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The selection of closed-class words in noun phrase production: The case of Dutch determiners

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Abstract

In three experiments we tested the predictions of two models of determiner selection in the production of Dutch noun phrases (NPs). In Experiment 1, participants named pictures using plural and unmarked determiner + noun NPs. In Experiment 2, participants named pictures using diminutive and unmarked determiner + noun NPs. In both experiments, we found that production latencies for plural and diminutive NPs relative to their unmarked baselines were affected by the gender of the base noun even though this feature of nouns is logically unnecessary in the selection of determiners in these types of NPs. In Experiment 3, we replicated the findings of Experiments 1, and generalized the observed pattern of results to a new condition: plural-diminutive NPs. This pattern of results, showing that the gender of the base noun is visible to the determiner selection process even when this information is logically superfluous, finds a ready explanation in frame-based models of determiner selection and is inconsistent with hierarchical models of determiner selection.

Language production involves selecting and ordering different types of words. A major distinction among word types is that between open-class (content) words, including nouns, verbs, and adjectives, and closed-class (function) words, such as auxiliaries, determiners, and prepositions. There are important differences between the processes that govern the selection of open- and closed-class words (e.g., Garrett, 1980). Consider the following sentence fragments in English (1), Dutch (2), and Italian (3):

1. The book; the church
2. Het boek [the book]; de kerk [the church]
3. Il libro [the book]; la chiesa [the church];

The processes that govern the selection of nouns appear to be similar across the three languages. That is, in English, the selection of the nouns *book* and *church* depends strictly on the semantic representation of the intention the speaker wants to express. Similarly, in Dutch and Italian the processes for selecting the nouns *boek*, *kerk*, *libro*, and *chiesa* are also driven exclusively by the semantic representation of the speaker's intention. This property of noun retrieval is captured in the architecture of models of lexical access by the fact that the only input to open-class lexical nodes comes from the semantic system (e.g., Caramazza, 1997; Dell, 1986; Levelt, Roelofs, & Meyer, 1999). In some models lexical retrieval is affected by feedback from other processing levels within the system (e.g., the phonological level; see Dell, 1986; Stemberger, 1985), however, here we simply want to stress the fact that in all models of lexical access in language production the information necessary for noun retrieval is supplied by the semantic system.

The processes involved in determiner selection appear to be different from those of nouns. This contention can be appreciated by considering the distribution of determiners in English, Dutch, and Italian, and the types of information that guide their selection. In the case of English, the selection of the determiner *the* is specified by

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the semantic property *definite* of the relevant argument in the proposition that the speaker intends to express. More important, the selection of the determiner *the* is largely independent of the properties of the noun that it corresponds to. In other words, the feature *definite* exhausts the information needed in order to select the proper determiner in English. The agreement constraints between nouns and determiners in English are rather weak: any common noun can follow the determiner *the*.[1]

Many languages have more stringent agreement rules between determiners and nouns than is the case for English. Dutch is one such language. In Dutch, the selection of the definite determiner *het* as in *het boek* depends on properties of the noun, as can be appreciated by the fact that not all nouns take the determiner *het*. When a speaker intends to say something about a specific church, rather than a specific book, the correct determiner is *de*, as in *de kerk*. The choice of the correct definite determiner in Dutch depends on a specific property of Dutch nouns, namely their grammatical gender (see Corbett, 1991, for a linguistic analysis of this feature). Dutch singular nouns are associated with one of two genders: common- or neuter-gender. Each gender is associated with a specific determiner form—*de* for common-gender nouns and *het* for neuter-gender nouns. Consequently, the selection of a specific determiner form in a singular noun phrase (NP) in Dutch depends on the availability of (at least) *two* distinct types of information: definiteness and grammatical gender. This means that determiner selection can only occur after the noun is selected and its gender property has become available. While the focus of this paper is on Dutch, it is important to point out that in other languages such as Italian and French determiner selection is even more complex. In these languages the selection of a determiner not only depends on the definiteness value of the NP and the noun's grammatical gender, but also on the immediate phonological context of the determiner (see Caramazza, Miozzo, Costa, Schiller, & Alario, 2001, for further discussion).

From these examples it is evident that there are important differences between the processes that govern the selection of nouns and those that govern the selection of determiners (see Caramazza et al., 2001, for further discussion). Three differences are relevant in the present context. First, as already noted, the selection of nouns can occur largely independently of other words in the sentence whereas the selection of determiners is dependent on the selection of their controlling nouns in the NP. Thus, for example, in a language such as Dutch, the specific form of a definite determiner in singular NPs depends on the grammatical gender of the controlling noun. Second, in contrast to the selection of nouns, the selection of determiners requires the combination of several kinds of information. For example, in Dutch NPs, the feature 'definite' alone does not fully specify the correct determiner form. Only when the lexical feature 'gender' also becomes available can the correct determiner be selected. Hence, both information about the NP's "definiteness" and information about the noun's grammatical gender are necessary in order to select the correct determiner form (Schriefers, 1993). Third, given that semantic, grammatical and phonological informations become available at different points in the course of NP production (see Bock & Levelt, 1994; Garrett, 1980), the various features needed for determiner selection do not become available simultaneously but do so over several "stages" of processing. In the case of Italian, for example, the relevant information for determiner selection spans the full range from the stage where semantic representations are specified to the stage where the segmental content of the word following the determiner is selected (Miozzo & Caramazza, 1999; and see Alario & Caramazza, 2002, and Costa, Sebastian-Galles, Miozzo, & Caramazza, 1999, for other Romance languages). In the latter case, determiner selection is necessarily a very late process in NP production.

This brief analysis of (one aspect of) the determiner systems of English and Dutch illustrates a crucial difference between the processes of noun and determiner selection: the latter but not the former requires the integration of information that becomes available at different stages of processing for the selection of the correct phonological form. What are the implications of this fact about determiners for theories of lexical access? Does each of the features needed to specify a determiner form independently activate its associated forms at the point in time where the feature is selected, or is determiner selection accomplished by first collecting all the required features into a determiner frame, which then activates its associated determiner? Here we address this issue by exploiting certain properties of the Dutch determiner system.

Consider the following NPs in Dutch:

4. het boek [the book]; de boeken [the books]; het boekje [the book (little)]
5. de kerk [the church]; de kerken [the churches]; het kerkje [the church (little)]
6. de kerkjes [the churches (little)]; de boekjes [the books (little)]

As already noted, Dutch nouns are associated with one of two genders, common or neuter. In (4) and (5), the neuter noun *boek* and the common noun *kerk* are shown in singular, plural, and diminutive noun phrases; in (6) the two nouns are shown in plural diminutive NPs. Two facts are immediately apparent. Although neuter and common nouns take different determiners when

[1] This is not the case for indefinite determiners whose selection depends crucially on the mass/count feature of nouns. Thus, consider mass nouns, which cannot be preceded by the indefinite determiner 'a' (e.g. *a sand).

used in singular NPs (*het boek* versus *de kerk*), they both take the determiner *de* in plural NPs (*de boeken* and *de kerken*) and they both take the determiner *het* in singular diminutive NPs (*het boekje* and *het kerkje*). Plural diminutive NPs take the determiner *de* (*de boekjes* and *de kerkjes*). The facts about the determiner system of Dutch captured in (4)–(6) reflect a hierarchical control structure such that the plural feature dominates the selection of the determiner in all contexts and the diminutive feature dominates the selection of the determiner in singular NP contexts. We can represent this property of the Dutch determiner system for plurals as in Fig. 1. We will defer discussion of the superficially similar case of diminutive NPs until a later point in this paper.

The hierarchical control structure of the Dutch determiner system encourages a simple hypothesis about the process of determiner selection: As each relevant feature becomes available it activates its associated determiner form(s) and selection occurs as soon as sufficient information is available for selection of the appropriate determiner. For ease of exposition, we will label this hypothesis the *hierarchical selection hypothesis.*

This hypothesis implies, for example, that the selection of plural determiners can take place as soon as the feature *plural* becomes available. This is because in definite NPs, the feature *plural* uniquely specifies a determiner form (*de*). If we were to further assume that information about grammatical number becomes available before information about a noun's gender we would be committed to the claim that the gender feature is invisible to the determiner selection process and that, therefore, the ease with which the plural determiner is selected is unaffected by the noun's gender.

Alternatively, it might be the case that the decision to select a determiner form is not taken until all the features that are associated with the determiner selection process have become available, whether or not they are necessary for specifying the correct determiner form in a given context. Thus, in the example of plural NPs above, the decision to select the determiner form *de* would not be made until both the number and the gender features have become available, even though the decision could have been made strictly on the basis of the feature *plural* alone. Following Alario and Caramazza (2002) we will refer to this hypothesis as the *unitized activation hypothesis* to stress the fact that all the features that are involved in determiner selection are collected in a language-specific determiner frame before selection of the appropriate determiner. We will also follow those researchers in assuming that each feature that is inserted in the determiner frame independently activates its associated determiner form(s), thereby priming those determiners that receive such activation—the *primed unitized activation hypothesis.* The latter assumption simply reflects the general principle of cascaded processing, which assumes that activated nodes in the system continuously send activation to their linked nodes. Thus, for example, the features *plural* and *neuter* in the feature combination *plural* + *neuter* each sends activation to its associated determiner (*de* and *het*, respectively) and the unitized representation *plural* + *neuter* also sends activation to its associated determiner (*de*).

The two hypotheses can be evaluated experimentally by considering the patterns of variation in naming latencies of different types of determiner + noun NPs. Their predictions are clearest in the case of plural NPs. The hierarchical selection hypothesis predicts that the gender of a noun should not affect latencies in plural NP production. The expectation follows from the assumption that the early selection of the feature *plural* will lead to the activation and immediate selection of the plural determiner *de*, leaving no opportunity for potential competition from other determiner forms. By contrast, the primed unitized activation hypothesis predicts that the gender of the noun should contribute to variation in naming latencies of plural NPs. This expectation follows from the assumption that the gender of the noun contributes to the activation of determiner forms even though it is logically superfluous—that is, grammatical gender is visible to the plural determiner selection process. Given this assumption, and the widely shared assumption that selection of lexical forms is a competitive process (where ease of selection is a function of the activation level of the target relative to those of potential competitors; e.g., Roelofs, 1992), we would expect slower production latencies in those cases where the gender of the noun activates a different determiner form from that required by the feature *plural.*

The predictions made by the two hypotheses in the case of diminutive NP production are more complicated, and depend on the assumptions that are made about the representation of diminutive nouns. Different predictions are

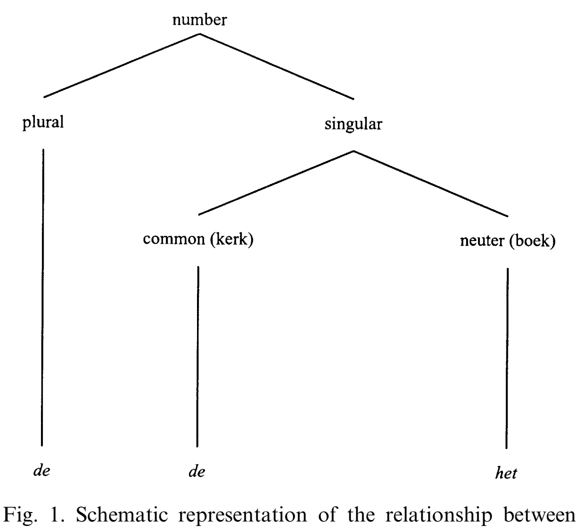

Fig. 1. Schematic representation of the relationship between number and gender in the selection of determiners.

made depending on whether diminutive nouns are represented in the lexicon in their "derived" form or whether they are computed on-line from a base form. Because of this complicating factor, we will defer discussion of diminutive NP production to a later part of the paper.

The predictions of the hierarchical selection and unitized activation hypotheses were tested in three experiments using singular, plural, and diminutive NPs. In Experiment 1, participants named pictures using singular and plural NPs; in Experiment 2, they named pictures with singular unmarked and diminutive NPs; and in Experiment 3, they named pictures using singular, plural, diminutive, and plural-diminutive NPs.

Experiment 1—Naming plural NPs

In this experiment, participants named pictures using determiner + noun NPs. Noun phrases were either singular or plural. Half of the pictures had common-gender and half had neuter-gender names. The primed unitized activation hypothesis predicts that relative to singular NPs the production of plural NPs with neuter nouns (e.g., de boeken [the books] versus het boek [the book]) should be slower than plural NPs with common nouns (e.g., de kerken [the churches] versus de kerk [the church]). This is because in the case of neuter nouns the features *plural* and *neuter*, respectively, activate the determiner forms *de* and *het*, which can compete for selection, whereas the features *plural* and *common* both activate the determiner form *de*. By contrast, the hierarchical selection hypothesis predicts no difference in production latencies between plural NPs with neuter nouns and common nouns. This is because for both common and neuter nouns, the feature *plural* is expected to lead to the immediate selection of the determiner form *de*. Hence, production latencies for both common and neuter nouns in plural NPs should be equal.

If we do find a difference in latencies between common and neuter nouns in singular and plural NPs, this would not necessarily reflect an effect of gender-based determiner selection. This is because the comparison carried out is between different sets of nouns for the two genders, and thus we cannot exclude that factors other than gender contributed to the results. In particular, it is possible that uncontrolled properties of the experimental stimuli or such properties interacting with the construction of NPs could influence the results. Two additional control experiments are reported to rule out such interpretations. In the first control experiment, participants named the stimuli from Experiment 1 with bare singular and plural nouns (e.g., boek, kerk, [book, church] versus boeken, kerken, [books, churches]). If the pattern of naming latencies in Experiment 1 is due to properties of the two sets of nouns themselves and not the process of determiner selection as we have hypothesized, we would expect a similar pattern of results for Experiment 1 and this control experiment. In the second control experiment, participants named the stimuli from Experiment 1 with quantifier + noun NPs (e.g., een boek, kerk [one book, church] versus twee boeken, kerken [two books, churches]). Note that Dutch quantifiers are not gender marked. If the results of Experiment 1 merely reflect properties of the two nouns in the context of NP constructions and not specifically properties of the determiner selection process, we would expect similar patterns of results for Experiment 1 and this control experiment.

Methods

Participants

Eighteen native Dutch speakers recruited from the University of Nijmegen participated in the experiment. They were paid four Euro upon completion of the experiment.

Materials

Sixty pictures were selected from several sources (ArtExplosion, 1998; Cycowicz, Friedman, Rothstein, & Snodgrass, 1997) as experimental items. All pictures were black and white line drawings of everyday objects or animals. Half of the pictures had a common-gender and half had a neuter-gender name. Other properties of the common- and neuter-gender words (i.e., surface frequency, number of syllables, and number of letters) were kept as similar as possible for both singular and plural picture names (see Table 1).

In order to elicit the appropriate singular and plural responses from participants (e.g., "het boek" [the book],

Table 1
Average surface frequency (per million from CELEX (Baayen, Piepenbrock, & van Rijn, 1993)), number of syllables, and number of letters of the singular and plural picture names in Experiment 1

Gender	Properties					
	Frequency		Syllables		Letters	
	Singular	Plural	Singular	Plural	Singular	Plural
Common	66.2	19.2	1.4	2.1	4.8	6.6
Neuter	68.1	18.5	1.4	2.3	4.9	6.8

"de boeken" [the books]), two versions were created from each picture. Participants were instructed to name stimuli depicting a single picture with singular NPs and to name stimuli depicting two identical pictures with plural NPs. All stimuli were presented in a white rectangle on a black background. The size of the white rectangle was 6 cm high and 20 cm wide. Stimuli depicting a single picture were constructed by placing the picture in the center of the rectangle. Stimuli depicting two pictures were constructed by placing the two pictures 5 cm apart.

Ten additional practice pictures (half common- and half neuter-gender names) were selected and modified in the same way as described above. Finally, 30 filler pictures with a neuter-gender name were selected. These filler pictures were always presented as a single picture, thus eliciting a singular NP response. The rationale for including these filler items is explained below. In total, 100 different pictures were selected for use in the experiment.

Design

The factor Gender of the base form (*common* or *neuter*) was crossed with the factor Number (*singular* or *plural*). All 120 experimental stimuli (60 singular and 60 plural stimuli) were presented to each participant. Of these 120 experimental items, the number of stimuli requiring the determiner *de* was 90 (60 plural NPs plus 30 singular common-gender NPs) whereas the number of stimuli requiring the determiner *het* was 30 (30 singular neuter-gender NPs). This imbalance could potentially lead to strategic effects in which participants anticipate the determiner form. Therefore, we included 30 filler items that required a singular neuter gender NP response. As a result, of the 150 stimuli, 90 required the determiner form *de* and 60 required the determiner form *het.*

The 150 stimuli were presented to participants in pseudo-randomized lists. Each list adhered to the following four constraints: (1) There were never more than three consecutive trials that required the same determiner form; (2) there were never more than three consecutive trials with an identical number type; (3) there were no trials on which the target picture name had a phonological onset identical to the target picture name on the preceding trial; and (4) there were no trials on which the target picture was semantically related to the target picture on the preceding trial. Each participant was shown the stimuli in a different order.

Procedure

Participants sat in front of an Apple Macintosh Quadra 610, with a 15-in. monitor in a dimly lit room. They wore a Sennheiser headphone with attached microphone. The microphone was connected to a buttonbox developed at the Nijmegen Institute for Cognition and Information. The buttonbox was equipped with a voice key and provided accurate measurements of vocal responses with a 1 ms resolution. The experimental software was Psyscope (Cohen, MacWhinney, & Flatt, 1993).

The experiment consisted of three parts. In the first part, participants were familiarized with the 100 experimental pictures. Participants were instructed to name pictures in the singular form without a determiner. Each trial was structured as follows. First, a fixation cross appeared for 500 ms. Next, a single picture was presented on the screen for 2000 ms. During the final 1000 ms of this presentation, the picture's name appeared beneath the picture and cued the participant to name the picture aloud. Finally, participants pressed a button on the buttonbox to initiate the next trial.

The second part consisted of practicing the experimental task while the third part was the actual experiment. The instructions and trial structure for both parts were identical. Participants were required to name single pictures with a singular determiner + noun NP and two identical pictures with a plural determiner + noun NP. The structure of a trial was as follows. First, a fixation cross appeared for 500 ms. Next, the target stimulus was presented for 1500 ms or until the participant made a vocal response. Finally, the participant pressed a button on the buttonbox to begin the next trial. The experiment lasted approximately 20 min.

Results

Trials on which the voice key triggered due to nonvocal responses, stuttering, or hesitations were excluded from the analysis. Trials on which participants produced an incorrect determiner, inflection, or noun were also excluded (6.2%). Finally, reaction times (RTs) that were above or below 3 standard deviations from the subject's mean and RTs above 2500 ms or below 300 ms were also excluded from further analysis (1.5%). From a total of 2160 trials (excluding fillers), 170 data points were discarded (7.9%).

The two factors we examined, Gender of the base form and Number, were treated as within-subjects factors in the F_1 analyses, and as between-subjects factors in the F_2 analyses. In all further analyses and tables the factor Gender refers to the gender of the base form. Mean RTs and error percentages for each condition are presented in Table 2. The error analyses revealed an interaction between Gender and Number in the subject but not in the item analysis [$F_1(1, 17) = 5.02, p < .05$, $F_2(1, 116) = 1.52, p = .22$]. The main effects of Gender and Number were not significant in the error analyses.

The RT analyses revealed no main effect of Gender [$F_1(1, 17) = 3.60, p = .08, F_2(1, 116) = 1.76, p = .19$] or Number (both Fs < 1). The interaction between Gender and Number was significant [$F_1(1, 17) = 23.97$,

Table 2
Mean reaction times (in ms) and error percentage (in brackets) for each condition in Experiment 1

Gender	Number		
	Singular	Plural	*Difference*
Common	817 (8.0)	765 (5.2)	52
Neuter	781 (8.5)	832 (9.8)	−51
Difference	36	−67	

$p < .0001, F_2(1, 116) = 23.10, p < .0001$]. We further explored this interaction by making individual comparisons of the *singular* and *plural* conditions for each gender condition with simple *t* tests. For common gender nouns, the *singular* condition differed from the *plural* condition [$t_1(17) = 3.93, p < .001, t_2(29) = 6.11, p < .001$] reflecting slower common-gender singular NPs than common-gender plural NPs. For neuter-gender nouns, the *singular* condition was also different from the *plural* condition [$t_1(17) = 4.06, p < .001, t_2(29) = 3.78, p < .001$], but in this case it was the plural NP that was slower, reflecting a cost in producing a neuter-gender plural NP relative to a neuter-gender singular NP.

The two control experiments were identical to Experiment 1 in all regards except for the type of response required in the naming task. Eighteen participants who had not taken part in Experiment 1 named the stimuli from Experiment 1 with bare singular and plural nouns. Mean RTs and error percentages are presented in Table 3. In the error analyses, we found no significant main effects of Gender [$F_1(1, 17) = 1.66, p = .21, F_2(1, 116) = 1.75, p = .18$], Number [$F_1(1, 17) = 4.01, p = .06, F_2(1, 116) = 1.75, p = .18$], or interaction between Gender and Number (both Fs < 1). Similarly, the RT analyses revealed no effects of Gender [$F_1(1, 17) = 2.12, p = .17, F_2 < 1$], Number [$F_1(1, 17) = 1.46, p = .24, F_2 < 1$], or interaction between Gender and Number (both Fs < 1).

In the second control experiment, 18 different participants named the stimuli from Experiment 1 with quantifier + noun NPs. Mean RTs and error percentages are presented in Table 3. The error analyses revealed a main effect of Gender [$F_1(1, 17) = 16.59, p < .01, F_2(1, 116) = 5.14, p < .03$]. Neither the main effect of Number (both Fs < 1) nor the interaction between Gender and Number [$F_1(1, 17) = 1.62, p = .22, F_2 < 1$] reached significance. The RT analyses revealed main effects of both Gender [$F_1(1, 17) = 7.48, p < .02, F_2 = (1, 116) = 5.97, p < .02$], and Number [$F_1(1, 17) = 6.54, p < .03, F_2 = (1, 116) = 5.95, p < .02$], but crucially, no interaction between Gender and Number (both Fs < 1).

Discussion

The results of Experiment 1 have established a clear fact: when considered relative to their respective singular NP baselines, the production of neuter-gender plural NPs is slower than that of common-gender plural NPs. That is, it is relatively harder to produce *de boeken* than *de kerken*, relative to their singular forms *het boek* and *de kerk*, presumably because the selection of the determiner *de* in *de boeken* competes for selection with the determiner *het*, but no such competition occurs in the case of *de kerken*. Two control experiments further bolster this conclusion. When participants named the same stimuli as in Experiment 1 with bare nouns or quantifiers (which are not gender marked in Dutch), a different pattern of results was obtained. In these control experiments there was no cost associated with naming neuter-gender plural nouns or quantifier + noun NPs unlike the case of determiner + noun plural NPs. These results strengthen our interpretation of the results of Experiment 1 as reflecting determiner selection processes.

The results we have reported are inconsistent with the hierarchical selection model, which predicts no differences in the production of plural NPs as a function of their gender type. The model's prediction is based on the assumption that the early availability of the number feature *plural* should lead to the immediate selection of the determiner *de*, precluding the possibility that activation of the noun's gender feature could contribute to the process of determiner selection. By contrast, the results are consistent with the primed unitized activation model, which predicts slower production latencies for neuter- than for common-gender plural NPs, relative to their respective singular forms. This model assumes that in the production of plural NPs, the features *definite*, *plural*, and *neuter* or *common gender* are selected and inserted into a standard determiner frame. In addition, the selection of each of these features will lead to activation (priming) of their associated determiner forms. When all features relevant to the selection of the deter-

Table 3
Mean reaction times and error percentage (in brackets) for singular and plural bare noun and quantifier + noun NPs naming

Gender	Bare noun			Quantifier + noun NP		
	Singular	Plural	*Difference*	Singular	Plural	*Difference*
Common	741 (4.6)	751 (6.1)	−10	652 (7.0)	633 (6.7)	18
Neuter	748 (6.1)	759 (8.1)	−11	670 (9.8)	653 (11.3)	17
Difference	−7	−8		−18	−20	

miner form have been selected, the specific feature configuration of the frame will send an extra jolt of activation to one determiner form, leading to its selection. On this account, the gender of the noun affects the selection process of determiners even though it may be logically superfluous in some contexts (e.g., plural NPs). This may be seen clearly by considering the expected effects for common- and neuter-gender nouns.

In the production of common-gender plural NPs, the determiner-relevant features to be activated first are the features *definite* and *plural*. These are phrasal features and do not depend on the selection of a specific noun. Each feature will send some activation to its associated determiner form(s). The next feature to be selected is the gender feature of the noun, in this case, *common*. This feature sends activation to its associated determiner form, *de*. The selection of the gender feature completes the set of features needed by the determiner frame, which sends activation to the determiner forms associated with the configuration *definite + plural + common*: *de*. In this example, the determiner form activated by the gender feature *common* and the determiner frame configuration *definite + plural + common* are the same, *de*, leading to fast selection and production of the determiner. In the case of neuter-gender plural NPs, different determiner forms are activated by the gender feature *neuter*, *het*, and the determiner frame configuration *definite+ plural + neuter*, *de*, creating the opportunity for competition between determiner forms and subsequent slowing down of the selection and production of the appropriate form. Thus, the primed unitized activation model provides a plausible account for our results, which have shown that relative to their respective singular NP baselines the production of neuter-gender plural NPs is slower than that of common-gender plural NPs.

A crucial assumption in the argument developed here is that in the production of plural NPs the gender of the noun stem is visible to the determiner selection mechanism. Our results confirm the plausibility of this assumption and therefore we can use the effects of a noun's gender on NP production to infer whether this grammatical feature is visible to the determiner selection process in other types of NPs. Especially relevant is the case of diminutive NPs. This is because the representation of diminutive nouns remains controversial. Although most Dutch nouns can be produced in their diminutive form (i.e., the domain is productive), the meaning of the diminutive noun is not always clearly related to the meaning of its noun stem plus suffix. That is, although the meaning of the majority of diminutive nouns is highly transparent (e.g., 'kerkje' meaning 'church, little'), there are diminutive nouns whose meaning is rather opaque (e.g., 'schatje', meaning 'darling', literal meaning 'treasure, little'). These observations about the domain of diminutive nouns motivate two general assumptions about diminutive representation. It could be argued that diminutives are represented in the lexicon in their full, derived form (Fig. 2a) or that semantically transparent diminutives are computed on-line by affixation of the diminutive suffix (Fig. 2b). Depending on which of the two assumptions is made, different expectations follow for the production of diminutive NPs. We turn to this issue next.

Let us consider first the assumption that diminutives are represented in the lexicon in their full, derived form (Fig. 2a). Recall that in Dutch all diminutive singular nouns take the determiner *het*. Therefore, if diminutives are represented in the lexicon in their derived form they would have the gender feature *neuter* ($kerkje_{\text{neu}}$; $boekje_{\text{neu}}$). What are the implications of this assumption for the production of diminutive singular NPs? A clear prediction follows: the production of diminutive singular NPs with common- and neuter-gender nouns in their unmarked forms should not differ, relative to their respective unmarked NP baselines (e g., *de kerk* and *het boek*). This is because the only gender information available to the determiner selection mechanism in the course of producing diminutive NPs would be the feature *neuter*, which is the gender feature of *all* diminutive nouns, and therefore the gender of the unmarked noun would be irrelevant to this process.

Different expectations follow if we were to assume that diminutive nouns are not stored in the lexicon in their derived form but are computed on-line in the production of diminutive singular NPs ($kerk_{\text{com}} + je_{\text{neu}}$; $boek_{\text{neu}} + je_{\text{neu}}$) (Fig. 2b). In this case, the gender of the base noun would be expected to affect the production of diminutive NPs for reasons similar to those presented for plural NPs. Consider first the production of diminutive NPs (e.g., *het kerkje*) with common-gender base nouns (e.g., *de kerk*). The determiner-relevant grammatical features that are selected first are the features *definite*, *singular*, and *diminutive*. The first two are phrasal features and the feature *diminutive* necessarily dominates features of the base noun. As before, these features send activation to their associated determiners. The next feature to be selected is the gender of the base noun, in this case the feature *common*, which is associated with the determiner *de*. The selection of the gender feature of the base noun completes the set of features required by the determiner frame and the assembled feature set activates its corresponding determiner: *het* in this case. Because the noun's gender activates a determiner (*de*) that is different from the NP-appropriate determiner (*het*) the two determiners will compete for selection, resulting in relatively slow production latencies for diminutive NPs with common-gender base nouns. By contrast, no such interference is expected for the production of diminutive NPs with neuter-gender base nouns. This is because the determiner associated with neuter nouns (*het*) and with singular diminutive NPs (*het*) is the same. In short, if the gender of the base noun in diminutive NPs is visible to the determiner

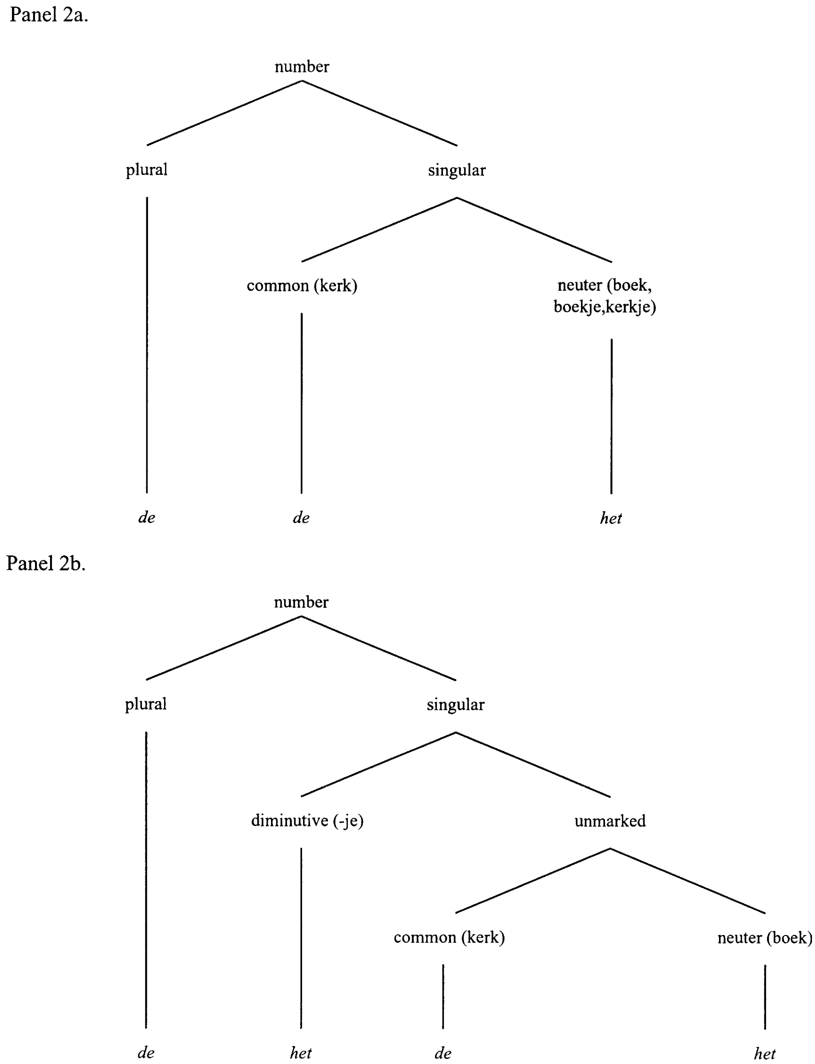

Fig. 2. Panel 2a shows a schematic representation showing the relationship between number, gender, and diminutive features in the selection of determiners. In this representation diminutive forms are assumed to be represented in the lexicon as stored, derived forms. They have the gender feature *neuter*. Panel 2b shows diminutive forms which are assumed to be computed by affixation and are not stored in the lexicon in their full derived form. The gender feature *neuter* is inherited from the diminutive suffix.

selection process we would expect slower naming times for diminutive NPs with common- than neuter-gender base nouns, relative to their respective unmarked NPs. Note that this pattern of performance, as a function of the gender of the base noun in diminutive NPs, is the opposite to the pattern observed with plural NPs, where performance with common-gender nouns was faster than with neuter-gender nouns.

Experiment 2Diminutive NP naming

In this experiment, participants named the set of pictures with common- and neuter-gender names from Experiment 1 in diminutive (e.g., het kerkje versus het boekje [the church, the book, little]) and unmarked NPs (e.g., de kerk versus het boek [the church, book]). If the gender of the base noun is visible to the determiner selection process, the unitized activation model predicts slower production latencies for common- than for neuter-gender nouns. Note that the predicted pattern of performance is the reverse of that found for plural NPs. As in the case of Experiment 1, we report two control experiments for Experiment 2 in an effort to rule out factors other than gender as responsible for any differences between common- and neuter-gender NPs. In one control experiment, participants named the stimuli from Experiment 2 with bare unmarked and diminutive nouns (e.g., boek, kerk, versus boekje, kerkje). In another control experiment, a different group of participants named the stimuli with indefinite + noun unmarked and diminutive NPs (e.g., een boek, een kerk [a book, church] versus een boekje, een kerkje [a book, church, little]). The motivation for these control experiments is identical to that for those used with Experiment 1.

Methods

Participants
Eighteen native Dutch speakers recruited from the University of Nijmegen took part in the experiment. They did not participate in Experiment 1. They were paid four Euro upon completion of the experiment.

Materials

The same 60 pictures as in Experiment 1 were used. In the initial selection of these materials care was taken that the diminutive name for each picture was semantically transparent. Whether or not a diminutive noun was transparent was based on the linguistic intuitions of the first author, who is a native speaker of Dutch. Because the diminutive is arguably more frequent in spoken than in written language, we do not have adequate control of the frequency of diminutive surface forms. The CELEX (Baayen et al., 1993) database mainly consists of entries from written corpora.

In order to elicit the desired unmarked and diminutive responses from participants (e.g., "het boek" [the book] or "het boekje" [the book, little]), we created two different-sized versions of each picture. The stimuli designed to elicit diminutive responses were the original pictures. The stimuli designed to elicit the unmarked responses were created by enlarging the original pictures by 200%. Participants were instructed to name stimuli depicting a normal sized picture with an unmarked determiner + noun NP and to name stimuli depicting a small picture with a diminutive determiner + noun NP. All stimuli were presented in a white rectangle on a black background. The size of the rectangle was about 12 cm by 12 cm. Both diminutive and unmarked stimuli were presented in the center of the white rectangle. The unmarked stimuli nearly filled the rectangle whereas the diminutive stimuli were considerably smaller than the rectangle. Pilot testing with unmarked and diminutive stimuli revealed that participants could easily distinguish between small and normal-sized pictures.

The same ten practice pictures from Experiment 1 were modified accordingly for use in this experiment. Finally, 30 filler pictures with a common-gender name were selected. The rational for including these filler items was similar to the one used in Experiment 1—that is, to provide a more balanced distribution of the required target determiner forms.

Design

The factor Gender (*common* or *neuter*) was crossed with the factor Size (*unmarked* or *diminutive*). Of the 120 experimental stimuli (60 unmarked plus 60 diminutive NPs) the determiner *het* was required for 90 stimuli (60 diminutive NPs plus 30 neuter gender NPs) and the determiner *de* was required for 30 stimuli (30 common-gender NPs). With the inclusion of the 30 filler stimuli with singular common-gender NPs, the number of stimuli with *het* determiner forms was 90 and the number of stimuli with *de* determiner forms was 60. As in Experiment 1, the resulting 150 stimuli were pseudo randomized in a list following the same constraints as in Experiment 1. Eighteen such lists were created.

Procedure

The experimental procedure was the same as in Experiment 1.

During familiarization, participants saw the unmarked stimuli. In the experimental and practice phase, participants were instructed to use an unmarked determiner + noun NP or a diminutive determiner + noun NP depending on the relative size of the picture.

Results

Trials on which the voice key triggered due to nonvocal responses, stuttering, or hesitations were excluded from the analysis. Trials on which participants produced an incorrect determiner, inflection, or noun were also excluded (8.5%). Furthermore, reaction times (RTs) that were above or below 3 standard deviations from the subject's mean and RTs above 2500 ms or below 300 ms were also excluded from further analysis (1.5%). From a total number of 2160 trials (excluding fillers), 216 data points were excluded (10.0%).

A summary of the mean RTs and error rate for each condition is presented in Table 4. The error analysis revealed an effect of Size in the item but not in the subject analysis [$F_1(1,17) = 3.85, p = .07, F_2(1,116) = 5.32, p < .03$] suggesting a trend towards more errors in the diminutive than in the unmarked condition. Furthermore, the error analysis revealed an interaction between Size and Gender [$F_1(1,17) = 11.02, p < .005$, $F_2(1,116) = 8.16, p < .006$]. We explored this interaction by making individual comparisons of the conditions *unmarked* and *diminutive* separately for each gender by means of a t test. For neuter gender nouns, the conditions *unmarked* and *diminutive* did not differ significantly (both ts < 1). For common-gender nouns, there were significantly more errors in the *diminutive* than the

Table 4
Mean reaction times (in ms) and error percentage (in brackets) for each condition in Experiment 2

Gender	Size		
	Unmarked	Diminutive	*Difference*
Common	881 (7.0)	942 (15.7)	−61
Neuter	874 (9.1)	869 (8.1)	5
Difference	7	73	

unmarked condition $[t_1(17) = 2.74, p < .02, t_2(29) = 4.71, p < .001]$.

The analyses of RTs revealed a main effect of Gender $[F_1(1,17) = 14.50, p < .002, F_2(1,116) = 7.63, p < .007]$ and a main effect of Size by subjects but not by items $[F_1(1,17) = 7.35, p < .02, F_2(1,116) = 2.99, p = .09]$. Most important, the interaction between Gender and Size was significant $[F_1(1,17) = 12.53, p < .003, F_2(1,116) = 4.69, p < .04]$. We further explored this interaction by making individual comparisons of the *unmarked* and *diminutive* conditions for each gender condition with t tests. For neuter-gender nouns, the *unmarked* condition did not differ from the *diminutive* condition (both ts < 1). For common-gender nouns, the *unmarked* condition differed from the *diminutive* condition $[t_1(17) = 4.30, p < .001, t_2(29) = 3.24, p < .003]$ reflecting a cost in producing diminutive common-gender NPs relative to unmarked common-gender NPs.

The two control experiments were identical to Experiment 2 except for type of response. In one control experiment, 18 participants who had not taken part in any of the other experiments named the stimuli from Experiment 2 with bare unmarked and diminutive nouns. Mean RTs and error percentages are presented in Table 5. The error analyses revealed a main effect of Gender in the subject but not the item analysis $[F_1(1,17) = 6.00, p < .03, F_2 < 1]$. A main effect of Size was found $[F_1(1,17) = 6.57, p < .03, F_2(1,116) = 4.91, p < .03]$. The interaction between Gender and Size was significant in the subject but not the item analysis $[F_1(1,17) = 10.13, p < .01, F_2(1,116) = 2.23, p = .14]$. The RT analyses revealed no effect of Gender $[F_1(1,17) = 2.84, p = .11, F_2 < 1]$. A significant effect of Size $[F_1(1,17) = 6.54, p < .03, F_2(1,116) = 7.61, p < .01]$ was observed. There was no interaction between Gender and Size $[F_1(1,17) = 2.84, p = .11, F_2 < 1]$.

In the other control experiment, 18 different participants named the stimuli from Experiment 2 with indefinite+noun NPs. Mean RTs and error percentages are presented in Table 5. In the error analyses, no main effect of Gender was found $[F_1(1,17) = 3.73, p = .07, F_2(1,116) = 3.09, p = .08]$. The factor Size reached significance only in the subject analysis $[F_1(1,17) = 5.58, p < .04, F_2(1,116) = 2.71, p = .10]$. The interaction between Gender and Size was not significant (both Fs < 1). The RT analyses revealed no effect of Gender (both Fs < 1). The factor Size was significant $[F_1(1,17) = 5.61, p < .04, F_2 = (1,116) = 7.67, p < .01]$. Finally, there was no significant interaction between Gender and Size $[F_1(1,17) = 1.92, p < .18, F_2 < 1]$.

Discussion

For diminutive NP naming, we found slower RTs for common- than for neuter-gender base nouns, relative to their respective unmarked NPs. These effects disappeared when no determiner selection was necessary (bare noun naming control experiment) or when the determiner was not gender marked (indefinite determiner NP production control experiment). This pattern of results demonstrate that the gender feature of the base noun in diminutive NPs is visible to the determiner selection process. Two implications follow from this fact. First, the results are consistent with the primed unitized activation hypothesis of determiner selection. As argued above, the fact that performance in producing diminutive NPs is a function of the gender of the base noun implies that the determiner selection mechanism considers the full suite of features normally associated with that process even when a particular feature is logically superfluous for the decision. We take this implication as providing support for a frame-based model of determiner selection.

The other implication of the results of Experiment 2 is that the base form of a diminutive noun is active during morphological processing of diminutive NPs. Because the production latencies of diminutive NPs were affected by the gender of the base form, we could conclude that the base form associated with the gender was also selected. However, an alternative possibility can be entertained. Perhaps the activation of the base form arises in parallel with the independent selection of the full, diminutive form. Thus, for example, we could assume that the semantic representation of a diminutive noun (e.g.,

Table 5
Mean reaction times and error percentage (in brackets) for unmarked and diminutive bare noun and indefinite+noun NP naming

Gender	Bare noun			Indefinite+noun NP		
	Unmarked	Diminutive	*Difference*	Unmarked	Diminutive	*Difference*
Common	753 (7.0)	788 (8.1)	−35	672 (5.2)	686 (8.5)	−14
Neuter	770 (7.0)	788 (12.8)	−18	667 (8.7)	695 (10.7)	−28
Difference	−17	0		5	−9	

[CHURCH, LITTLE]) activates both the lexical node of the full diminutive form ($kerkje_{neu}$) and the lexical node of the base form ($kerk_{com}$). This situation would arise if we assumed that diminutive forms are represented in their full derived form and independently of their base form, and if the semantic representations of diminutives activate both diminutive and base forms. Therefore, evidence indicating that the base forms of diminutives are activated in the course of diminutive NPs does not allow us to distinguish between assumptions regarding morphological processing of diminutive nouns.

The difference in production latencies between common- and neuter-gender nouns found in Experiments 1 and 2 cannot be attributed to a difference in properties of the base nouns other than gender. The reasoning here is as follows. If the results found in Experiment 1 were due to differences in the materials other than gender, we would have expected to find these same differences in Experiment 2, as the same materials were used. However, opposite patterns of results were found in the two experiments. That is, in Experiment 1, neuter nouns were slower than common nouns in plural noun phrases, but in Experiment 2, common nouns were slower than neuter nouns in diminutive noun phrases. This pattern of results, along with the results of the control experiments, indicates that the causes of the observed effects are most likely the gender properties manipulated in the two experiments.

Although the results obtained in Experiments 1 and 2 appear to be quite robust, it is important to replicate them, especially since they have fairly strong implications for theories of grammatical feature selection and determiner production. In Experiment 3 we carried out a replication of the first two experiments. In addition, it is important to investigate whether the observed results generalize to other conditions. For this purpose, we included a condition in which participants named pictures in diminutive plural NPs. As mentioned in the Introduction, these NPs take the determiner form *de*. Thus, relative to appropriate baselines, we should observe costs in naming NPs with neuter-gender base nouns, but also in naming diminutives with common-gender base nouns since the feature *diminutive* will activate the competing determiner *het*.[2]

[2] It could be argued that we should make an additional prediction regarding the production of plural diminutive NPs relative to plural NPs. A potentially important difference between these NPs is that the former but not the latter type of NP includes the grammatical feature diminutive, hence allowing the opportunity to evaluate the contribution of this specific feature on NP production. Such a difference depends, on the assumptions regarding the morphological representation of diminutives (i.e., on-line computation or full form storage). However, as noted above, these assumptions need to be evaluated empirically before we can base our predictions on them.

Experiment 3–Diminutive plural NP naming

In this experiment we included all the pictures from Experiments 1 and 2. In addition, the pictures were modified to create stimuli appropriate for eliciting diminutive plural NPs.

Methods

Participants

Sixteen native Dutch speakers recruited at the University of Nijmegen were asked to participate in the experiment. None had participated in Experiments 1 or 2. They were paid four Euro upon completion of the experiment.

Materials

The same 60 pictures as in Experiments 1 and 2 were used. To elicit the unmarked, diminutive, plural, and diminutive-plural NP responses from participants (e.g., het boek [the book], het boekje [the book (little)], de boeken [the books], de boekjes [the books (little)]), we created four sets of experimental stimuli. The set of stimuli for eliciting the unmarked responses was created by enlarging the original pictures by 200%. The set of stimuli for eliciting the diminutive responses was identical to the set of original pictures. The set of stimuli for eliciting the diminutive-plural response was created by placing two identical pictures from the set of diminutive stimuli side-by-side. Finally, the set of stimuli for eliciting plural responses was created by first enlarging the original pictures by 140% and then placing two identical pictures side-by-side.

All pictures were presented to participants as a black outline on a white background. In order to facilitate the discrimination among the four different types of required responses, each picture was encompassed by a thin, one pixel wide black rectangle. The size of the rectangle for a specific picture depended on the required type of response for that picture. Thus, four different sizes of rectangle were created where each size corresponds to one particular response type.

Design

The factor Gender with two levels (*common* or *neuter*) was crossed with the factor Utterance Type with four levels (*unmarked, diminutive, plural,* and *plural-diminutive*). There were 60 pictures (30 common and 30 neuter gender) in each Utterance Type condition, hence, the total number of stimulus items in the experiment was 240. The number of stimuli with determiner form *de* was 150, and the number of stimuli with determiner form *het* was 90. The constraints of pseudo randomizing each of these 240 stimuli into experimental lists were identical to those in Experiments 1 and 2.

Procedure

The procedure was similar to Experiments 1 and 2. In the familiarization phase, participants saw all pictures from the unmarked stimulus set. In the practice phase, the participants were told that four different types of responses were possible. Participants were told to pay attention to the thin rectangle encompassing each picture as this would inform them which type of response was appropriate. The experiment lasted approximately 25 min.

Results

Trials on which the voice key triggered due to nonvocal responses, stuttering, or hesitations were excluded from the analyses. Trials on which participants produced an incorrect determiner, inflection, or noun were also excluded (7.1%). Finally, reaction times (RTs) that were above or below 3 standard deviations from the subject's mean and RTs above 2500 ms or below 300 ms were also excluded from further analysis (1.4%). From a total number of 3840 data points, 329 data points were excluded (8.5%).

A summary of the mean RTs and percentage of errors in each condition is presented in Table 6. The error analysis yielded a significant result for the interaction between Gender and Utterance Type in the subject but not in the item analysis [$F_1(3,45) = 5.08, p < .007$, $F_2(3,232) = 2.10, p = .10$]. The RT analysis revealed a main effect of Gender in the subject but not in the item analysis [$F_1(1,15) = 4.57, p < .05, F_2(1,232) = 1.97, p = .16$]. No main effect of Utterance Type was found [$F_1(3,45) = 1.34, p = .27, F_2 < 1$]. Most importantly, the interaction between Gender and Utterance Type was significant [$F_1(3,45) = 8.75, p < .0001, F_2(3,232) = 7.320, p < .0001$].

We further explored this interaction using t tests by making individual comparisons between *unmarked* and *diminutive*, *plural*, and *diminutive-plural* for each Gender condition. For neuter-gender nouns, a significant difference was found between *unmarked* and *diminutive-plural* [$t_1(17) = 2.66, p < .02, t_2(29) = 3.85, p < .001$] reflecting a cost for *diminutive-plural* (45 ms). *Unmarked* and *plural* conditions [$t_1(17) = 3.06, p < .007, t_2(29) = 3.76, p < .001$] were different, reflecting a cost for *plural* (41 ms). We observed no difference between *unmarked* and *diminutive* (both ts < 1). For common-gender nouns, a statistical difference was observed between *unmarked* and *plural* [$t_1(17) = 2.84, p < .02, t_2(29) = 2.59, p < .02$] reflecting a gain of 33 ms for the *plural* condition. The analyses revealed no differences between *unmarked* and *diminutive* (both ts < 1), and between *unmarked* and *diminutive-plural* [$t_1 < 1, t_2(29) = 1.25, p = .22$].

Discussion

The pattern of results found in Experiment 3 replicates the pattern found in Experiment 1, and are consistent with the findings from Experiment 2. When the determiner form associated with the gender of the base noun was inconsistent with the determiner form that had to be produced, response latencies were delayed. These results confirm the hypothesis that the gender of the base noun is visible to the determiner selection process, even when that information is logically superfluous to the selection of the correct determiner form.

We do not replicate the findings from Experiment 2. For diminutive NPs, common-gender nouns were not delayed relative to their respective unmarked NP baselines. Further research is necessary in order to confirm the robustness of this particular result. All other findings from Experiment 1 replicate and appear to be robust. Moreover, the pattern observed in Experiment 1 generalizes to another condition–the diminutive-plural.

One final point. In Experiment 1, the number of stimuli requiring a singular determiner is 90 and the number of stimuli requiring a plural determiner is 60. One could argue that this situation might have led participants to activate the singular determiner for plural stimuli. The results of Experiment 1 would then be considered mere task artifacts. In Experiment 3, the number of singular stimuli is 60 and the number of plural stimuli is 120 (plural, and plural-diminutive). This near reversal of the proportions of singular to plural NPs does not influence the results. We replicate the results from Experiment 1 in Experiment 3. Therefore, it is unlikely that results obtained in Experiment 1 merely reflect the proportion of singular and plural stimuli in the experiment.

Table 6
Mean reaction times (in ms) and error percentage (in brackets) for each condition in Experiment 3

Gender	Utterance type			
	Unmarked	Plural	Diminutive	Dim-Plural
Common	808 (9.4)	778 (5.2)	821 (11.0)	795 (9.6)
Neuter	767 (7.7)	808 (8.5)	773 (6.3)	812 (10.8)
Difference	41	−30	48	−17

General discussion

In three experiments we tested the predictions of two models of determiner selection in the production of Dutch NPs. In Experiment 1, participants named pictures using plural and unmarked determiner + noun NPs. We found that when the determiner in the plural NP (*de boeken*) was inconsistent with the determiner of the base noun (*het boek*), there was a cost in production latency. That is, production latencies for plural NPs with neuter-gender base nouns were delayed by comparison to plural NPs with common-gender base nouns relative to their respective singular NP baselines.[3] Two control experiments rule out attributing these effects to factors other than gender. In Experiment 2, participants named pictures using diminutive and unmarked determiner + noun NPs. We found that when the determiner of the diminutive NP was inconsistent with the determiner in the unmarked case, there was a cost in production latency. That is, the production latencies of diminutive NPs with common-gender base nouns (*het kerkje*) were delayed by comparison to diminutive NPs with neuter-gender base nouns (*het boekje*), relative to their respective unmarked NPs (*de kerk* and *het boek*). Again, two control experiments ruled out that factors other than gender influenced the results. In Experiment 3, we replicated the findings of Experiment 1, and generalized the observed pattern of results to a new condition: plural-diminutive NPs. In the latter case, the production latencies of plural-diminutive NPs (always *de*) were relatively delayed in the case of neuter-gender nouns.

What are the implications of this pattern of results for theories of lexical access and more specifically for theories of determiner selection in NP production? We have argued that this pattern of results is *not* consistent with a hierarchical activation model that considers only the sufficient conditions for determiner selection. On such a model the gender of a noun would be invisible to the determiner selection process in the production of plural NPs in Dutch: the noun's gender would not be selected since the feature *plural* completely specifies the determiner of the NP—always *de*. Contrary to these expectations, the data clearly indicate that the gender of the base noun is visible to the determiner selection process, even in those instances, such as Dutch plural NPs, where this information is logically superfluous.

[3] Schriefers, Jescheniak, and Hantsch (2002) have obtained similar results in German. In German, as in Dutch, there is only one determiner used for all plural NPs (*die*), irrespective of the noun's gender. They found that when the gender of the base noun was associated with a different determiner from the one required by plural NPs response latencies were delayed. Thus there is cross language generalizability of the determiner interference phenomenon reported here.

The primed unitized activation model presented in the Introduction can account for the basic facts of determiner production in Dutch. This model assumes that as the features relevant to determiner selection become available they are inserted in a determiner frame. When the determiner frame is fully specified, the configuration of the filled frame will activate the specific determiner with which it is associated. For instance, in the production of singular NPs, the feature configuration *definite + singular + neuter* will activate the determiner *het*, while the configuration *definite + singular + common* will activate the determiner *de*. The model also assumes that as individual features are activated/selected they send activation to the determiner with which they are associated (see Fig. 1 for the specific connections). Thus, the feature *definite* would send activation to *het* and *de*, as would the feature *singular*. However, the gender feature *neuter* sends activation only to *het* and the gender feature *common* sends activation only to *de*. Similarly, the feature *plural* sends activation only to *de*, while the feature *diminutive* sends activation only to *het*. An implication that follows from the assumption that determiners receive activation both from specific features (e.g., $neuter \rightarrow het$) as well as feature-configurations (e.g., $definite + plural + neuter \rightarrow de$) is that in some instances more than one determiner will be activated. Furthermore, the activation levels of the determiners will vary as a function of the number and magnitude of inputs they receive.

To illustrate the implications of these assumptions about activation from individual features as well as feature configurations, consider again the case of plural NPs. In the production of common-gender plural NPs, the feature combination *definite + plural + common* activates the determiner *de*, as do the features *plural* and *common*. By contrast, in the production of neuter-gender plural NPs, the feature combination *definite + plural + neuter* also activates the determiner *de*, as does the feature *plural*, but the feature *neuter* activates the determiner *het*. The selection of the determiner *de* for neuter-gender plural NPs is doubly disadvantaged relative to the case of common-gender plural NPs): it receives activation from fewer sources and it must compete with the determiner *het*, which is strongly activated by the gender feature *neuter*. Consequently, relative to their respective baselines, the selection of the determiner of neuter-gender plural NPs should be more difficult than the selection of the determiner of common-gender plural NPs. This is precisely the pattern of results obtained in Experiments 1 and 3. Furthermore, the results of Experiment 2 show that the base noun's gender is visible to the determiner selection process in the production of diminutive NPs, as indicated by the fact that latencies in producing diminutive NPs are affected by the gender of the base nouns in the NPs. Thus, the results in naming plural and diminutive NPs are well accounted for within the primed unitized activation model of determiner selection.

The fact that the gender of the base form affected production latencies in diminutive NPs could be interpreted to indicate that the base form's gender is selected during production of diminutive NPs. What implications does this interpretation have for theories of morphological processing of diminutives? Selection of the base form and its associated gender would suggest that, in contrast to full-form storage accounts of diminutive nouns, the form of such nouns is computed on-line by affixation of the diminutive suffix to the base form. However, as we noted previously, the results we have reported allow an alternative interpretation. It could be argued that the base-form gender effect reflects the fact that the semantic representations of diminutive nouns activate in parallel the lexical representations of both the full derived form and the noun base form. In such a case, our data would not allow us to distinguish between competing theories of the morphological processing of diminutive nouns. Predictions that follow from these theories await further empirical testing.

The primed unitized activation model is consistent with data from a recent study by Alario and Caramazza (2002) in which French subjects named pictures with determiner + noun NPs. In order to examine how closed-class words are selected in French, the authors exploited certain specific characteristics of the French language. In French, the form of the determiner depends on both the gender of the noun and the determiner's phonological context. This is clearly the case for possessives. The form of possessive determiners in French depends on a combination of information about the determiner's phonological context and the noun's gender. However, there is an asymmetry in the way the phonological onset of the noun affects the form of the possessive determiner for feminine and masculine nouns. That is, whereas the correct possessive determiner form for *masculine nouns* is always *mon* (e.g., mon chapeau [my hat]; mon arbre [my tree]), the correct possessive determiner form for *feminine nouns* is *ma* for consonant-initial nouns (e.g., ma table [my table]) and *mon* for vowel-initial nouns (e.g., mon ampoule [my light bulb]). Thus, in French, like other Romance languages such as Italian and Catalan, the selection of the determiner form depends on a combination of gender and phonological information.

This leads to the following observation about the structure of the French possessive determiner system. When the phonological context is a vowel, the determiner form is always *mon* irrespective of the noun's gender. If the phonological context is a consonant, the form of the determiner is specified by the noun's gender. For a masculine noun, the determiner form is *mon*. For a feminine noun, the determiner form is *ma*. Since for vowel-initial nouns the determiner form is always *mon*, the question arises whether the gender of the noun plays any role in determiner selection for vowel-initial nouns or whether phonology is all that matters. If phonology is consulted before making a decision on whether or not to consider gender, then, the gender of vowel-initial nouns should have no effect on naming latencies (since gender would be invisible to the determiner selection process). If, however, gender is always considered, even when apparently superfluous, we would then expect NPs with vowel-initial feminine nouns to be produced slower than vowel-initial masculine nouns. This expectation follows from the fact that the determiner form associated with the masculine gender is congruent (*mon*), while the determiner form associated with the feminine gender is incongruent (*ma*) with the target determiner form for vowel-initial nouns (*mon*). The results reported by Alario and Caramazza (2002) revealed a cost in producing NPs with vowel-initial feminine nouns.

The primed unitized activation model accounts for these data in the following way. As the individual features *possessive*, *gender*, and *phonological context* become available, they are stored in a determiner frame. Each feature primes its (or their) associated determiner form(s). In the case of vowel-initial feminine nouns, the features *feminine* and *vowel-initial* lead to the activation of the determiner forms *ma* and *mon*, resulting in a selection conflict. By contrast, in the case of vowel-initial masculine nouns, there is no determiner selection conflict because the features *masculine* and *vowel-initial* both lead to the activation of the determiner form *mon*.

Although the data reported for French are consistent with the unitized activation model, strictly speaking, they do not allow a direct test of the hierarchical selection hypothesis. This is because although French is similar to Dutch in that in some contexts determiner selection *logically* depends on only a subset of the features normally used in this process, it is unlike Dutch in the temporal order of the availability of the information logically sufficient for selecting a determiner. In Dutch the information logically sufficient for determiner selection becomes available *before* gender information, whereas the reverse is true in the case of French. In the latter case, the logically sufficient information–vowel-initial phonological context–becomes available later than gender information (e.g., Van Turennout, Hagoort, & Brown, 1998). Nevertheless, the results for French and our results converge in showing that in the production of NPs the determiner selection mechanism considers gender information even when it is logically superfluous.

The results reported here also have important implications for the interpretation of the gender congruity effect observed in some experiments with the picture-word interference paradigm. Schriefers (1993) (Schriefers & Teruel, 2000; see also LaHeij, Mak, Sander, & Willeboordse, 1998; Van Berkum, 1997) investigated whether the selection of grammatical features is an automatic or a competitive process that is affected by the activation level of other relevant grammatical features (as is assumed to be the case for lexical nodes). He investigated this issue by having Dutch participants name pictures by using determiner + adjective + noun phrases (e.g., de groene stoel; het groene bed [the green chair; the green bed]).[4] A distractor word was superimposed on each picture in the experiment. The gender of the picture name and the distractor word could be the same or different. The results revealed longer naming latencies when the genders of the distractor word and picture name were different than when they were the same–the so-called gender congruency effect. Schriefers interpreted these results as reflecting competition in the selection of a word's grammatical gender.

An alternative interpretation of the gender congruency effect has been proposed by Caramazza et al. (2001). These researchers argued that the congruency effect reflects competition between determiners and not between grammatical features. They proposed that a word's grammatical features are selected *automatically* and non-competitively upon selection of its lexical node. By contrast, the selection of determiners is a competitive process just like that of any other word. On this view, the gender congruency effect reflects competition (facilitation) between the determiner activated by the target word and the determiner activated by the distractor word. This proposal is based on three additional observations about the gender congruency effect. First, no gender congruency effects have been found in the Romance languages that have been tested to date: Italian (Miozzo & Caramazza, 1999), Catalan and Spanish (Costa et al., 1999), and French (Alario & Caramazza, 2002). These languages are characterized by the interesting property that determiner selection depends not only on the noun's gender but also on local phonological context (see Introduction). Second, a gender congruency effect is not reliably found in Dutch and German (Schiller & Caramazza, in press), and Croatian (Costa, Kovacic, & Caramazza, submitted) when participants are asked to name pictures using adjective + noun NPs. Third and most important, no gender congruency effect is found in Dutch and German when participants produce plural NPs (Schiller & Caramazza, in press). Recall, that in these languages the same determiner is used for all genders for plural NPs (*de* in Dutch and *die* in German). If the gender congruency effect were due to competition between gender features, it should make no difference whether participants name pictures with singular or plural NPs. However, if the interference effect is due to competition between determiner forms, the effect should be found with singular but not with plural NPs. This is because in the plural NPs condition the determiner form activated by the distractor word is always congruent with the target determiner. As already noted, Schiller and Caramazza (in press) replicated the gender congruency effect for singular NPs but not for plural NPs. Thus, it would appear that the gender congruency effect is only obtained reliably in those cases where the target and the distractor word activate competing free-standing phonological forms (such as determiners) (see also LaHeij et al., 1998).

However, the interpretation of the results reported by Schiller and Caramazza (in press) can be contested. It could be argued that since plural NPs in Dutch and in German are not gender marked, the nouns' gender features are not selected in the production of these phrases. And if the gender features are not selected in plural NPs there would be no basis for a gender congruency effect in the production of these utterances. If this conjecture were correct, the results by Schiller and Caramazza would not speak to the issue of how grammatical features and determiners are selected. Hence, the crucial question that needs to be answered is whether the noun's gender feature is considered in the production of plural NPs. The results we have reported here provide an answer to this question. In Experiments 1 and 3, it was demonstrated that in plural NPs, the gender feature contributes to the selection of the determiner even though it is logically unnecessary. Thus, we can conclude that the results of Schiller and Caramazza (in press) converge with other results in showing that the activation and selection of grammatical features is not a competitive process.

In conclusion, the experiments reported here have established a crucial fact: the base noun's gender feature is visible to determiner selection processes even in those cases where the feature is logically superfluous, as is the case in the production of plural and diminutive NPs. This conclusion is consistent with a frame-based model of determiner selection in which all the relevant features are collected for activation of the proper determiner.

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[4] In Dutch, the adjective in determiner + adjective + noun phrases always has the same form irrespective of the noun's gender.

Appendix A. Objects with neuter gender names used in Experiments 1, 2, and 3

Picture name	Gender	Diminutive	Plural
Anker ('anchor')	Neuter	Ankertje	Ankers
Bed ('bed')	Neuter	Bedje	Bedden
Been ('leg')	Neuter	Beentje	Benen
Boek ('book')	Neuter	Boekje	Boeken
Bureau ('desk')	Neuter	Bureautje	Bureaus
Kompas ('compass')	Neuter	Kompasje	Kompassen
Fornuis ('stove')	Neuter	Fornuisje	Fornuizen
Hart ('heart')	Neuter	Hartje	Harten
Hek ('fence')	Neuter	Hekje	Hekken
Hert ('deer')	Neuter	Hertje	Herten
Kasteel ('castle')	Neuter	Kasteeltje	Kastelen
Konijn ('rabbit')	Neuter	Konijntje	Konijnen
Mes ('knife')	Neuter	Mesje	Messen
Nest ('nest')	Neuter	Nestje	Nesten
Net ('net')	Neuter	Netje	Netten
Oor ('ear')	Neuter	Oortje	Oren
Paard ('horse')	Neuter	Paardje	Paarden
Pistool ('gun')	Neuter	Pistooltje	Pistolen
Potlood ('pencil')	Neuter	Potloodje	Potloden
Raam ('window')	Neuter	Raampje	Ramen
Schaap ('sheep')	Neuter	Schaapje	Schapen
Skelet ('skeleton')	Neuter	Skeletje	Skeletten
Slot ('lock')	Neuter	Slotje	Slotten
Touw ('rope')	Neuter	Touwtje	Touwen
Varken ('pig')	Neuter	Varkentje	Varkens
Vergiet ('colander')	Neuter	Vergietje	Vergieten
Vest ('vest')	Neuter	Vestje	Vesten
Wiel ('wheel')	Neuter	Wieltje	Wielen
Zadel ('saddle')	Neuter	Zadeltje	Zadels
Zwaard ('sword')	Neuter	Zwaardje	Zwaarden

Objects with common gender names used in Experiments 1, 2, and 3

Picture name	Gender	Diminutive	Plural
Kikker ('frog')	Common	Kikkertje	Kikkers
Deur ('door')	Common	Deurtje	Deuren
Arm ('arm')	Common	Armpje	Armen
Auto ('car')	Common	Autootje	Auto's
Vogel ('bird')	Common	Vogeltje	Vogels
Trompet ('trumpet')	Common	Trompetje	Trompetten
Borstel ('brush')	Common	Borsteltje	Borstels
Voet ('foot')	Common	Voetje	Voeten
Jurk ('dress')	Common	Jurkje	Jurken
Vos ('fox')	Common	Vosje	Vossen
Wortel ('carrot')	Common	Worteltje	Wortels
Leeuw ('lion')	Common	Leeuwtje	Leeuwen
Bus ('bus')	Common	Busje	Bussen
Riem ('belt')	Common	Riempje	Riemen
Vlieg ('fly')	Common	Vliegje	Vliegen
Stoel ('chair')	Common	Stoeltje	Stoelen
Krant ('newspaper')	Common	Krantje	Kranten
Sigaar ('cigar')	Common	Sigaartje	Sigaren
Molen ('windmill')	Common	Molentje	Molens
Hond ('dog')	Common	Hondje	Honden

Appendix A (*continued*)

Picture name	Gender	Diminutive	Plural
Kaars (‘candle’)	Common	Kaarsje	Kaarsen
Stekker (‘plug’)	Common	Stekkertje	Stekkers
Berg (‘mountain’)	Common	Bergje	Bergen
Lamp (‘lamp’)	Common	Lampje	Lampen
Fiets (‘bike’)	Common	Fietsje	Fietsen
Gieter (‘watering can’)	Common	Gietertje	Gieters
Bijl (‘axe’)	Common	Bijltje	Bijlen
Beer (‘bear’)	Common	Beertje	Beren
Raket (‘rocket’)	Common	Raketje	Raketten
Pijl (‘arrow’)	Common	Pijltje	Pijlen

Filler items in Experiments 1 and 2. Item always name in singular

Experiment 1		Experiment 2	
Picture name	Gender	Picture name	Gender
Oog (‘eye’)	Neuter	Mond (‘mouth’)	Common
Geld (‘money’)	Neuter	Kerk (‘church’)	Common
Glas (‘glass’)	Neuter	Vinger (‘finger’)	Common
Blad (‘leaf’)	Neuter	Boom (‘tree’)	Common
Papier (‘paper’)	Neuter	Bank (‘bank’)	Common
Vuur(‘fire’)	Neuter	Zak (‘bag’)	Common
Haar (‘hair’)	Neuter	Fles (‘bottle’)	Common
Eiland (‘island’)	Neuter	Neus (‘nose’)	Common
Brood (‘bread’)	Neuter	Bloem (‘flower’)	Common
Ei (‘egg’)	Neuter	Trein (‘train’)	Common
Bord (‘plate’)	Neuter	Vis (‘fish’)	Common
Vliegtuig (‘plane’)	Neuter	Kat (‘cat’)	Common
Kruis (‘cross’)	Neuter	Schoen (‘shoe’)	Common
Zout (‘salt’)	Neuter	Maan (‘moon’)	Common
Horloge (‘watch’)	Neuter	Ster (‘star’)	Common
Kussen (‘pillow’)	Neuter	Kruk (‘stool’)	Common
Graf (‘grave’)	Neuter	Kam (‘comb’)	Common
Hemd (‘shirt’)	Neuter	Schaar (‘scissors’)	Common
Cadeau (‘present’)	Neuter	Tang (‘pliers’)	Common
Masker (‘mask’)	Neuter	Clown (‘clown’)	Common
Blik (‘can’)	Neuter	Bezem (‘broom’)	Common
Spook (‘ghost’)	Neuter	Spuit (‘syringe’)	Common
Tapijt (‘carpet’)	Neuter	Rits (‘zipper’)	Common
Brein (‘brain’)	Neuter	Zaag (‘saw’)	Common
Kanon (‘canon’)	Neuter	Pinda (‘peanut’)	Common
Kostuum (‘suit’)	Neuter	Boor (‘drill’)	Common
Lam (‘lamb’)	Neuter	Sla (‘lettuce’)	Common
Stoplicht (‘light’)	Neuter	Trechter (‘funnel’)	Common
Vlot (‘raft’)	Neuter	Slee (‘sled’)	Common
Luipaard (‘leopard’)	Neuter	Schep (‘scoop’)	Common

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