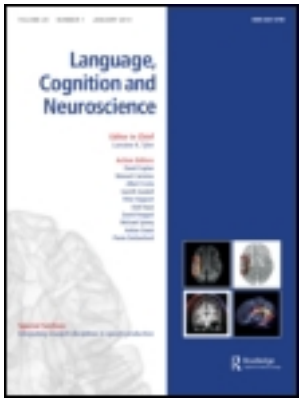

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Effects of semantic integration on subject-verb agreement: evidence from Dutch

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Effects of semantic integration on subject–verb agreement: evidence from Dutch

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The generation of subject–verb agreement is a central component of grammatical encoding. It is sensitive to conceptual and grammatical influences, but the interplay between these factors is still not fully understood. We investigate how semantic integration of the subject noun phrase ('the secretary of/with the governor') and the Local Noun Number ('the secretary with the governor/governors') affect the ease of selecting the verb form. Two hypotheses are assessed: according to the notional hypothesis, integration encourages the assignment of the singular notional number to the noun phrase and facilitates the choice of the singular verb form. According to the lexical interference hypothesis, integration strengthens the competition between nouns within the subject phrase, making it harder to select the verb form when the nouns mismatch in number. In two experiments, adult speakers of Dutch completed spoken preambles (Experiment 1) or selected appropriate verb forms (Experiment 2). Results showed facilitatory effects of semantic integration (fewer errors and faster responses with increasing integration). These effects did not interact with the effects of the Local Noun Number (slower response times and higher error rates for mismatching than for matching noun numbers). The findings thus support the notional hypothesis and a model of agreement where conceptual and lexical factors independently contribute to the determination of the number of the subject noun phrase and, ultimately, the verb.

Keywords: subject–verb agreement; language production; semantic integration; notional number

In many languages, including English and Dutch, the grammatical subject of a sentence agrees in number with the main verb. In principle, the system is simple: Singular subjects require singular verbs and plural subjects require plural verbs (e.g., *the dog barks* and *the dogs bark*). The process of agreement is a key component of grammatical encoding, and speakers calculate it in many, if not most of their utterances, and as such, the cognitive processes underlying the generation of agreement have been investigated in numerous studies (Bock & Miller, 1991; Bock, Nicol, & Cutting, 1999; Eberhard, 1997; Franck, Vigliocco, & Nicol, 2002; Haskell & MacDonald, 2003; Humphreys & Bock, 2005; Vigliocco, Butterworth, & Garrett, 1996). Given the frequency with which agreement occurs, it is clear that a comprehensive theory of language production should explain the mechanisms underlying the generation of agreement. In addition, the issue of how agreement is established is tightly linked to other central issues in psycholinguistics, such as how conceptual information is mapped onto linguistic representations, which processing units speakers prefer when they plan utterances, and how conceptual and linguistic information are stored in working memory while utterances are prepared.

Much of the experimental research on the production of agreement has used a sentence completion paradigm first introduced by Bock and Miller (1991). In this paradigm, participants hear or read subject noun phrases, such as *the key to the cabinets*, and complete them by adding matching verb phrases. In order to explore agreement processes, researchers have varied the content and structure of the preambles and observed how these variations affect the participants' choice of verb form. Of particular interest have been the conditions influencing the likelihood of committing agreement errors, such as *the key to the cabinets ARE lost*. Although this paradigm is not a pure production task as participants must first comprehend the preambles, it has provided critical insight into how both syntactic and semantic constraints influence the generation of agreement. Many agreement studies, including the present investigation, have used preambles where the head noun (*key* in the example), is followed by another noun, called the local noun (*cabinets* in the example). A robust finding across these studies is the attraction effect: When the number of the head noun is singular, speakers are more likely to use an incorrect plural verb form when the number of the local noun is plural relative to when it is singular. The attraction effect points to interference between the number features associated with the head noun and the local noun. Interference could arise during the assignment of number to the subject noun phrase or during the selection of the corresponding verb form (see Bock & Middleton, 2011, for a critical evaluation of different accounts of the attraction effect).

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In order to understand the origin of attraction and the cognitive processes involved in the generation of agreement more generally, many studies have varied the conceptual and syntactic properties of the preambles and observed the effects on the rates of agreement errors (e.g., Bock & Cutting, 1992; Bock & Miller, 1991; Franck et al., 2002; Haskell & MacDonald, 2005; Kaan, 2002). The current study focuses on a conceptual variable called semantic integration. The importance of this variable for agreement processes was first highlighted by Solomon and Pearlmutter (2004). They defined integration as 'how closely linked two parts of a message are within a discourse representation or mental model' (p. 4). In integrated noun phrases, one noun is often physically or characteristically part of the other noun, or role-defined with respect to it. For instance, in *the secretary of the governor* there is a tight relationship between the two concepts referred to in the noun phrases, because being employed by the governor is a formal role of the secretary. This is not the case in *the secretary with the governor*, which refers to a secretary somewhere close to a governor. Similarly, there is a tighter conceptual relationship in *the pizza with the yummy toppings* relative to *the pizza with the tasty beverages*. In five sentence completion experiments, Solomon and Pearlmutter (2004) varied the degree of semantic integration in the preambles and observed the effects on the rates of plural verb agreement and attraction. In all experiments, they found the usual increase in error rates when singular head nouns were combined with plural rather than singular local nouns. More importantly, however, they found a larger attraction effect for integrated relative to unintegrated preambles.

Solomon and Pearlmutter's explanation of the increase in attraction with increased integration put lexical–grammatical number properties at the forefront: retrieval interference between nouns that differ in grammatical number disrupts the agreement process. More interference arises when referents are integrated because the components of the referring expression (the subject noun phrase) are more likely to be lexicalised in parallel. As Solomon and Pearlmutter noted, this account fits well with other evidence demonstrating that speakers may process several phrases in parallel, which can lead to lexical interference (Allum & Wheeldon, 2007; Butterworth, 1981; Oppermann, Jescheniak, Schriefers, & Görges, 2009, for more recent findings demonstrating parallel processing of several phrases).

However, considering the conceptual representation of number, the interaction with attraction is somewhat paradoxical: more integration typically implies more conceptual unity, and this in turn is typically associated with singular agreement. In line with this view, Brehm and Bock (2013) proposed that stronger integration in the message promotes notional singularity. According to their notional hypothesis, the variation in conceptual number induced by semantic integration stems from referential properties behind subject noun phrases. Specifically, an integrated referent is more likely to be construed as a single notional entity (i.e., one unit), whereas unintegrated referents are more likely to be treated as notional aggregates (i.e., multiple units). Given the known impact of notional number on agreement processes (Eberhard, 1999; Thornton & MacDonald, 2003; Vigliocco, Butterworth, & Semenza, 1995; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996), this view predicts that strong semantic integration should bias speakers towards the selection of singular verb forms, and weak semantic integration towards the selection of plural verb forms regardless of the plurality of the head and local nouns. To account for Solomon and Pearlmutter's opposite results, Brehm and Bock noted that there was an unusually low response rate for unintegrated subject noun phrases in Solomon and Pearlmutter's experiments. The implication is that less attraction might have occurred after unintegrated subjects because there were fewer opportunities for attraction to occur, not because unintegrated subjects reduced retrieval interference.

Brehm and Bock (2013) conducted two experiments to evaluate the contrasting predictions following from their notional hypothesis and Solomon and Pearlmutter's lexical interference hypothesis. One experiment aimed to replicate the findings reported by Solomon and Pearlmutter using the same materials and procedure.[1] As in Solomon and Pearlmutter's study, the attraction effect was found to be stronger for highly integrated than for less integrated preambles. However, this pattern arose primarily because integration led to a lower error rate in the matching (i.e., singular head noun, singular local noun) relative to the mismatching (i.e., singular head noun, plural local noun) condition. Overall, Brehm and Bock found fewer errors after integrated than unintegrated preambles. These results are not consistent with Solomon and Pearlmutter's lexical interference hypothesis since there cannot be any interference between the number features of the head and local nouns in the matching condition, regardless of the degree to which the phrases are integrated.

In a second experiment, Brehm and Bock (2013) used the same materials but a different task: Instead of repeating the preambles and completing them in any way they wished, the participants read the preamble silently and then produced a verb phrase combining *is* or *are* with one of four adjectives (*good*, *bad*, *ready* and *true*; for use of similar paradigms see Gillespie & Pearlmutter, 2011; Haskell & MacDonald, 2003; Staub, 2009, 2010). This constrained procedure has two advantages over the classic completion paradigm: First, it yields a higher proportion of responses that can be scored with respect to verb number. Second, as the participants do not repeat the preambles, response latencies can be examined as well as

error rates. For both dependent measures, Brehm and Bock found evidence for attraction, i.e. more errors and slower response onsets after plural relative to singular local nouns. In addition, they found a facilitatory effect of integration – faster response onsets and fewer errors after integrated than after unintegrated preambles. Importantly, these effects did not interact. These results thus provided critical support for Brehm and Bock's notional hypothesis, and are at odds with the lexical interference hypothesis.

Given the inconsistencies of the findings obtained by Solomon and Pearlmutter and by Brehm and Bock, we sought additional evidence that might help decide between the competing accounts of the effects of semantic integration. The current study was carried out in Dutch, a language which is well suited to this goal because, despite broad similarities in other facets of the languages, English and Dutch differ in the incidence of number inflection and the relevance of grammatical number specification to verb agreement. In English, regular verbs specify number only for the third person in the present tense, and not at all in the past tense. Among past tense verbs, only forms of *to be* (*was* and *were*) carry overt flags for number. By comparison, verbs in Dutch carry inflections that specify number with morphemes that are highly regular and present on most verbs in both the present and past tenses. According to the notional hypothesis, integration effects should be present to similar degrees regardless of the lexical–grammatical properties of a language's number morphology. The interference hypothesis makes a different prediction: to the extent that interference among the words carrying lexical–grammatical properties is a source of agreement errors, in a language where lexical–grammatical properties have primacy in the agreement system, it is more likely that mismatching features will lead to error. Thus, if semantic integration creates notional number variations that systematically influence singular and plural number agreement, integration effects in Dutch should be similar to those found in Brehm and Bock: more integration should support singular agreement. But to the extent that integration leads to parallel retrieval and competition between words, as Solomon and Pearlmutter have argued, integration in Dutch is likely to create the opposite effect: stiff competition between singular and plural noun forms for control of the verb should readily lead to error, due to the nearly exceptionless triggering of plural verb morphology by plural noun morphology.

In the present study, we examined these hypotheses using factorial manipulations of integration and Local Noun Number. Experiment 1 used a constrained sentence completion paradigm similar to that used by Brehm and Bock. The main difference was that instead of choosing one of the four adjectives on each trial, the participants in our study used an adjective provided at trial onset in conjunction with the appropriate form of the verb *zijn (to be)*, singular *is* or plural *zijn*. In Experiment 2, we used a speeded metalinguistic judgement task introduced by Staub (2009, 2010). Participants silently read the same preambles as in Experiment 1 and then selected the appropriate Dutch form of *zijn (to be)*, *is* or *zijn*, as quickly as possible. The main goal was to obtain converging evidence for the conclusions drawn on the basis of the results of Experiment 1 using a slightly different method and a new sample of participants. In addition, we aimed to assess whether this paradigm, which is simpler and faster to administer and analyse, would be as sensitive to the experimental manipulations as the more laborious spoken preamble completion paradigm.

The predictions for both experiments were the same. First, there should be attraction effects on both error rates and response latencies, indicating that agreement with a singular head noun is more difficult in the presence of a plural rather than a singular local noun. Second, there should be effects of integration on error rates and response times. The notional hypothesis predicts a main effect of integration: faster responses and fewer errors for integrated than unintegrated preambles. By contrast, the lexical interference hypothesis predicts an interaction of integration with attraction: stronger attraction for integrated than unintegrated preambles.

Experiment 1

Method

Participants

The experiments described in this paper were conducted with adult native speakers of Dutch, who were recruited through advertisements in local newspapers. They gave written informed consent before the study and were paid €8 for participating. Experiment 1 was carried out with 27 participants. The data obtained from three participants were excluded from the analyses because they failed to repeat the preambles correctly on more than a third of the trials. The remaining 24 participants (21 female) ranged in age from 18 to 54 years (M = 26.96 years, SD = 11.1). Seventeen participants were university students.

Materials

The materials consisted of 100 experimental items, 100 fillers, 24 items used on catch trials, and 6 practice items. Each item consisted of a preamble and an adjective. The materials are listed in Appendices A–D.

Sixty-eight of the experimental preambles were Dutch translations or adaptations of items used by Solomon and Pearlmutter (2004) and Brehm and Bock (2013). Adapting the items was necessary to avoid nouns ending in their singular form with *-en* or *-s*. These endings are homophonous to Dutch plural morphemes and might cause number confusion (Haskell & MacDonald, 2003). We also avoided neuter nouns, where the determiner – *het* for

Table 1. Example of an experimental item.

Integration	Local Noun Number	Sentence	Adjective
Integrated	SG	De oppas van de kleuter	geestig
	PL	De oppas van de kleuters	geestig
Unintegrated	SG	De oppas met de kleuter	geestig
	PL	De oppas met de kleuters	geestig
		The baby-sitter of/with the toddler(s)	*funny*

Note: SG = singular, PL = plural.

Table 2. Mean (SD) plausibility ratings of the adjectives for each condition.

	Integration	
	Unintegrated	Integrated
Singular local noun	4.43 (2.15)	5.67 (1.76)
Plural local noun	4.53 (2.17)	5.69 (1.74)
Fillers (high plausibility)		6.48 (1.09)
Fillers (low plausibility)		1.57 (1.22)

singular and *de* for plural – specifies number. Thus, all head and local nouns were common gender nouns, which take the number ambiguous definite article *de*.

Thirty-two of the original preambles included relative clauses (e.g., *the report that described the traffic accident(s)*). These items could not be translated or adapted because in Dutch relative clauses the verb, rather than the local noun, appears in the clause-final position (e.g., *het rapport dat het ongeluk (de ongelukken) beschrijft* – the report that the accident(s) describes). They were replaced by 32 new items, which were structurally similar to the remaining items (see Appendix A).

Each of the 100 experimental items appeared in four versions resulting from crossing the variables Semantic Integration (integrated vs. unintegrated) and Local Noun Number (singular vs. plural, see Table 1 for an example). In 57 items, the integrated and unintegrated versions only differed in the preposition (e.g., *the drawing of/with the flower(s)*). In the remaining 43 items, the two versions differed in the local noun (e.g., *the bowl with the stripe(s)/with the spoon(s)*). As in Solomon and Pearlmutter's (2004) study, the head noun in all experimental preambles was singular.

Fifty of the filler items were structurally similar to the experimental items but featured a plural head noun. The remaining 50 filler items were coordinated noun phrases (see Appendix B). Thus, all filler items required plural verb forms. Catch trials (in which participants had to repeat and complete the entire preamble, see Procedure) were constructed to make sure that the participants always read the preambles in such a way that they would be able to repeat them (see Appendix C). The items used on the 24 catch trials were structurally similar to the remaining items, although (due to an oversight) four featured simple noun phrases. Twelve of the catch trials required singular verb forms and the other 12 required plurals. The set of practice items included four items each requiring singular and plural verb forms. Two additional practice trials were catch trials. Each preamble was combined with an adjective, which was selected to be a plausible continuation of the preamble. This was later confirmed in a rating study by 60 participants who did not participate in the main experiments. The participants were asked to rate how plausible they thought the adjective was in combination with the subject of the sentence on a 7-point scale. Every participant saw 50 of the experimental items combined with 25 plausible and 20 implausible filler items, which were expected to yield high and low plausibility ratings, respectively. The average ratings are shown in Table 2.

Four lists of materials were created and each list was seen by six participants. Each list included all practice, catch and filler items and one version of each experimental item. In each list, 25 of the experimental items appeared in each condition, and each experimental item was presented in a different condition in each list. Stimuli were shown in black on a grey background, in Arial font (0.4° visual angle).

The lists were divided into a practice block of 6 trials, and four experimental blocks of 56 trials, each consisting of 25 experimental items, 25 filler items, and 6 catch trials. The trials in each block were individually randomised and the order of the blocks was fixed.

Procedure

The participants were tested individually in a soundproof booth. The experimental and filler trials had the following structure: First, a small fixation cross (0.5° visual angle) was shown on the left side of the screen (10% from the left margin) for 500 ms. It was followed by the adjective, shown for 1000 ms, another fixation cross, shown for 500 ms, and the preamble. The preamble was presented for 40 ms per character, or 1000 ms, whichever was longest. Then an exclamation mark *(!)* was shown for 500 ms. After 2600 ms, the next trial began. The catch trials had the same structure, except that the word *herhaal (repeat)* was shown instead of the exclamation mark, and the duration of the trials was extended by 2000 ms.

The participants were told that on most of the trials, they would see an exclamation mark and should then complete the preamble using *is* or *zijn* and the adjective shown at trial onset. On some trials, when *herhaal* was shown, they should first reproduce the beginning of the sentence and then add *is* or *zijn* and the adjective.

After the main experiment, Integration Ratings were collected from the participants. They received a written list of the preambles in the version they had seen before and were asked to rate the degree of semantic integration on a scale from 1 (not very integrated) to 7 (tightly integrated). The instructions and examples were translations of the instructions and examples used by Solomon and Pearlmutter.[2] Participants were asked to rate the integration between the nouns in the preamble, regardless of any semantic similarity between the nouns. The example for a weakly integrated preamble was *de ketchup met de mosterd/the ketchup with the mustard*, and the example for a highly integrated preamble was *de armband van zilver/the bracelet of silver*. Although *ketchup* and *mustard* are semantically closely related, they are not integrated but merely physically close. On the other hand, the *bracelet* is made of *silver*, which makes them highly integrated in this particular phrase.

It could be the case that the participants' evaluation of the items as being more or less integrated changed over the cause of the experiment so that the ratings given after the experiment did not capture their initial impression of the items. To assess whether this was the case, Integration Ratings were obtained from an additional 60 participants who did not participate in the experiment (see Table 3).

Apparatus

The experiment was programmed in Presentation 15.0 and presented on a cathode ray tube (CRT) monitor with a 1024 × 768 screen resolution. Response times were registered by the Presentation voice key and later checked and where necessary corrected using Praat speech analysis software (Boersma & Weenink, 2010).

Table 3. Mean (SD) Integration Ratings for each condition.

		Integration	
Experiment 1		Unintegrated	Integrated
	Singular local noun	3.18 (1.97)	5.08 (1.93)
	Plural local noun	3.15 (2.02)	4.96 (1.93)
Experiment 2			
	Singular local noun	3.18 (1.90)	4.79 (1.95)
	Plural local noun	3.10 (1.87)	4.78 (1.96)
Independent sample			
	Singular local noun	2.91 (2.05)	4.88 (2.04)
	Plural local noun	2.95 (2.03)	4.93 (2.02)
Mean ratings			
		3.03 (2.00)	4.90 (1.99)

Analyses

Although we created an integrated and unintegrated version of each item and the average Integration Ratings of the stimuli differed according to this manipulation, there was some overlap in the Integration Ratings (see Appendix A). Therefore, we decided to treat semantic integration as a continuous variable in the main analyses below. Each item was assigned the average Integration Rating given by the participants of the two main studies and the additional rating study. Appendix E reports supplementary analyses treating integration as a dichotomous variable.

The responses in the main experiment were coded for accuracy and response time. Response times shorter than 200 ms or more than three standard deviations above the participant's mean were excluded from the analyses (246 cases, 6.1% of all responses). Statistical analyses were run using linear mixed effects models with crossed effects of subjects and items using the lme4 package (Bates, 2005; R Development Core Team, 2011). In order to avoid collinearity and to maximise the likelihood of model convergence, the variables list, block, plausibility, semantic integration and Local Noun Number were mean centred prior to analysis (Baayen, 2008). As histograms showed that the distribution of the response times was rightward skewed, analyses were performed on natural log-transformed response times.

The experimental fixed effects included in the statistical models were Mean Integration Ratings (1 through 7), Local Noun Number (singular vs. plural) and Block (1 through 4). The list that participants saw was initially included as a fixed factor, but as it did not contribute to any of the models, we collapsed across this factor. Similarly, the plausibility of the adjectives did not contribute and was excluded. All models included random intercepts for subjects and items. In order to determine which random factors to include, we used forward selection, starting with a model that included Integration and Local Noun Number, adding Block and the interactions between these variables. Then the random slopes of Integration and Local Noun Number were added to the subjects and items, first one-by-one, later both of them. Model comparison was used to determine whether the inclusion of various random slopes improved the model fit while minimising model complexity (as measured with AIC/BIC). Whether random slopes were included in a particular analysis is indicated in the results tables. The inclusion of random slopes in the analysis of response times meant that resampling methods for calculating statistical probability were not available. Thus, we adopted the procedure in Baayen (2008) and judged factors significant when the absolute t-value exceeded 2. Error rates were analysed using a logistic linking function (e.g., Jaeger, 2008), a procedure which does provide

statistical probabilities, and these are indicated in the results given in the tables.

Results

Integration Ratings

Table 3 summarises the average Integration Ratings given by the participants of both experiments and of the supplementary rating study. The table shows that on average, the integrated preambles received higher ratings than unintegrated preambles. The difference between integrated and unintegrated ratings was significant (t (99) = 23, p < .001 for the mean ratings). There was no consistent effect of Local Noun Number and no interaction of the two variables.

As the table shows, the average ratings for the three samples were very similar. Moreover, the correlation between the average ratings per item in the two experiments was high (r = .90). The correlations of the ratings given after the experiments to the ratings of the independent sample, though still substantial, were lower (r = .57 and r = .53 for Experiment 1 and 2, respectively). This suggests that the ratings obtained from the participants after the experiment may not have reflected their initial interpretation of integration during the experiment. Therefore, we stabilised the measure of Integration Rating by averaging across the three samples of participants. Local Noun Number did not significantly influence the Integration Ratings, thus we collapsed ratings across this variable.

Error rates

Responses from 123 experimental trials (5.1%) were missing because of recording failure or because participants provided no response. Out of the remaining 2277 valid responses, 476 were incorrect (20.9%). Experimental items required a singular response, thus correct adjectives produced with a plural verb were coded as agreement errors. Other errors were responses featuring incorrect adjectives, speech disfluencies or self-repairs, and repetition of the entire preamble.

Figure 1 plots the model's estimates of the logit-transformed error rates depending on the Local Noun Number and the degree of integration. Results of the analysis (Table 4) revealed main effects of Integration Rating and Local Noun Number, but no interaction between the two variables (see Tables E1 and E2 in Appendix E for analyses treating integration as a dichotomous variable, which confirm our main conclusions). Examination of Figure 1 reveals that participants made more agreement errors after plural than after singular local nouns, and they made more errors after weakly integrated than after tightly integrated preambles. The error rate decreased across the course of the experiment, yielding the significant main effect of Block.

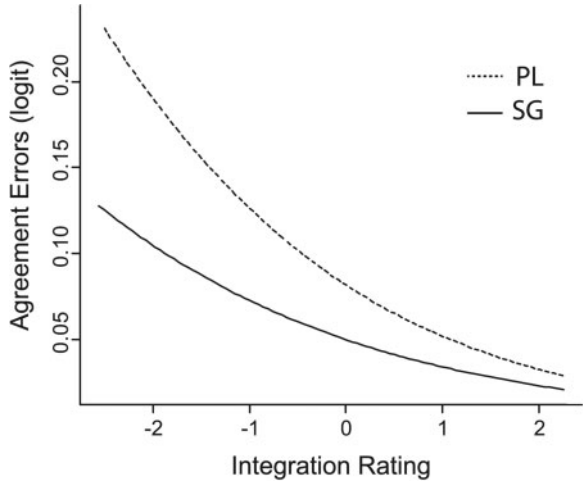

Figure 1. Experiment 1: Error rates for the Integration Ratings for plural (PL) and singular (SG) local nouns. Lines represent model estimates for each Local Noun Number condition. The value 0 on the x-axis corresponds to the mean Integration Rating; higher values represent tighter integration.

As explained earlier, the materials included two sets of items differing in whether the degree of integration was varied by using different prepositions (preposition variation items, as in *the drawing of/with the flower(s)*) or by using different local nouns (noun variation items, *the bowl with the stripe(s)/spoon(s)*). To assess how this variable, Item Type, affected the results, an additional model was run that included Item Type as a predictor (see also Table E1, in which the means are specified for each Item Type).

Table 4. Experiment 1: Agreement errors predicted by Integration Rating and Local Noun Number.

Variable	Coefficient	SE	z-value	Pr(>|z|)	Random slope
(Intercept)	−2.28	0.24	−9.70	<.001	
Integration Rating	−0.38	0.06	−6.84	<.001	items
Local Noun Number	0.21	0.09	2.26	.024	subjects, items
Block	−0.11	0.05	−1.99	.047	
Number*Block	−0.14	0.04	−3.32	<.001	
Rating*Number	−0.03	0.05	−0.63	.528	

Note: Interactions with Block indicate a practice effect.

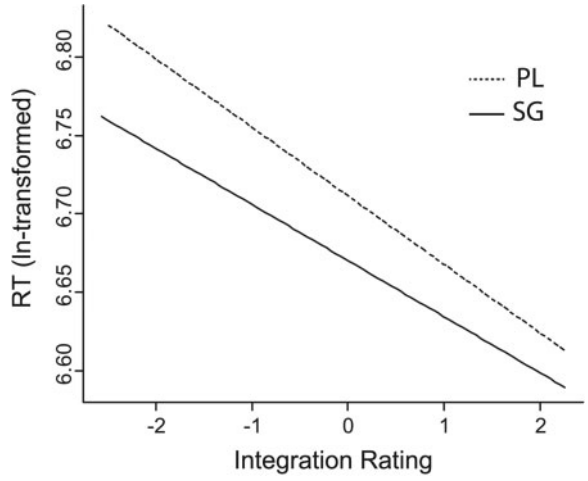

Figure 2. Experiment 1: Natural log-transformed response times (RT) for the Integration Ratings for plural (PL) and singular (SG) local nouns. Lines represent model estimates of each local noun condition. The value 0 on the *x*-axis corresponds to the mean Integration Rating; higher values represent tighter integration.

There was no significant main effect of Item Type (β = 0.14, p = .10) and no significant interaction with Integration (β = 0.003, p = .95) or with Local Noun Number (β = 0.003, p = .97).

The plausibility ratings showed that integrated items were rated slightly higher than unintegrated items. Indeed, the plausibility and Integration Ratings were correlated (r = .55). In order to assess whether the effects of integration were affected by the plausibility of the adjective, we ran an additional model that included Plausibility. Because plausibility ratings are partially dependent on integration (but not the reverse for Integration Ratings), the model included a predictor for plausibility after removing variance associated with Integration Ratings (i.e., the residuals of Plausibility predicted by Integration). Results of this analysis showed that none of the above-described results were a result of differences in plausibility of the adjective: there was no main effect of Plausibility (β = −0.08, p = .41) and no interactions with Plausibility.

Finally, we evaluated the participants' performance on the catch trials. Errors (i.e., any deviations from verbatim recall) occurred on average on 2.8 of 24 preambles (SD = 1.7), and participants made on average 0.9 agreement errors (SD = 0.9).

Response latencies

Only correct responses were included in the analyses of response latencies. Latencies deviating by more than three standard deviations from the participant mean were excluded (0.8% of correct responses). This left 2260 data points for the analyses. Consistent with the error rates, the participants responded faster after singular than after plural local nouns, and they were faster after tightly integrated than after weakly integrated preambles. Figure 2 plots the model estimates of the natural log-transformed response latencies, and Table 5 reports the results of the statistical analyses (see Tables E3 and E4 in Appendix E for the results of analyses treating integration as a dichotomous variable, confirming the patterns of the main analyses). There were significant main effects of Integration, Local Noun Number, and Block (with response times decreasing across blocks).

Table 5. Experiment 1: Response times predicted by Integration Rating and Local Noun Number.

Variable	Coefficient	SE	t	Random slope
(Intercept)	6.73	0.04	184.17	
Integration Rating	−0.03	0.01	−4.50	items
Local Noun Number	0.02	0.01	2.36	subjects
Block	−0.04	0.01	−6.30	
Rating*Number	−0.01	0.01	−1.31	

Note: Effects were considered significant if $|t|>2$.

In a model including Item Type, the general patterns were similar, while there was no significant main effect of Item Type (β = 0.02, t = 1.39), or interaction with Integration (β = −0.002, t = −0.27) or with Local Noun Number (β = 0.01, t = 0.68). Similar to the error analysis, Plausibility did not contribute to the model (β = −0.003, t = −0.28) and was excluded from the final model.

Discussion

The present experiment replicated the attraction effect seen in many earlier studies: participants generated more errors and slower responses when the head noun and local noun mismatched in number relative to when they matched. We also found a main effect of semantic integration: participants made more errors and responded more slowly when preambles were weakly integrated relative to when they were tightly integrated. Critically, there was no interaction between these variables, suggesting that the effects of semantic integration and Local Noun Number were additive. These results were remarkably stable across numerous analyses. The same patterns arose, for instance, when looking only at the participants who were university students, and also in the newly constructed items as well as in the items that were translated or adapted from Solomon and Pearlmutter's original items.

In addition, the different treatments of semantic integration yielded exactly the same pattern: whether the ratings of the degree of integration were averaged for each item across the three groups of raters (our main analysis), averaged for each item across the participants in Experiment 1, or whether integration was dichotomised (see the analyses in Appendix E), all analyses showed main effects

of Integration and Local Noun Number and no interactions between them.

Another important analysis distinguished between the different types of items used to manipulate semantic integration. The degree of integration in the experimental items was varied by either using a different preposition (*of/with*) or changing the local noun (*the bowl with the stripe/spoon*). One might expect that the difference in integration is more clearly instantiated in the latter Item Type than in the former. This is because in Dutch, as in English, a phrase such as *a picture with a flower*, which was meant to be interpreted in the sense of a *picture next to a flower*, can also be interpreted in the sense of *a picture showing a flower*. Thus, the unintegrated *with* items might have been given an integrated interpretation. The Integration Ratings suggested, however, that the participants clearly distinguished between the integrated and unintegrated versions of the *of/with* items. Furthermore, additional analyses of the error rates and response latencies showed that there was neither a main effect of Item Type nor an interaction of Item Type with Integration or Local Noun Number.

Finally, it was important to assess whether any of the effects we observed may have come about as a result of differences in plausibility between the sentence materials. The adjectives the participants were asked to use to complete the sentences had been selected to be plausible continuations of the preambles. As noted, a rating study confirmed this but showed slightly higher ratings for integrated sentences compared to unintegrated sentences. Yet, analyses including Plausibility as a predictor ruled out the possibility that differences in integration that were observed were a result of differences in the plausibility of the adjective.

Experiment 2

The main findings of Experiment 1 were that the semantic integration facilitated the generation of subject–verb agreement and that this effect was additive to the attraction effect from the Local Noun Number. The goal of the second experiment was to determine whether these findings could be replicated in a new sample of participants and with a different task. We used a speeded forced-choice task adapted from Staub (2009, 2010) in which participants read the same preambles as in Experiment 1 presented word-by-word. After the end of the preamble, the verb forms *is* and *zijn* were simultaneously presented on the screen, and the participants had to select the correct form as quickly as possible by pressing one of two response buttons. No adjectives were presented. Thus, using this paradigm allowed us to rule out any remaining concerns about the influence of the plausibility of the preamble–adjective combinations. This task is a speeded metalinguistic judgement task directing the participants' attention quite explicitly towards subject–verb agreement. One advantage of this task relative to the preamble completion paradigm is that it is easier to administer and analyse. Replicating the results of Experiment 1 would provide an important validation of this simpler paradigm.

The predictions for this experiment are the same as for Experiment 1. The lexical interference hypothesis predicts an interaction between semantic integration and Local Noun Number, with larger attraction effects for tightly integrated preambles. The notional number hypothesis, on the other hand, predicts main effects of Local Noun Number and of integration: fewer errors and faster response times for tightly integrated preambles than for weakly integrated preambles.

Method

Participants

The experiment was carried out with 24 participants (16 female), ranging in age from 18 to 59 years (M = 30.29 years, SD = 16.32). Seventeen participants were university students. None of the participants had taken part in Experiment 1.

Materials

The same preambles were used on experimental and filler trials as in Experiment 1. No adjectives were presented and there were no catch trials. Six additional preambles were created for use in the practice block.

Procedure

Participants were tested individually in a soundproof booth. The experiment was programmed in Presentation 15.0. The trials had the following structure: First, a fixation cross (0.5° visual angle) was presented in the centre of the screen for 1000 ms. Then, the preamble was presented word-by-word in the centre of the screen. Each word was shown for 250 ms and was followed by a blank interval of 150 ms. After presentation of the preamble, the singular and plural forms of the verb *to be*, *is* and *zijn*, were presented simultaneously, slightly to the left and right of the centre of the screen. Participants were instructed to indicate as quickly as possible which of the two forms would be the correct continuation of the preamble by pressing the F-key on their keyboard for the left word and the J-key for the right word. Feedback was provided if the response was incorrect using the word *FOUT* (*wrong*) displayed in red. The next trial began 1500 ms after the response.

The experiment started with a practice block of 12 trials, followed by four blocks of 50 trials each (25 experimental items and 25 filler items). The positions of the two verb forms on the screen alternated across blocks; *is* appeared on the left in Blocks 1 and 3, and on the right

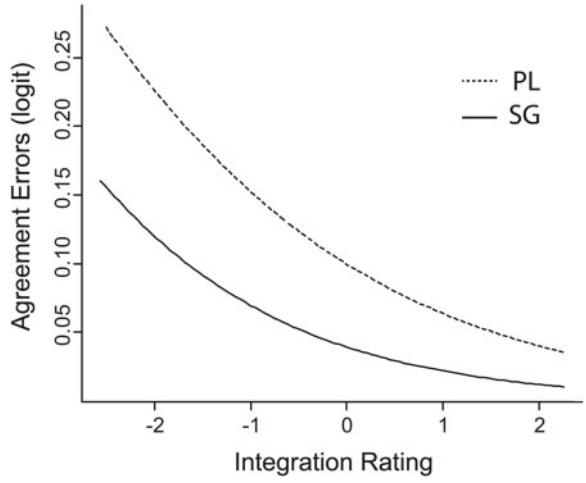

Figure 3. Experiment 2: Error rates for the Integration Ratings for plural (PL) and singular (SG) local nouns. Lines represent model estimates for each Local Noun Number condition. The value 0 on the *x*-axis corresponds to the mean Integration Rating; higher values represent tighter integration.

in Blocks 2 and 4. Participants were assigned to one of the four stimulus lists, and each list was seen by six participants. After the main experiment, they rated the degree of integration of the experimental items.

Results

Error rates

Out of the 2400 responses to experimental preambles, 307 were incorrect (12.8%). Weakly integrated preambles yielded on average more errors than tightly integrated preambles, and plural local nouns yielded more errors than singular local nouns. Figure 3 plots the estimated error rates depending on the Local Noun Number and the degree of integration. The mixed effects model showed main effects of Integration, Local Noun Number and Block (with error rates decreasing across blocks), but no interactions between these variables (see Table 6). Tables E5 and E2 in Appendix E show the results of analyses treating integration as a dichotomous variable. They confirm the patterns of the main analysis with main effects of Integration and Local Noun Number and no interaction.

Item Type (*of/with* versus different local nouns) did not influence the error rates, as there was no main effect of Item Type (β = 0.09, p = .35), and no interactions with Integration (β = −0.03, p = .71) or with Local Noun Number (β = 0.05, p = .51).

Response times

Only correct responses were included in the latency analyses. Latencies below 200 ms (3.3% of correct responses) and latencies deviating by more than three standard deviations above the participant mean (1.5%) were excluded from the analyses. The results for the remaining 1992 responses are shown in Figure 4 and Table 7 (see Tables E6 and E4 in Appendix E for analyses with integration as a dichotomous variable).

The participants were significantly faster to respond to tightly integrated relative to weakly integrated preambles, and they were faster to respond to preambles with singular than with plural local nouns. Results of the mixed effects model showed a main effect of Integration and Local Noun Number, but no interaction between the two variables.

To test for the influence of Item Type, Item Type was included as a factor. Unlike the previous analyses, this analysis indicated that there was a significant main effect of Item Type (β = 0.03, t = 2.59),[3] and an interaction of Item Type and Integration (β = 0.02, t = 2.15), but not of Item Type and Local Noun Number (β = −0.03, t = 1.65). The main effect reflects the fact that items in which integration was manipulated by substituting the local noun (e.g., *the bowl with the spoons/stripes*) yielded longer response times than items in which the preposition was substituted (e.g., *the drawing of/with the flowers)*. Also, this type of item (*spoons/stripes*) showed a slightly weaker Integration effect (β = −0.03, t = −2.70) than the (*of/with*) items (β = −0.07, t = −5.44).

Discussion

The results of Experiment 2 are similar to those of Experiment 1. Error rates and response times showed the classic attraction effect, indicating that selecting the appropriate singular verb form was more difficult after plural than after singular local nouns. The facilitatory

Table 6. Experiment 2: Agreement errors predicted by Integration Rating and Local Noun Number.

Variable	Coefficient	SE	*z*-value	Pr(>|*z*|)	Random Slope
(Intercept)	−2.55	0.22	−11.78	<.001	
Integration Rating	−0.41	0.08	−5.23	<.001	items
Local Noun Number	0.41	0.12	3.18	.001	subjects, items
Block	−0.19	0.05	−3.64	<.001	
Rating*Number	0.03	0.06	0.60	.551	

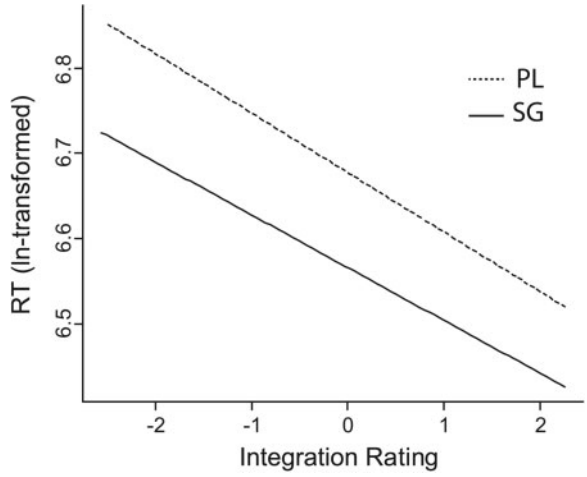

Figure 4. Experiment 2: Natural log-transformed response times (RT) for the Integration Ratings for plural (PL) and singular (SG) local nouns. Lines represent model estimates of each local noun condition. The value 0 on the *x*-axis corresponds to the mean Integration Rating; higher values represent tighter integration.

effect of semantic integration was also replicated: participants made fewer errors and were faster to select a verb form after tightly integrated than after weakly integrated preambles. As in the first experiment, the effects did not interact. Although the way integration was manipulated (*of/with* versus different local nouns) had an effect on the reaction times, it is important to note that the main effects of integration and Local Noun Number remained significant and did not interact. The results of the two experiments thus suggest that the effects of grammatical number and notional number are independent of each other.[4]

One goal of the study was to compare the results of the sentence completion and speeded forced-choice paradigm. The conclusion is clear: the two paradigms yielded similar results, though overall the effects of the experimental variables were somewhat smaller in the speeded forced-choice than in the sentence completion paradigm. The forced-choice task yields an informative response (either a correct response or an agreement error) on virtually all trials. In contrast, in the constrained response task, uninformative responses (e.g., omitted verb forms) can occur. Furthermore, the results of the forced-choice task are faster to analyse than those of the constrained response task where speech onset latencies have to be established. As such, the forced-choice task may be preferable to the constrained or full preamble completion paradigms. Of course, one should keep in mind that the forced-choice task is a speeded metalinguistic judgement task, focusing the participants' attention on the verb forms. For some research purposes, this may not be optimal (see Staub, 2009, 2010, for further discussion of the task).

Table 7. Experiment 2: Response times predicted by Integration Rating and Local Noun Number.

Variable	Coefficient	SE	*t*	Random slope
(Intercept)	6.63	0.11	59.74	
Rating	−0.05	0.01	−5.80	items
Local Noun Number	0.06	0.01	5.65	subjects
Item Type	0.03	0.01	2.69	subjects, items
Block	−0.01	0.01	−0.85	
Number*Block	−0.01	0.01	−2.21	
Item Type*Rating	0.02	0.01	2.10	
Rating*Number	−0.00	0.01	−0.41	

Note: Interactions with Block indicate a practice effect. Effects were considered significant if $|t|>2$.

General Discussion

The experiments described earlier assessed the influence of the degree of semantic integration and Local Noun Number on subject–verb agreement in Dutch. On the critical trials of the experiments, the participants read noun phrases that varied in semantic integration (*the secretary of the governor(s)* vs. *the secretary with the governor(s)*), and in which a singular head noun was combined with a singular or a plural local noun. In Experiment 1, the participants produced verb phrases including the singular or plural form of *zijn (to be)* and an adjective provided at trial onset (e.g., *mooi (pretty)* or *oud (old)*), whereas in Experiment 2, they selected the appropriate form of the verb *zijn* with a button press.

The results are easy to summarise: (1) we replicated the attraction effect seen in numerous earlier studies (Bock & Eberhard, 1993; Bock & Miller, 1991; Bock et al., 1999; Haskell & MacDonald, 2005; Vigliocco et al., 1995). In both experiments, the participants made fewer errors and were faster to respond when head and local noun matched in number than when they mismatched. (2) Semantic integration facilitated the choice of the correct singular verb forms. Participants made fewer errors and were faster to respond as the degree of integration of the preambles increased. (3) The two effects did not interact with each other.

Lexical Interference versus Notional Accounts of Semantic Integration

The main goal of the present study was to evaluate two hypotheses concerning the origin of the semantic integration effect on agreement processes. According to the lexical interference hypothesis, integration encourages parallel processing of the nouns in the subject noun phrase and therefore strengthens the attraction effect. According to the notional hypothesis, integration encourages the assignment of singular notional number to the subject noun phrase and therefore facilitates the

selection of the correct singular verb form. Thus, the lexical interference hypothesis predicts interacting effects of integration and attraction, with stronger attraction arising in integrated relative to unintegrated sentences. In contrast, the notional hypothesis predicts main effects of attraction and integration, with more singular agreement in integrated than unintegrated sentences.

Earlier studies by Solomon and Pearlmutter (2004) and Brehm and Bock (2013) yielded some evidence for each of these hypotheses. Results obtained by Solomon and Pearlmutter suggested that semantic integration increased attraction, whereas the results obtained by Brehm and Bock showed that integration reduced the number of agreement errors. This difference in the results of the two studies was an important reason for assessing the effects of attraction again in the present experiments. Number is marked on a far higher proportion of inflected verb forms in Dutch than in English, and in Dutch, subject–verb agreement might rely more strongly on grammatical and less on notional number (cf. Berg, 1998, for a similar suggestion concerning agreement in German and English). Therefore, one might expect grammatical influences in Dutch to be relatively stronger and notional influences to be weaker relative to English. Thus, if the lexical interference hypothesis is correct, one should be more likely to observe the interaction of semantic integration and Local Noun Number as the grammatical features of the words are more highly activated in Dutch.

However, the present results do not support the main prediction from the lexical interference hypothesis: integration facilitated the selection of the correct singular verb form. Furthermore, it did not systematically affect the size of the attraction effect. This pattern does not support the view that integration leads to more interference among the nouns in the subject noun phrase.

It is important to note that the lexical interference hypothesis encompasses two assumptions, namely that integration leads to increased lexical competition and that increased lexical competition leads to stronger attraction. Our results suggest that in the paradigms we used these assumptions are unlikely to both be correct. However, they do not rule out either of the assumptions individually. Thus, it is possible that nouns are more likely to be processed simultaneously in integrated than in unintegrated preambles (Gillespie & Pearlmutter, 2011); but if this is the case, it does not measurably increase the competition among the number features of the nouns. Likewise, the present results do not rule out that the time course of processing the nouns in a preamble may affect the strength of the attraction process, and specifically, that simultaneous processing of the head and local noun increases the likelihood of attraction errors (Bock & Cutting, 1992). However, if this is the case, variation of the degree of integration does not substantially alter the time course of noun processing.

Our results fit in well with other findings demonstrating conceptual/notional effects on agreement. Most of these studies manipulated conceptual variables such as collectivity or distributivity. For instance, phrases with collective head nouns (such as *army*, *furniture*), which are grammatically singular but notionally plural, yield larger attraction effects than those containing notionally and grammatically singular head nouns (Bock, Eberhard, & Cutting, 2004; Bock et al., 1999; Haskell & MacDonald, 2003). Similarly, phrases such as *the key to the cabinets*, where the head noun specifies a single object, yield weaker attraction effects than distributive phrases such as *the label on the bottles*, where the head noun refers to multiple objects (e.g., one on every bottle; Hartsuiker, Kolk, & Huinck, 1999; Humphreys & Bock, 2005; Vigliocco, Butterworth, et al., 1996; Vigliocco et al., 1995; Vigliocco, Hartsuiker, et al., 1996).

Most importantly, the pattern of results seen in the present study closely resembles those observed by Brehm and Bock (2013), who also observed fewer agreement errors and, when a speeded task was used, faster responses to integrated than unintegrated preambles. This indicates that the direction of the effect of integration – to facilitate, rather than hinder correct singular agreement – is the same in both English and Dutch. In fact, our results are somewhat more straightforward to interpret than those obtained by Brehm and Bock. When integration was treated as a continuous variable, an interaction emerged in Brehm and Bock's first experiment, with stronger attraction for the low levels of integration. Critically, however, the interaction was not due to the typical change that underlies increased attraction. Rather than an elevation in plural agreement after plural local nouns (i.e., mismatching local nouns), for weakly integrated sentences there was more *singular* agreement after singular local nouns (i.e., matching local nouns, the baseline condition). In Experiment 2, Brehm and Bock again found an interaction between integration and Local Noun Number. Similar to Solomon and Pearlmutter's results, the attraction effect was stronger in integrated than unintegrated sentences. However, this interaction was again explained by a drop in baseline, rather than increased attraction. This pattern of results was not present in the current investigation. Semantic integration consistently facilitated agreement, and never interacted with the attraction effect.

The pattern of results from our study and (largely) those from Brehm and Bock can be interpreted within the framework of the Marking and Morphing model proposed by Eberhard, Cutting, and Bock (2005). A key assumption of the model is that verb number is governed exclusively by the number assigned to the subject noun phrase (rather than depending directly on the number assigned to the head or local noun). The number assigned to the subject

noun phrase (the singular-and-plural value, SAP) depends on two additive components: the notional specification and the lexical specification. The latter component is a weighted sum of number specifications of the nouns in the noun phrase, with the highest weight given to the head noun. In this model, attraction arises because phrases with singular head nouns and singular vs. plural local nouns differ in the contribution to SAP stemming from the lexical specification. By contrast, the semantic integration effect arises because integrated and unintegrated phrases differ in notional specification. SAP values can be transformed into probabilities of choosing singular and plural verb forms and, though this was not done by Eberhard et al., this is possible for latencies as well (for a related approach see Roelofs, 1997). This model predicts that integration should facilitate singular agreement, and that the effects of integration and attraction should typically be additive (see also Anton-Mendez & Hartsuiker, 2010).

Limitations

An important goal of the current study was to obtain additional evidence that might help to arbitrate between the accounts of the integration proposed by Solomon and Pearlmutter (2004) and by Brehm and Bock (2013). Given this motivation, the choice of paradigm – preamble completion – followed quite naturally. In order to allow for comparisons of the results of the three studies, the general method and the materials had to be as similar as possible. Methodologically, this triad of studies fits in well with other psycholinguistic work on agreement, most of which has used the preamble completion paradigm as well.

The preamble completion paradigm used in Experiment 1 is often considered a speech production task because the participants produce the verb phrases. The speeded forced-choice paradigm used in Experiment 2 might also be seen as production task since the participants are asked to indicate which of the two verb forms they would choose if they had to complete the sentence. This would be in line with the view advocated by, for instance, Pickering and Garrod (2007) that predicting upcoming words in spoken or written sentences involves speech production processes. Regardless of the plausibility of this assumption, it is evident that neither of the two versions of the preamble completion task used here is a pure production task, as participants read the preambles rather than generating them on the basis of conceptual information. Thus, the preamble completion task is a hybrid task, involving both comprehension and production components.

The implications of the current findings for the creation of agreement in other tasks, speaking or listening, remain to be determined. The attraction effect appears to be robust to a number of experimental manipulations, and has been shown in comprehension studies as well (Pearlmutter, Garnsey, & Bock, 1999; Wagers, Lau, & Phillips, 2009). More generally, evidence from behavioural and neuropsychological studies suggests that the core mechanisms underlying grammatical processes in comprehension may largely be shared (Menenti, Gierhan, Segaert, & Hagoort, 2011; Segaert, Menenti, Weber, Petersson, & Hagoort, 2012; Tooley & Bock, in press). Semantic integration has, to our knowledge, only been studied in the three studies discussed here. It is conceivable that the impact of this variable on agreement is stronger or weaker in other tasks depending, for instance, on how much attention a listener or reader pays to the meaning of the subject noun phrase.

Conclusion

The present study showed that Dutch speakers found it easier to select the correct singular form of the verb when the subject noun phrase was strongly relative to weakly integrated, and when the Local Noun Number was singular relative to when it was plural. Following Brehm and Bock (2013), we interpret our findings within the Marking and Morphing model proposed by Eberhard et al. (2005). Accordingly, integration biases the computation of the notional number of the subject noun phrase towards unity, whereas the presence of a plural local noun biases the lexical specification of the noun phrase towards plurality.

Notes

1. Solomon and Pearlmutter carried out five experiments and a meta-analysis; Brehm and Bock carried out two experiments using all items from Solomon and Pearlmutter's experiments.
2. We thank N. Pearlmutter for making the text available.
3. As for Experiment 1, absolute *t*-values above 2 were considered significant.
4. In an additional experiment, 12 participants completed the same task as in Experiment 2 but, similar to Experiment 1, were required to repeat and complete the preamble verbally on 24 catch trials. The results were very similar to those seen in Experiment 2: there were significantly more errors and longer response times for preambles with plural local nouns (relative to singular local nouns) and for weakly integrated preambles (relative to tightly integrated preambles). Again, the two variables did not interact.

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Appendix A: The experimental items.

Items 1 to 57 differ only in preposition, items 58 to 100 differ only in local noun. The average Integration Ratings are given for the Integrated and Unintegrated items (collapsed over Local Noun Number), respectively.

	Integrated/Unintegrated Singular local noun (plural local noun)	Adjective	Ratings
1	De tekening van/met de bloem(en)* *The drawing of/with the flower(s)*	creatief *creative*	5.30/2.86
2	De afbeelding van/met de edelsteen/edelstenen* *The picture of/with the gem(s)*	duur *expensive*	4.67/4.23
3	De sculptuur van/met de sleutel(s)* *The sculpture of/with the key(s)*	nieuw *new*	3.12/1.88
4	De schets van/met de boekenkast(en)* *The sketch of/with the bookcase(s)*	mooi *beautiful*	5.04/3.33
5	De beeltenis van/met de ballon(nen) *The picture of/with the balloon(s)*	kleurrijk *colorful*	4.07/2.35
6	De verzorger van/met de vogel(s) *The tender of/with the bird(s)*	lelijk *ugly*	5.12/3.52
7	De cassette van/met de lp('s)* *The tape of/with the record(s)*	versleten *worn off*	3.91/1.92
8	De foto van/met de akte(s)** *The photo of/with the certificate(s)*	mislukt *failed*	4.60/3.16
9	De afdruk van/met de memo('s)** *The print out of/with the memo(s)*	vaag *blurred*	4.86/3.14
10	De video van/met de pop(pen)* *The video of/with the puppet(s)*	lang *long*	4.35/2.90
11	De illustratie van/met de landkaart(en)* *The illustration with/of the map(s)*	informatief *informative*	5.09/3.84
12	De fotokopie van/met de publicatie(s)** *The photocopy of/with the publication(s)*	nuttig *useful*	5.54/3.10
13	De reproductie van/met de prent(en)** *The reproduction of/with the engraving(s)*	modern *modern*	5.22/2.75
14	De fax van/met de blauwdruk(ken)* *The fax of/with the blueprint(s)*	achterhaald *outdated*	5.16/4.14
15	De tv-uitzending van/met de film(s)* *The telecast of/with the movie(s)*	saai *boring*	4.78/2.96
16	De uitvergroting van/met de brief/brieven** *The enlargement of/with the letter(s)*	klein *small*	4.02/2.18
17	De beschrijving van/met de cd('s)* *The description of/with the cd(s)*	uitgebreid *extensive*	4.67/2.16
18	De dia van/met de krant(en)* *The slide of/with the newspaper(s)*	helder *bright*	3.43/1.89
19	De verfilming van/met de show(s)** *The screen version of/with the show(s)*	beroemd *famous*	5.68/2.37
20	De uitdraai van/met de scriptie(s) *The print out of/with the thesis/theses*	zwart-wit *black and white*	5.21/3.47
21	De zus van/met de baby('s) *The sister of/with the baby/babies*	blij *happy*	4.09/3.16
22	De polaroidfoto van/met de postzegel(s)* *The polaroid of/with the stamp(s)*	vreemd *strange*	3.78/2.51
23	De ansichtkaart van/met de schoen* *The postcard of/with the shoe(s)*	grappig *funny*	3.86/2.75
24	De poster van/met de kroon/kronen** *The poster of/with the crown(s)*	artistiek *arty*	4.14/2.89
25	De assistent voor/met de inspecteur(s)* *The assistant for/with the inspector(s)*	gestrest *stressed*	3.10/2.90
26	De chauffeur voor/met de acteur(s)* *The chauffeur for/with the actor(s)*	onvriendelijk *unfriendly*	3.47/2.94

Appendix (*Continued*)

	Integrated/Unintegrated Singular local noun (plural local noun)	Adjective	Ratings
27	De leerling voor/met de kleermaker(s)* *The apprentice for/with the tailor(s)*	verlegen *shy*	3.76/2.28
28	De aanhanger van/met de evangelist(en)* *The supporter of/with the evangelist(s)*	loyaal *loyal*	4.45/2.96
29	De vertaler van/met de ambassadeur(s)* *The translator of/with the ambassador(s)*	slim *smart*	4.55/3.06
30	De secretaresse van/met de bestuurder(s)** *The secretary of/with the governor(s)*	elegant *elegant*	3.83/3.22
31	De accountant voor/met de miljonair(s)* *The accountant for/with the millionaire(s)*	arrogant *arrogant*	4.76/3.19
32	De verpleegster voor/met de chirurg(en)* *The nurse for/with the surgeon(s)*	aardig *nice*	4.44/3.61
33	De adviseur van/met de producent(en)* *The consultant of/with the producer(s)*	ervaren *experienced*	4.81/3.86
34	De raadsman van/met de advocaat (advocaten)* *The advisor of/with the attorney(s)*	nerveus *nervous*	5.60/4.33
35	De bediende voor/met de diplomaat (diplomaten)* *The servant for/with the diplomat(s)*	angstig *anxious*	3.86/2.50
36	De manager van/met de band(s)* *The manager of/with the band(s)*	klein *small*	5.53/4.29
37	De agent voor/met de artiest(en)* *The agent for/with the artist(s)*	drukbezet *busy*	4.04/3.47
38	De trainer voor/met de atleet (atleten)* *The trainer for/with the athlete(s)*	teleurgesteld *disappointed*	5.25/4.47
39	De dokter van/met de patiënt(en)* *The doctor of/with the patient(s)*	zorgzaam *caring*	6.23/5.22
40	De leraar voor/met de scholier(en)** *The teacher for/with the pupil(s)*	moe *tired*	5.00/3.98
41	De coach van/met de turnster(s)* *The coach of/with the gymnast(s)*	energiek *energetic*	5.07/3.18
42	De fotograaf van/met de mannequin(s)* *The photographer of/with the model(s)*	verward *confused*	5.26/2.86
43	De promotor voor/met de DJ('s)* *The promoter for/with the DJ(s)*	verdrietig *sad*	4.70/3.76
44	De tuinman van/met de landeigenaar (landeigenaren)* *The gardener of/with the landowner(s)*	boos *angry*	4.46/3.55
45	De moeder van/met de zuigeling(en) *The mother of/with the baby/babies)*	aardig *nice*	5.49/4.76
46	De buurvrouw van/met de jongeman(nen) *The neighbor of/with the young man/men*	vervelend *annoying*	4.53/2.20
47	De fan van/met de zanger(s) *The fan of/with the singer(s)*	opgewonden *excited*	5.60/3.36
48	De baas van/met de werknemer(s) *The boss of/with the employee(s)*	oneerlijk *unfair*	5.70/3.80
49	De bestuurder van/met de trein(en) *The driver of/with the train(s)*	bezorgd *worried*	5.44/3.64
50	De collega van/met de vriend(en) *The colleague of/with the friend(s)*	oud *old*	4.31/2.89
51	De oppas van/met de kleuter(s) *The baby-sitter of/with the toddler(s)*	geestig *funny*	5.12/4.46
52	De fabrikant van/met de creatie(s) *The manufacturer of/with the creation(s)*	trots *proud*	3.93/3.02
53	De lakei van/met de prins(en) *The servant of/with the prince(s)*	lui *lazy*	5.54/3.98
54	De eigenaar van/met de dure auto(s) *The owner of/with the expensive car(s)*	enthousiast *enthusiastic*	4.94/3.16

Appendix (*Continued*)

	Integrated/Unintegrated Singular local noun (plural local noun)	Adjective	Ratings
55	De dochter van/met de zendeling(en) *The daughter of/with the missionary (missionaries)*	knap *handsome*	5.02/2.19
56	De vader van/met de jongeman(nen) *The father of/with the young man (men)*	verantwoordelijk *responsible*	4.66/2.88
57	De papegaai van/met de kleinzoon(s) *The parrot of/with the grandson(s)*	luidruchtig *noisy*	4.32/3.35
58	De dichtbundel met de omgevouwen bladzijde(n)/rode pen(nen) *The volume of poems with the torn page(s)/red pen(s)*	dun *thin*	5.32/3.43
59	De panty met de rare opdruk(ken)/vieze handdoek(en)* *The tights with the crazy print(s)/dirty towel(s)*	schoon *clean*	4.98/2.51
60	De ring met de nep-diamant(en)/gouden armband(en)* *The ring with the fake diamond(s)/gold bracelet(s)*	glinsterend *shiny*	5.43/1.84
61	De appel met de bruine plek(ken)/verse perzik(en)* *The apple with the brown spot(s)/fresh peach(es)*	lekker *tasteful*	5.22/2.56
62	De stropdas met de lelijke streep/strepen/katoenen blazer(s)* *The tie with the hideous stripe(s)/cotton blazer(s)*	rood *red*	5.24/2.44
63	De klok met de missende wijzer(s)/zwarte portemonnee(s)** *The clock with the missing hand(s)/black wallet(s)*	kapot *broken*	5.64/2.50
64	De jas met de kapotte rits(en)/natte paraplu('s)* *The jacket with the faulty zipper(s)/wet umbrella(s)*	vies *dirty*	5.55/3.39
65	De kam met de gebroken tand(en)/lege tube(s)** *The comb with the broken tooth/teeth/empty tube(s)*	bruin *brown*	5.33/1.40
66	De sleutel met de gekartelde rand(en)/glanzende munt(en)* *The key with the jagged edge(s)/shiny coin(s)*	roestig *rusty*	4.78/2.02
67	De fauteuil met de krakende veer (veren)/grote boekenkast(en)** *The chair with the creaky spring(s)/tall bookcase(s)*	smal *narrow*	4.33/2.14
68	De telefoon met de missende toets(en)/kapotte broodrooster(s)* *The phone with the missing button(s)/broken toaster(s)*	oud *old*	5.04/2.37
69	De bedsprei met de vieze vlek(ken)/wollen deken(s)** *The bedspread with the dirty stain(s)/woolen blanket(s)*	wit *white*	4.96/3.53
70	De kroonluchter met de felle lamp(en)/antieke pianokruk(ken)** *The chandelier with the harsh light(s)/antique music-stool(s)*	grijs *grey*	5.61/2.20
71	De krant met de kleurige advertentie(s)/koffiemok(ken)** *The newspaper with the colorful ad(s)/coffee mug(s)*	populair *popular*	5.05/2.88
72	De trui met de losse zoom (zomen)/zwarte pantalon(s)** *The sweater with the loose hem(s)/black slack(s)*	smaakvol *tasteful*	5.53/2.98
73	De rekening met de hoge prijs (prijzen)/afgesloten doos (dozen)* *The receipt with the high price(s)/sealed box(es)*	gescheurd *torn*	4.92/1.71
74	De boom met de dode tak(ken)/lage struik(en)* *The tree with the dead branch(es)/small shrub(s)*	groot *tall*	5.02/3.49
75	De pizza met de lekkere topping(s)/frisse dorstlesser(s)* *The pizza with the tasty topping(s)/fresh beverage(s)*	ongezond *unhealthy*	4.46/2.31
76	De melk met de extra vitamine(s)/bosbessenmuffin(s)* *The milk with the extra vitamin(s)/blueberry muffin(s)*	koud *cold*	4.60/1.78
77	De gitaar met de losse snaar/snaren/luide trommel(s)* *The guitar with the loose string(s)/loud drum(s)*	vals *out of tune*	5.48/3.06
78	De deken met de losse draad (draden)/schone rok(ken)** *The blanket with the loose thread(s)/clean skirt(s)*	muf *musty*	5.02/1.79

Appendix (*Continued*)

	Integrated/Unintegrated Singular local noun (plural local noun)	Adjective	Ratings
79	De beker met de lange scheur(en)/kristallen kom(men)**	tweedehands	3.78/2.59
	The mug with the lengthy crack(s)/crystal bowl(s)	*secondhand*	
80	De fiets met de verbogen spaak (spaken)/surfplank(en)*	paars	5.07/2.59
	The bike with the bent spoke(s)/surfboard(s)	*purple*	
81	De stoel met de losse poot (poten)/oude tafel(s)*	oncomfortabel	5.18/3.74
	The chair with the wobbly leg(s)/old table(s)	*uncomfortable*	
82	De koe met de zwarte vlek(ken)/zwarte geit(en)	ziek	4.98/2.54
	The cow with the black spot(s)/goat(s)	*ill*	
83	De plant met de mooie bloem(en)/ronde steen (stenen)	groen	5.58/2.78
	The plant with the pretty flower(s)/round rock(s)	*green*	
84	De cd met de rustige ballade(s)/spannende roman(s)	stuk	5.54/2.12
	The cd with the slow ballad(s)/exciting novel(s)	*broken*	
85	De piano met de losse toets(en)/scheve kruk(ken)	zwart	5.43/3.39
	The piano with the loose key(s)/lopsided stool(s)	*black*	
86	De schoen met de kapotte veter(s)/schone sok(ken)	bruin	5.88/4.28
	The shoe with the broken lace(s)/clean sock(s)	*brown*	
87	De kom met de rode streep (strepen)/houten lepel(s)	blauw	5.04/3.31
	The bowl with the red stripe(s)/wooden spoon(s)	*blue*	
88	De verzamelmap voor de oude foto(s)/ketting(en)	geërfd	5.14/2.74
	The album for the old photo(s)/necklace(s)	*inherited*	
89	De jongedame met de zere vinger(s)/hond(en)	jong	5.14/2.74
	The young lady with the sore finger(s)/dog(s)	*young*	
90	De bal met de rode stip(pen)/sportschoen(en)	hard	4.71/2.14
	The ball with the red dot(s)/sports shoe(s)	*hard*	
91	De kerstboom met de slinger(s)/kerststal(len)	gigantisch	5.92/4.67
	The Christmas tree with the garland(s)/nativity scene(s)	*gigantic*	
92	De kat met de scherpe nagel(s)/witte muis (muizen)	rood	5.31/3.14
	The cat with the sharp nail(s)/white mouse/mice	*red*	
93	De tegel met de spreuk(en)/fotolijst(en)	opgehangen	5.21/2.90
	The tile with the proverb(s)/photo frame(s)	*hung up*	
94	De laptop met verlichte knop(pen)/broodtrommel(s)	gestolen	5.35/2.72
	The laptop with the illuminated button(s)/bread bin(s)	*stolen*	
95	De woning met de rode deur(en)/vrijstaande garage(s)	bewoond	5.59/4.48
	The residence with the red door(s)/detached garage(s)	*inhabited*	
96	De spijkerbroek met de scheur(en)/trui(en)	tweedehands	5.22/3.09
	The jeans with the tear(s)/sweater(s)	*second-hand*	
97	De blouse met de gouden knoop (knopen)/leren handschoen(en)	oranje	5.70/1.98
	The blouse with the golden button(s)/leather glove(s)	*orange*	
98	De kandelaar met de witte kaars(en)/zilveren schaal (schalen)	waardevol	5.52/3.26
	The chandelier with the white candle(s)/silver platter(s)	*valuable*	
99	De zakdoek met de geborduurde letter(s)/rode kauwgombal(len)	gestreken	4.83/3.18
	The handkerchief with the embroidered character(s)/red bubble gum(s)	*ironed*	
100	De auto met de lekke band(en)/bestelbus(sen)	beschadigd	6.14/3.09
	The car with the flat tire(s)/delivery truck(s)	*damaged*	

Note. Adjectives were not used in Experiment 2. *Direct translation from Solomon & Pearlmutter (2004)

**Adaptation from Solomon & Pearlmutter.

Appendix B: The filler items.

	Sentence	Adjective
1	De reisleider en de toerist	gekidnapt
	The guide and the tourist	*kidnapped*
2	De sokken van de directeur	gebreid
	The socks of the director	*knitted*
3	Het toetsenbord en de muis van de computer	draadloos
	The keyboard and the mouse of the computer	*wireless*
4	De dokter en de verpleegster	behulpzaam
	The doctor and the nurse	*helpful*
5	De leraar en de student	blij
	The teacher and the student	*happy*
6	De pakjes voor de kinderen	bezorgd
	The presents for the children	*delivered*
7	Het resultaat en de verwachting	hoopgevend
	The result and the expectation	*hopeful*
8	De schommel en de wip in de pas aangelegde speeltuin	populair
	The swing and the seesaw in the new playground	*popular*
9	De antwoorden van de politicus	dom
	The answers of the politician	*dumb*
10	De sandwich en de chocolade muffin	verpakt
	The sandwich and the chocolate muffin	*wrapped*
11	De inbrekers met de bivakmutsen	gearresteerd
	The burglars with the balaclavas	*arrested*
12	De klanten van de telefoon-maatschappij	opgelicht
	The costumers of the telephone company	*swindled*
13	De achtbaan en het reuzenrad	favoriet
	The rollercoaster and the big wheel	*favorite*
14	De eenden in het park	brutaal
	The ducks in the park	*impudent*
15	De jongetjes op de kleuterschool	stout
	The boys at the kindergarten	*naughty*
16	De raamkozijnen van het kantoor	geverfd
	The window frames of the office	*painted*
17	De technicus en zijn zoon	sportief
	The technician and his son	*sporty*
18	De pennen uit het etui	leeg
	The pens from the case	*empty*
19	De reizigers op het vliegveld	vermoeid
	The travelers at the airport	*tired*
20	De bus en de trein richting het noorden	vertrokken
	The bus and the train heading north	*departed*
21	De politie-agent en de buurtbewoonster	oplettend
	The police officer and the local	*observant*
22	De kunstenaar en zijn beeldschone muze	gelukkig
	The artist and his gorgeous muse	*happy*
23	De cijfers van de student voor het moeilijke vak	uitmuntend
	The grades of the student for the difficult course	*excellent*
24	De bierglazen op de plank	vies
	The beer glasses on the shelf	*dirty*
25	De kevers op de tak	schattig
	The bugs on the branch	*cute*
26	De skileraar en de cursist	verdwaald
	The skiing instructor and the student	*lost*

Appendix (*Continued*)

	Sentence	Adjective
27	De voetballers in de lastige wedstrijd	uitgeput
	The soccer players in the tough game	*exhausted*
28	De pantoffels met de rode stippen	warm
	The slippers with the red dots	*warm*
29	De bloemen in de mooie vaas	verdord
	The flowers in the pretty vase	*withered*
30	Het kamermeisje en de receptioniste van het keurige hotel	efficiënt
	The chambermaid and the receptionist of the neat hotel	*efficient*
31	Het album en de cd-single van de nieuwe popgroep	succesvol
	The album and the cd single of the new pop group	*successful*
32	Het bos en het natuurgebied	beschermd
	The forest and the nature reserve	*protected*
33	De potloden van de ijverige scholier	geslepen
	The pencils of the diligent pupil	*sharpened*
34	Het paspoort en de ID-kaart	rechtsgeldig
	The passport and the ID card	*legally valid*
35	De sperziebonen uit de supermarkt	afgeprijsd
	The green beans from the supermarket	*on sale*
36	De stuntman en de cameraman	gewond
	The stuntman and the cameraman	*hurt*
37	De ballonnen voor het feestje	opgeblazen
	The balloons for the party	*blown up*
38	De tanden van de Hollywood acteur	gebleekt
	The teeth of the Hollywood actor	*bleached*
39	Het gerecht en de saus	pikant
	The dish and the sauce	*spicy*
40	De schat en de schatkaart	verborgen
	The treasure and the map	*hidden*
41	De helm en de linker kniebeschermer	beschadigd
	The helmet and the left knee-guard	*damaged*
42	De wortels uit de groentetuin	geoogst
	The carrots from the vegetable garden	*harvested*
43	De resultaten van het slechte onderzoek	onbetrouwbaar
	The results of the bad survey	*unreliable*
44	De gasten voor de trouwerij	opgedoft
	The guests for the wedding	*spruced up*
45	De slagerij en de kapsalon	gesloten
	The butcher's shop and the hairdresser's shop	*closed*
46	De salade en het verse fruit	gezond
	The salad and the fresh fruit	*healthy*
47	De piano's van de muziekschool in de stad	gestemd
	The pianos of the music school in town	*tuned*
48	De worstjes op de barbecue	klaar
	The sausages on the barbecue	*done*
49	De concerten van het populaire orkest	uitverkocht
	The concerts of the popular orchestra	*sold out*
50	De documenten voor de sleuteloverdracht	officieel
	The documents for the handover of the keys	*official*
51	Het hert en het everzwijn	afgeschoten
	The deer and the wild boar	*shot*
52	De spijker en de schroef in de buitenmuur	roestig
	The nail and the screw in the outer wall	*rusty*
53	De wolken in de donkere lucht	onheilspellend
	The clouds in the dark sky	*ominous*

Appendix (*Continued*)

	Sentence	Adjective
54	De jas en de broek	ouderwets
	The jacket and the pants	*old-fashioned*
55	De supporters van de voetbalclub	agressief
	The supporters of the football club	*aggressive*
56	De sterren aan de hemel	schitterend
	The stars in the sky	*shiny*
57	De tomaat en de appel	rood
	The tomato and the apple	*red*
58	De laborant en de onderzoeker in het ziekenhuis	ambitieus
	The chemist and the researcher in the hospital	*ambitious*
59	De uitspraken van de kroegbaas	dubbelzinnig
	The statements of the public house keeper	*ambiguous*
60	De badkamer en de keuken van het oude huis	vochtig
	The bathroom and the kitchen of the old house	*humid*
61	Het meisje en de automobilist	overstuur
	The girl and the car driver	*upset*
62	De voeten van de marathon-loper	pijnlijk
	The feet of the marathon runner	*painful*
63	De juryleden van het tv-programma	tevreden
	The members of the jury of the television program	*satisfied*
64	De kledingontwerper en het internationale topmodel	arrogant
	The clothing designer and the international top model	*arrogant*
65	De dominee en zijn vrouw	stomverbaasd
	The reverend and his wife	*flabbergasted*
66	De broek en het shirt van de atleet	bezweet
	The pants and the shirt of the athlete	*sweaty*
67	De tractor en de hijskraan	gerepareerd
	The tractor and the hoisting crane	*fixed*
68	De regels van het ingewikkelde spel	uitgeprint
	The rules of the complicated game	*printed*
69	De vragen op het tentamen	ingewikkeld
	The questions on the exam	*complicated*
70	De film en het boek	saai
	The movie and the book	*boring*
71	De gebakjes op het feest	zelfgemaakt
	The cakes at the party	*homemade*
72	De nachtwaker van het museum en de beveiliger	geschrokken
	The night-watcher of the museum and the security guard	*scared*
73	De miljonair en zijn ex-vrouw	rijk
	The millionaire and his ex-wife	*rich*
74	De secretaresse en de conciërge	nijdig
	The secretary and the janitor	*angry*
75	De schuur en de koeienstal	afgebrand
	The barn and the cowshed	*burned down*
76	De bewoners van de grote boerderij	zuinig
	The inhabitants of the big farm	*thrifty*
77	De bergbeklimmers op de top van de berg	hongerig
	The mountaineers on the top of the mountain	*hungry*
78	De vork en het mes	afgewassen
	The fork and the knife	*washed*
79	De prins en de prinses	verliefd
	The prince and the princes	*in love*
80	De sterrenkundige en de tekstschrijver	bevriend
	The astronomer and the scriptwriter	*close*

Appendix (*Continued*)

	Sentence	Adjective
81	De beek en de rivier	overstroomd
	The brook and the river	*overflown*
82	De huisvrouw en de zuster	opgebeld
	The housekeeper and the sister	*rung*
83	Het aantal deelnemers en het slagingspercentage	teleurstellend
	The number of contesters and the success rate	*disappointing*
84	De eieren in het ontdekte eendennest	kapot
	The eggs in the discovered duck nest	*broken*
85	De brief en de ansichtkaart	gepost
	The letter and the postal card	*mailed*
86	De oma en de opa	opgewekt
	The grandmother and grandfather	*cheerful*
87	De fysiotherapeut en zijn neef	mager
	The physiotherapist and his cousin	*skinny*
88	De straat en het steegje	nauw
	The street and the alley	*narrow*
89	De snoepjes uit de snoepjespot van de meester	op
	The candy out of the candy jar of the teacher	*empty*
90	De danseressen in de voorstelling	knap
	The dancers in the show	*handsome*
91	De nichtjes van de kapper	linkshandig
	The nieces of the hairdresser	*left-handed*
92	De pensionaris en zijn vrouw	vergeetachtig
	The pensioner and his wife	*forgetful*
93	De computers van de middelbare school	gestolen
	The computers of the high school	*stolen*
94	De schets en het schilderij van de beroemde schilder	geveild
	The sketch and the painting of the famous painter	*auctioned*
95	Het sleutelbeen en de bovenarm	gebroken
	The collarbone and the upper arm	*broken*
96	De blaadjes van het jonge boompje	teer
	The leaves of the young tree	*fragile*
97	De zolder en de kelder van het oude huis	stoffig
	The attic and the cellar of the old house	*dusty*
98	De leerlingen van de kunstopleiding	getalenteerd
	The students of the art school	*talented*
99	Het slootwater en het zeewater	getest
	The ditchwater and the seawater	*tested*
100	De vissen in de vijver	groot
	The fish in the pond	*big*

Note: Adjectives were not used in Experiment 2.

Appendix C: The catch items.

	Sentence	Adjective
1	De trainingsbroeken	uitverkocht
	The sweatpants	*sold out*
2	De stratenmakers	bekwaam
	The road-makers	*capable*
3	De nagellak en de lippenstift	donkerrood
	The nail polish hand the lipstick	*dark red*
4	De vader en de zoon	zenuwachtig
	The father and the son	*nervous*
5	Het bericht van de kaping	onverwacht
	The news of the hijacking	*unexpected*
6	De opbrengst van de benefietacties	hoog
	The proceeds of the benefit actions	*high*
7	De treinconducteurs in de intercity	streng
	The conductors in the fast train	*strict*
8	De uitslagen van de examens	bekend
	The results of the exams	*announced*
9	De frikadel en de kroket uit de muur	afgekoeld
	The snacks out of the wall	*cooled down*
10	De ruiter en het paard	gevallen
	The rider and the horse	*fallen*
11	Het idee van de uitvinders	geniaal
	The idea of the inventors	*brilliant*
12	De artiest met de bodyguard	beroemd
	The artist with the bodyguard	*famous*
13	De stofzuigers van de speciaalzaak	duur
	The vacuum cleaners from the specialist shop	*expensive*
14	De bewakers	oplettend
	The guards	*observant*
15	De strandjutter en zijn hond	natgeregend
	The beachcomber and his dog	*wet*
16	De kattenbak en de vogelkooi	verschoond
	The litter tray and the bird cage	*cleaned*
17	De moeder met de kinderwagen	ongerust
	The mother with the pram	*worried*
18	De Sinterklaas met de zwarte pieten	aangekomen
	Saint Nicholas and the Black Pete's	*arrived*
19	De wandelaars	vermoeid
	The hikers	*tired*
20	De mannen met de baarden	zeeziek
	The men with the beards	*seasick*
21	De sergeant en de generaal	uitgezonden
	The sergeant and the general	*posted*
22	De kuitspier en de hamstring	verstuikt
	The calf muscle and the hamstring	*sprained*
23	Het kind met de knikkers	blij
	The child with the marbles	*happy*
24	Het plan van de politicus	uitgelekt
	The plan of the politician	*leaked out*

Appendix D: The practice items.

	Sentence	Adjective
1	De palmbomen bij het strand	groot
	The palm trees at the beach	*big*
2	De broer van de collega van mijn vader	miljonair
	The brother of the colleague of my father	*millionaire*
3	De kip en het ei	wit
	The chicken and the egg	*white*
4	De overtreding door de wethouder	schandalig
	The offence by the alderman	*scandalous*
5	De sloot achter de kerk	vervuild
	The ditch behind the church	*polluted*
6	De man achter de toonbank	aardig
	The man behind the counter	*friendly*
7	De telefoon en de oplader	gestolen
	The telephone and the charger	*stolen*
8	De vleermuizen in de grot	eng
	The bats in the cave	*scary*
9	De minister van financiën van Italië	hoogopgeleid
	The minister of finance of Italy	*highly educated*
10	De pony's van de kinderboerderij	lief
	The ponies at the children's zoo	*sweet*
11	Het geld op de bank	verdwenen
	The money on the bank	*disappeared*
12	De deuren van de casino's	open
	The doors of the casino's	*open*

Note: Items 7 through 12 were only used in Experiment 2. The adjectives were only used in Experiment 1. Catch trials (items 3 and 5) were only used in Experiment 1 and the follow-up to Experiment 2.

Appendix E: Descriptives and statistics for analyses using dichotomous integration.

Table E1. Agreement error rates in ms (SD) per condition in Experiment 1.

		Integration	
Singular local noun	Item Type	Unintegrated	Integrated
	Noun variation items	19 (39)	7 (25)
	Preposition variation items	13 (34)	9 (29)
	All items	16 (37)	8 (27)
Plural local noun	Item Type		
	Noun variation items	24 (43)	15 (36)
	Preposition variation items	24 (43)	9 (29)
	All items	24 (43)	12 (33)

Table E2. Agreement errors predicted by Integration treated as a dichotomous variable.

Experiment 1					
Variable	Coefficient	SE	*z*-value	Pr(>|*z*|)	Random Slope
(Intercept)	−2.34	0.24	−9.86	<.001	
Integration	−0.53	0.10	−5.52	<.001	subjects
Local Noun Number	0.22	0.10	2.14	.032	subjects, items
Block	−0.16	0.06	−2.83	<.01	
Integration*Number	−0.08	0.07	−1.20	.232	
Integration*Block	−0.10	0.04	−2.23	.026	
Number*Block	−0.15	0.04	−3.35	<.001	
Experiment 2					
Variable	Coefficient	SE	*z*-value	Pr(>|z|)	Random Slope
(Intercept)	−2.65	0.22	−12.18	<.001	
Integration	−0.78	0.12	−6.54	<.001	subjects
Local Noun Number	0.44	0.13	3.28	.001	subjects
Block	−0.21	0.05	−3.91	<.001	
Integration*Number	0.11	0.09	1.18	.279	

Table E3. Response times in ms (SD) per condition in Experiment 1.

		Integration	
Singular local noun	Item Type	Unintegrated	Integrated
	Noun variation items	926 (366)	852 (333)
	Preposition variation items	885 (328)	835 (311)
	All items	906 (348)	844 (323)
Plural local noun	Item Type		
	Noun variation items	934 (360)	875 (325)
	Preposition variation items	933 (343)	831 (312)
	All items	933 (352)	854 (319)

Table E4. Response times predicted by Integration treated as a dichotomous variable.

Experiment 1				
Variable	Coefficient	SE	*t*	Random slope
(Intercept)	6.73	0.04	183.29	
Integration	−0.04	0.01	−5.34	
Local Noun Number	0.02	0.01	2.37	subjects
Block	−0.04	0.01	−6.75	
Integration*Number	−0.01	0.01	−0.91	
Integration*Block	−0.01	0.00	−2.58	
Experiment 2				
Variable	Coefficient	SE	*t*	Random slope
(Intercept)	6.63	0.11	59.68	
Integration	−0.07	0.01	−5.50	subjects, items
Local Noun Number	0.06	0.01	5.67	subjects
Block	−0.01	0.01	−2.25	
Integration*Number	0.00	0.01	0.36	
Number*Block	−0.01	0.01	−2.25	

Note: Interactions with Block indicate a practice effect. Effects were considered significant if $|t|>2$.

Table E5. Agreement error rates in percentages (SD) per condition in Experiment 2.

		Integration	
Singular local noun	Item Type	Unintegrated	Integrated
	Noun variation items	15 (36)	3 (16)
	Preposition variation items	12 (33)	2 (16)
	All items	14 (35)	2 (16)
Plural local noun	Item Type		
	Noun variation items	27 (44)	12 (33)
	Preposition variation items	21 (40)	9 (29)
	All items	24 (43)	11 (31)

Table E6. Response time in ms (SD) per condition in Experiment 2.

		Integration	
Singular local noun	Item Type	Unintegrated	Integrated
	Noun variation items	1001 (838)	854 (548)
	Preposition variation items	982 (788)	813 (575)
	All items	992 (814)	835 (560)
Plural local noun	Item Type		
	Noun variation items	995 (749)	1012 (665)
	Preposition variation items	1077 (846)	904 (684)
	All items	1035 (798)	960 (676)