, and it may not be entirely coincidental that Dutch lacks phonological correlates of gender. But we doubt that such cues obviate the need for or the use of abstract representations of grammatical gender in either speaking or listening. For one thing, speakers of Italian may sometimes have access to gender information

about words even when they have no access to sound information (Badecker, Miozzo, & Zanuttini, 1995; Miozzo & Caramazza, 1997; Vigliocco, Antonini, & Garrett, 1997). For another, the syntactic planning processes demanded by sentence production appear to require that structurally relevant grammatical information (like gender) be accessible before phonological information is normally accessed in the course of spontaneous speaking. Since the scope of phonological preparation is fairly narrow (Dell & O'Seaghdha, 1992; Meyer, 1996; Schmitt, Meyer, & Levelt, 1999), grammatical information may become active before and remain active after sound specifications are encoded.

Still, in principle there may be differences among languages in the ways that pronouns are processed, and these differences may reflect the kinds of information that are needed to mediate coreference. In English, for example, the only grammatically relevant information that pronouns reliably share with their antecedents is a number feature (singular or plural), and this number feature is typically (albeit imperfectly) correlated with conceptual number properties. This means that pronouns can almost always be formulated directly from a message or conceptual representation of the antecedent and still reflect the relevant number. In line with this, Bock, Nicol, and Cutting (in press) found little influence of grammatical number on the production of pronouns in American English compared to the influence of grammatical number on the production of verbs. What may make this possible is the reliability of conceptual information for marking grammatical number, which contrasts sharply with the unreliability of conceptual information (especially about inanimate objects) for marking grammatical gender.

Even within a single language, agreement features as well as different values of agreement features need not behave identically. In our data, there were unexpected differences in the magnitude of interference effects for neuter and common gender. In both experiments, common-gender pronouns were more likely than neuter-gender pronouns to be used correctly (overall, 85.1% vs 75.8%) and common-gender noun

antecedents were more potent sources of interference than neuter antecedents (overall, 27.1% vs 18.0% error in the mismatch conditions). The reasons for this can only be guessed at. The simplest possibility has to do with the type frequency of the two noun classes: There are roughly three times as many common-gender as neuter-gender nouns in Dutch, despite a tendency for neuter-gender nouns to be much higher in frequency (van Berkum, 1996, 1997). The net result is that about two of every three nouns in running text will bear common gender. If speakers tend to resolve uncertainty about which pronoun to use in terms of the most likely gender, they should use common gender more often than neuter gender, and they do.

In other respects, the overall patterns of interference in pronoun selection were comparable for neuter- and common-gender pronouns. Both suffered from gender mismatches between potential antecedents, and neither was more vulnerable to the effects of gender mismatch when gender was overtly tagged.

Apart from these points, the findings from the present experiments bear on two issues in the psycholinguistic literature having to do with language comprehension. One involves the relationship between comprehension and production in the cognitive processing of agreement, and the other has to do with how Dutch readers interpret relative clauses.

### *Comprehending and Producing Pronouns*

The most salient difference between pronoun production and pronoun comprehension is that speakers normally know the conceptual or referential antecedents of the pronouns they produce, whereas listeners must infer the antecedent from their interlocutors' speech or from the current context. The tasks used in the present experiments demanded both production and comprehension: comprehension of the preamble sentences, from which the representations of the antecedents were derived, and production of the pronouns.

This complicates the interpretation of the results in at least three ways. First, one cannot be certain whether antecedent gender is represented similarly for understanding and for

speaking. For example, when speakers generate antecedents directly from messages, they may be less likely than our speakers were to consult any sort of surface representation of the antecedent (either grammatical or morphological), instead relying more heavily on conceptual information alone. Although plausible, this same scenario might lead one to expect stronger support for the tag hypothesis than what we obtained. In fact, none of our results were fully consistent with the predictions of the tag hypothesis, and our only clear evidence for a contribution of overt gender marking came in Experiment 2. There the pronoun and antecedent were in the same sentence, which is precisely what traditional accounts (based primarily on observational evidence from written German) would predict. Moreover, our results provide evidence about what kind of antecedent representation is preferentially consulted during the generation of pronouns when several different types of information are available. In normal episodes of pronoun use, all of the sources of information that we investigated are accessible, in principle. For example, in conversation and other dialogues, speakers employ material from their interlocutors' speech, as well as their own speech, in formulating pronouns.

A related complication in interpreting our results is that the speakers may have suffered from problems in understanding the intended relationship between potential antecedents and modifiers or from problems in remembering the preambles. This could serve to disrupt the normal pronoun selection process. In fact, with the increasing determinacy of the intended antecedents between Experiments 1 and 2, the incidence of gender interference decreased. But despite this, the theoretically telling configuration of effects remained the same.

A third source of ambiguity in the results stems from the requirement for speakers to repeat the preambles, imposing explicit memory demands that are absent from normal speech situations. This could have increased the incidence of errors or, more worryingly, changed their distribution. The incidence of pronoun errors in spoken Dutch is unknown, so we cannot tell whether the task elicited an unusually high

number of errors. However, regarding the distributions of speech errors in laboratory tasks, there is considerable evidence that even when task demands increase the rates of error, they do so without changing the error patterns. This seems to hold for speech errors of all kinds (Stemberger, 1992) as well as for agreement errors elicited in tasks similar to ours (Bock & Miller, 1991).

### *Interpreting Relative Clauses*

The foregoing discussion assumes that there are deep parallels between comprehension and production processes. But arguments against such parallels have been raised in the literature, most notably with regard to how relative clauses are understood during reading or listening.

The analysis or interpretation of relative clauses has been a long-standing concern of psycholinguistic theories of parsing. A sentence like *Someone shot the servant of the actress who was on the balcony* can be understood to mean that either the servant or the actress was on the balcony. Recent studies suggest that readers' inclinations about this may vary, sometimes depending on their language. Cuetos and Mitchell (1988) found that Spanish readers tended to favor the reading in which the relative pronoun in Spanish would be taken to refer to *servant* in the sentence above (so-called *high attachment*), whereas readers of British English showed the reverse tendency (though see Gilboy, Sopena, Clifton, & Frazier, 1995). For Dutch, Brysbaert and Mitchell (1996) reported a preference comparable to that in Spanish. Subsequently, however, they reported an analysis of a newspaper corpus which appeared to reveal a strongly opposing distribution: In these written texts, the relative clauses reliably modified the second noun phrase (Mitchell & Brysbaert, 1998). Mitchell and Brysbaert concluded from this that Dutch readers display biases in comprehension that diverge from the patterns normally produced by Dutch writers.

We suspect that there may be a simpler reconciliation of these conflicting outcomes. In preliminary norming studies on the materials for Experiment 1, we observed a strong inclination for readers to take the first (and structur-

ally more prominent) of the two noun phrases in the experimental preambles as the antecedent for a demonstrative pronoun.<sup>2</sup> The preference for the first noun phrase was roughly 68%, including even the cases in which the first noun phrase was both semantically and syntactically unacceptable. This finding accords with Brysbaert and Mitchell's (1996) inasmuch as pronoun resolution may be intimately involved in the interpretation of relative clauses in languages like Dutch and German (Hemforth, Konieczny, & Scheepers, 1999). But in our second experiment, when speakers produced relative clauses, an interesting tendency appeared: Speakers almost always placed the relative clause immediately after the noun representing the intended antecedent, even when this entailed interrupting the complex noun phrase. We found the same tendency when we examined one issue of a daily national newspaper in The Netherlands, *De Volkskrant*. The complete issue contained 65,101 words and 312 relative clauses. In the relative clauses, over 86% followed their antecedents immediately. As a result, there were few cases such as ... *gebeld door iemand<sub>D</sub> van de BVD<sub>D</sub> die<sub>D</sub> van alles wilde weten ...* (... called by someone<sub>D</sub> from the FBI<sub>D</sub> who<sub>D</sub> wanted to know about everything...), where a structurally more prominent but distant noun [*iemand<sub>D</sub> (someone<sub>D</sub>)*] served as the antecedent of the relative pronoun [*die<sub>D</sub> (who<sub>D</sub>)*].

Consequently, when relative clauses were used immediately after the second noun in a complex noun phrase, the usual antecedent of the relative pronoun was the second noun itself, and not the earlier, structurally more prominent first noun. If proximity is the single most important means used by Dutch speakers and writers to indicate the antecedents of relative pronouns, corpus counts can be misleading when they focus exclusively on the antecedents of relative clauses that follow the second of two nouns in a complex noun phrase. Such counts naturally overlook the overwhelming weight of

<sup>2</sup> Structural prominence has to do with the fact that the first noun of complex subject noun phrases normally serves as what is informally called the subject noun in English.

TABLE 3

Probabilities of Alternative Relative Clause Placements for Each of Two Intended Antecedents of the Relative Pronouns in Experiment 2

Relative clause site	Intended antecedent	
	First noun	Second noun
After first noun phrase	.98 (2057)	.02 (46)
After second noun phrase	.03 (78)	.97 (2175)

*Note.* Numbers in parentheses represent the responses in each cell.

instances in which a relative clause immediately follows the initial noun of the complex phrase, counting equally all instances in which a relative clause immediately follows the second noun phrase.

To roughly estimate the tendencies toward alternative patterns of usage among the Dutch speakers we tested in Experiment 2, we calculated the probabilities of employing each of two relative clause sites for each of two different intended antecedents in our materials. For the complex noun phrases that we employed (analogous to *the servant of the actress*), the two sites are after one or the other of the constituent noun phrases (either *the servant* or *the actress*). These two phrases are likewise the possibilities for the intended antecedents. For these calculations, we also included the 124 responses that were not analyzed in Experiment 2, in which speakers placed a relative clause after a noun phrase that it was semantically unlikely to modify. Table 3 shows the relevant probabilities.

The overwhelming tendency toward immediate placement is evident, with an overall probability of .98. Beyond that, after initial noun phrases our speakers produced a small number of relative clauses that more sensibly modified the second noun phrase (along the lines of *the servant<sub>1</sub> who<sub>2</sub> married Prince Rainier of the actress<sub>2</sub>*), and these may be errors. If there is a roughly equivalent tendency to err in the opposite direction, a better estimate of the probability of a distant antecedent may be gotten by subtracting the probability of the clearly spuri-

ous cases (.02) from the probability of producing after the second noun phrase a relative clause that is intended to modify the first (.03), yielding .01. Extrapolating, among the relative clauses that follow complex noun phrases, at most one in one hundred will take the first noun phrase as the antecedent. In light of these trends, coupled with our corpus data, it appears doubtful that Dutch speakers (and writers) regularly produce relative clauses whose intended interpretations are at odds with the predilections of their readers and listeners.

## CONCLUSION

In this work we contrasted three accounts of how information about grammatical gender is selected for the production of pronouns in Dutch. In keeping with previous work on pronoun comprehension (Cacciari et al., 1997; Garnham et al., 1995) we found that speakers do not select pronouns on the basis of referential or conceptual information alone. Of course, being speakers, they must use referential and conceptual information from the outset of the formulation process. But our results suggest that they go beyond this information to call on linguistic features of the pronoun's antecedent. To further specify the nature of the linguistic information, we examined the contribution to pronoun selection of explicit gender marking on the antecedent. There were two notable effects. First, gender marking was associated with an overall decrease in the number of pronoun-gender errors when the pronoun and the antecedent were in the same sentence. Second, and more surprisingly, overt marking did not increase the incidence of interference from a different-gender candidate antecedent. Together, these effects argue that grammatical gender is not sought from an overt morphological representation, but rather from abstract specifications of gender associated with the lemmas of words.

## APPENDIX

### *Materials*

Items are grouped by the genders of the first and second noun (e.g., *de-de* indicates that the first and second nouns were common gender; *de-het* means that the first and

second nouns were common and neuter gender, respectively) and by the location of the expected antecedent (e.g., *first* indicates that the first noun was the expected antecedent). Only the definite-determiner versions of the items are shown. In the indefinite versions, the determiners *de* and *het* were replaced with the indefinite *een*. When presented to participants, all items began with "Kijk, daar..." ("Look, there..."). The English versions are glosses rather than literal translations. Note that item 35 contains a misclassified noun (*biefstuk*) and was omitted from the statistical analyses.

*de-de first*

01 ... staat de eend op de pannenkoek. LELIJK (... is the duck standing on the pancake. UGLY)

02 ... staat de ezel naast de fiets. DOM (... is the donkey next to the bicycle. STUPID)

03 ... zit de strik op de olifant. ELASTISCH (... is the bow on the elephant. ELASTIC)

04 ... ligt de mat onder de populier. VUIL (... is the mat lying under the poplar tree. DIRTY)

05 ... ligt de rugzak op de punaise. ZWAAR (... is the backpack lying on the thumbtack. HEAVY)

06 ... ligt de vesting bij de rivier. OMMUURD (... is the fortress by the river. WALLED)

07 ... staat de hond voor de deur. TROUW (... is the dog standing in front of the door. FAITHFUL)

08 ... hangt de sluier over de kat. DOORZICHTIG (... is the veil draped over the cat. SHEER)

09 ... staat de motor voor de flat. SNEL (... is the motorcycle in front of the apartment building. FAST)

10 ... staat de eik bij de vijver. VERTAKT (... is the oak by the pond. BRANCHING)

11 ... ligt de crepe in de pan. DUN (... is the crepe in the frying pan. THIN)

12 ... zit de spijker in de tas. KROM (... is the nail in the bag. BENT)

*de-de second*

13 ... staat de auto op de panty. DUN (... is the car standing on the pair of panty hose. THIN)

14 ... staat de koelkast achter de streep. DIK (... is the refrigerator standing behind the stripe. THICK)

15 ... ligt de atlas in de kelder. DONKER (... is the atlas in the cellar. DARK)

16 ... staat de stoel naast de kleuter. ACTIEF (... is the chair next to the toddler. ACTIVE)

17 ... ligt de steen onder de distel. STEKELIG (... is the stone lying under the thistle. THORNY)

18 ... ligt de roos op de vrieskist. KOUD (... is the rose lying on the freezer. COLD)

19 ... staat de poedel in de bus. VERROEST (... is the poodle in the bus. RUSTY)

20 ... ligt de worm in de flat. MODERN (... is the worm in the apartment building. MODERN)

21 ... ligt de maillot naast de slang. GEVAARLIJK (... is the pair of tights lying next to the snake. DANGEROUS)

22 ... staat de lijn op de telefoongids. VEROUDERD (... is the stripe on the telephone book. OUTDATED)

23 ... zit de snor boven de lip. ONTSTOKEN (... is the mustache above the lip. INFLAMED)

24 ... ligt de baby bij de bouvier. WAAKS (... is the baby lying close to the Belgian sheepdog. WATCHFUL)  
*de-het first*

25 ... is de gootsteen in het cafe. GEBARSTEN (... is the sink in the bar. CRACKED)

26 ... zit de haas naast het brood. ANGSTIG (... is the hare sitting next to the loaf of bread. FRIGHTENED)

27 ... ligt de fietsband naast het konijn. LEK (... is the bicycle tire next to the rabbit. FLAT)

28 ... ligt de boterham in het kanaal. BELEGD (... is the sandwich lying in the canal. BUTTERED)

29 ... is de deur achter het scherm. OPEN (... is the door behind the screen. OPEN)

30 ... is de disco bij het kerkhof. LAWAAIERIG (... is the discotheque near the cemetery. NOISY)

31 ... ligt de creamcracker op het luchtbed. KROKANT (... is the cracker lying on the air mattress. CRISPY)

32 ... ligt de zee achter het pad. DIEP (... is the ocean beyond the path. DEEP)

33 ... ligt de bikini op het kussen. SEXY (... is the bikini lying on the cushion. SEXY)

34 ... ligt de aardappel bij het badpak. GAAR (... is the potato lying next to the swimsuit. COOKED)

35 ... ligt de sloop over het biefstuk. GESTREKEN (... is the pillowcase lying on top of the steak. IRONED)

36 ... ligt de stift in het toilet. HARD (... is the peg in the restroom. HARD)

*de-het second*

37 ... ligt de schaar op het fauteuil. COMFORTABEL (... is the pair of scissors lying on the easy chair. COMFORTABLE)

38 ... ligt de bumper in het ravijn. DIEP (... is the bumper lying in the ravine. DEEP)

39 ... ligt de sloep in het lokaal. GESLOTEN (... is the dory in the community center. CLOSED)

40 ... ligt de zakdoek op het schip. STABIEL (... is the handkerchief lying on the ship. STABLE)

41 ... staat de stoel naast het spatbord. MODDERIG (... is the chair sitting next to the mudflap. MUDDY)

42 ... ligt de broek in het fort. VERSTERKT (... is the pair of trousers lying in the fortress. FORTIFIED)

43 ... zit de pen in het schort. GEBLOEMD (... is the pen in the apron. FLOWERED)

44 ... ligt de bloem naast het mes. BOT (... is the flower lying next to the knife. BLUNT)

45 ... is de kuil in het weiland. GEMAAID (... is the pit in the pasture. MOWN)

46 ... ligt de bunker onder het zeil. GESCHEURD (... is the bunker lying beneath the sail. TORN)

47 ... ligt de veer onder het juk. ZWAAR (... is the feather lying under the yoke. HEAVY)

48 ... ligt de ketting in het riool. STINKEND (... is the chain in the sewer. STINKY)

*het-de first*

49 ... ligt het lint in de berm. ROSE (... is the ribbon lying on the curb lawn. PINK)

50 ... staat het paard achter de schutting. INTELLIGENT (... is the horse behind the fence. INTELLIGENT)

51 ... is het portaal in de straat. OVERDEKT (... is the porch on the street. COVERED)

52 ... ligt het slipje op de kist. PIKANT (... is the pair of panties lying on the dresser. RACY)

53 ... hangt het schort over de ezel. GEBLOEMD (... is the apron draped over the donkey. FLOWERED)

54 ... ligt het landgoed achter de struik. OPENBAAR (... is the country house beyond the bush. PUBLIC)

55 ... ligt het slot in de tuin. STUK (... is the lock in the garden. BROKEN)

56 ... zit het vest in de doos. GEBREID (... is the vest in the box. KNITTED)

57 ... ligt het boeket in de trein. VERWELKT (... is the bouquet lying in the train. WILTED)

58 ... ligt het hakmes op de broek. GESLEPEN (... is the cleaver lying on the pair of trousers. SHARPENED)

59 ... ligt het perron achter de boom. VERLATEN (... is the platform beyond the tree. DESERTED)

60 ... ligt het gazon achter de flat. GEMAAID (... is the lawn behind the apartment building. MOWN)

*het-de second*

61 ... staat het aanrecht in de folder. DUN (... is the counter shown in the brochure. THIN)

62 ... is het bloedvat rond de ruggegraat. LENIG (... is the blood vessel surrounding the spine. SUPPLE)

63 ... ligt het papier op de trui. WARM (... is the piece of paper lying on the sweater. WARM)

64 ... ligt het pistool naast de mok. GEBARSTEN (... is the pistole beside the mug. CRACKED)

65 ... ligt het visnet in de straat. BETEGELD (... is the fishnet lying on the street. PAVED)

66 ... hangt het kleed over de schouder. GESPIERD (... is the dress draped over the shoulder. MUSCULAR)

67 ... ligt het boek naast de koekpan. AANGEKOEKT (... is the book lying next to the frying pan. BLACKENED)

68 ... ligt het album naast de bril. BESLAGEN (... is the scrapbook lying next to the pair of glasses. STEAMY)

69 ... ligt het wiel naast de hengel. BUIGZAAM (... is the wheel lying next to the fishing rod. FLEXIBLE)

70 ... staat het glas op de postzegel. ZELDZAAM (... is the glass standing on the stamp. RARE)

71 ... ligt het touw naast de ezel. DOM (... is the rope lying next to the donkey. STUPID)

72 ... ligt het vest over de diamant. RUW (... is the vest lying over the diamond. RAW)

*het-het first*

73 ... staat het veulen in het huis. DARTEL (... is the foal standing in the house. PLAYFUL)

74 ... ligt het eiland in het fjord. ONBEWOOND (... is the island in the fjord. UNINHABITED)

75 ... ligt het juweel op het papier. KOSTBAAR (... is the jewel lying on the piece of paper. PRECIOUS)

76 ... staat het beeld achter het hek. GELIJKEND (... is the statue behind the fence. LIFELIKE)

77 ... ligt het schrift in het nest. VERKREUKELD (... is the notebook lying in the nest. CRUMPLED)

78 ... staat het gehucht in het boek. UITGESTORVEN (... is the hamlet shown in the book. DESERTED)

79 ... staat het varken in het kasteel. VET (... is the pig standing in the castle. FAT)

80 ... ligt het tapijt op het plein. GESTOOMD (... is the carpet lying on the town square. DRYCLEANED)

81 ... staat het kuiken op het parket. KLEIN (... is the chicken standing on the parquet floor. SMALL)

82 ... staat het huis in het dal. VERVALLEN (... is the house in the valley. DILAPIDATED)

83 ... is het wegdek langs het kanaal. GEASFALTEERD (... is the roadway along the canal. ASPHALT)

84 ... staat het paleis in het hof. SPROOKJESACHTIG (... is the palace standing in the yard. FAIRYTALE-LIKE)

*het-het second*

85 ... ligt het potlood op het telegram. BEKNOPT (... is the pencil lying on the telegram. CONCISE)

86 ... staat het hek rond het zwijn. AGRESSIEF (... is the fence surrounding the hog. AGGRESSIVE)

87 ... staat het varken in het klooster. ONBEWOOND (... is the pig in the monastery. UNINHABITED)

88 ... ligt het geweer op het trottoir. BETEGELD (... is the rifle lying on the sidewalk. PAVED)

89 ... ligt het kompas in het kozijn. GEVERFD (... is the compass lying on the window sill. PAINTED)

90 ... ligt het artikel in het gebouw. HOOG (... is the article lying in the building. HIGH)

91 ... ligt het tijdschrift in het stadhuis. GERENOVEERD (... is the journal lying in city hall. RENOVATED)

92 ... zit het dak boven het matras. ZACHT (... is the roof above the mattress. SOFT)

93 ... ligt het ei op het boek. SAAI (... is the egg lying on the book. BORING)

94 ... ligt het laken op het terras. POPULAIR (... is the sheet lying on the terrace. POPULAR)

95 ... ligt het papier naast het horloge. PRECIES (... is the piece of paper lying next to the watch. PRECISE)

96 ... ligt het eikeblad naast het pistool. ZWAAR (... is the oak leaf lying next to the pistol. HEAVY)

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