Journal of Psycholinguistic Research, Vol. 34, No. 4, July 2005 (© 2005)
DOI: 10.1007/s10936-005-6139-3

Syntactic Priming: A Corpus-based Approach

Stefan Th. Gries[1]

The present study is a corpus-based investigation of syntactic priming, i.e. the tendency to reuse syntactic constructions. On the basis of data from the ICE-GB corpus, I analyze two different pairs of syntactic patterns, the so-called dative alternation and particle placement of transitive phrasal verbs. Although it has sometimes been argued that only experimental data can contribute to studies of priming, the analysis shows that (a) the corpus-based results for datives are very similar to the experimental ones; (b) priming is also obtained for the verb-particle construction, a construction hitherto not explored in the priming literature and (c), most importantly, in line with much previous psycholinguistic and corpus-linguistic work, priming effects turn out to be strongly verb-specific such that some verbs are much more resistant or responsive to priming than others. I conclude with a discussion of how corpus data relate to experimental data and how the corpus-based findings can contribute to psycholinguistic model building.

KEY WORDS: collostructions; corpus data; verb subcategorization; verb bias; structural/syntactic priming.

INTRODUCTION

As a variety of studies has shown, speakers tend to repeat syntactic structures they have just encountered (produced or comprehended) before. This tendency has been referred to as structural priming, syntactic persistence or syntactic priming; I will use the latter term throughout the remainder

[1] This paper is dedicated to Günter Rohdenburg on the occasion of his 65th birthday. Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany. email: gries@eva.mpg.de, http://people.freenet.de/Stefan_Th_Gries
I thank (in alphabetical order) Doris Schönefeld (Ruhr University of Bochum), Anja Steinlen (University of Southern Denmark) and Stefanie Wulff (University of Bremen) for comments on a previous draft of this paper. In addition, I have benefited a lot from discussion with Benedikt Szmrecsanyi (University of Freiburg) and from the very detailed and useful comments of one anonymous reviewer, which made it possible to improve the paper considerably. Naturally, all remaining inadequacies are my own.

0090-6905/05/0700–0365/0 © 2005 Springer Science+Business Media, Inc.

of this paper.[2] Levelt and Kelter (1982) and Weiner and Labov (1983) belong to the earliest studies to which the identification of this phenomenon is commonly attributed. The former study found that merchants in the Netherlands tended to formulate their answers to questions such that the syntactic structure of their answers was identical to that of the questions; for example, the Dutch equivalents of the questions in (1a) and (1b) tended to trigger (2a) and (2b) respectively as answers.

(1) a. At what time does your shop close?
    b. What time does your shop close?
(2) a. At five o'clock.
    b. Five o'clock.

The latter study found that the likelihood of a passive utterance at a particular point of time in a sociolinguistic interview is significantly increased by the presence of another passive utterance in the previous five sentences. Similar findings are presented in a corpus-based study on actives, lexical passives and transformational passives by Estival (1985), who also found a significant priming effect of actives and passive across five clauses which was robust enough to remain even after a variety of potentially interfering discourse-functional variables had been factored out.

The bulk of the studies on syntactic priming, however, consists of experimental approaches. The classic study in this respect is the picture description study of Bock (1986). Under the guise of a memory task, subjects first repeated prime sentences coming in one out of two alternating structures: the transitivity alternation (i.e., active vs. passive sentence form) or the so-called dative alternation (i.e., the syntactic choice between the ditransitive, or double-object, construction and the prepositional dative with *to* and *for*). Then, the subjects described semantically unrelated pictures allowing both syntactic alternatives from one of the two alternating structures. Bock found that subjects indeed preferred to formulate a description the syntactic structure of which matched that of the prime sentence.

Other studies (especially Bock & Loebell, 1990, but also, e.g., Smith & Wheeldon 2001) ruled out other attempts to explain syntactic priming. For instance, syntactic priming cannot be attributed to metrical similarity between primes and target choices by subjects: (3a) and (3b), instantiating

[2] I adopt the definition of syntactic priming proposed by Branigan *et al.* (1995: 490): "We define syntactic priming as the proposal that processing a particular syntactic structure within a sentence affects the processing of the same (or a related) syntactic structure within a subsequently presented sentence"; cf. Szmrecsanyi (2005) for discussion of whether *persistence* is the more appropriate cover term (specially for corpus-based studies).

the dative alternation just referred to, are identical in terms of their metrical structure but differ in terms of their different syntactic structures (adopted from Bock & Loebell, 1990:24), which is why (3a) results in a significant preference of prepositional datives (relative to a baseline/control condition) whereas (3b) does not.

(3) a. Susan [$_{\text{VP}}$ brought [$_{\text{NP}}$ a book] [$_{\text{PP}}$ to Stella]]
b. Susan [$_{\text{VP}}$ brought [$_{\text{NP}}$ a book] [$_{\text{S}}$ to study]]

Similarly, syntactic priming does not derive from the presence of closed-class lexical items in particular slots of the sentences or event-structural or thematic utterance characteristics. As to the former, Bock (1989), for example, provides experimental evidence showing that the priming effects she obtained cannot be explained by reference to closed-class lexical items involved in the dative alternation, viz. *to* and *for*. As to the latter claim, consider the examples in (4) and (5). While (4a) and (4b) are different in terms of their thematic structure, they are identical in terms of their syntactic structure and, thus, both (4a) and (4b) prime prepositional datives (relative to control conditions); the same holds for (5a) and (5b), both of which prime passives.

(4) a. The wealthy widow [$_{\text{VP}}$ gave [$_{\text{NP}}$ an old Mercedes] [$_{\text{NPrecipient}}$ to the church]]
b. The wealthy widow [$_{\text{VP}}$ drove [$_{\text{NP}}$ an old Mercedes] [$_{\text{NPlocative}}$ to the church]]

(5) a. The 747 was alerted [$_{\text{PP agentive}}$ by the airport's control tower]
b. The 747 was landing [$_{\text{PP locative}}$ by the airport's control tower]

Subsequent experimental work has mainly focused on spoken English, but has also been concerned with written English as well as Dutch (cf. Hartsuiker & Kolk, 1998; Hartsuiker, *et al.*, 1999; Hartsuiker & Westenberg, 2000) and German (cf. Scheepers & Corley, 2000) in both speaking and writing. The range of experimental methodologies has also been broadened considerably and now includes a wide variety of offline experimental paradigms such as sentence completion tasks (cf., e.g., Pickering & Branigan, 1998; Hartsuiker & Westenberg, 2000 etc.), sentence recall tasks (Potter & Lombardi, 1998), and picture descriptions in dialogs (cf. Branigan *et al.*, 2000). In addition, Smith & Wheeldon (2001) and Corley & Scheepers (2002) did online studies where priming effects were also measured in terms of production latencies. While most studies have investigated the dative alternation and the active–passive alternation in English (as in (4) and (5)), more recent work has also looked at the equivalent constructions in Dutch as well as Dutch locative PP alternations, the order of auxiliary verb and past participle in Dutch as well as dative-accusative verb alternation in German (cf. Scheepers & Corley, 2000), and the order of syntactic functions in Japanese (cf. Yamashita *et al.* [2002]).

The currently most pressing issues concerning syntactic priming (many of which will also be addressed in the present approach) are the following:

(i) the duration of syntactic priming: on the one hand, Levelt and Kelter (1982) and Branigan *et al.* (1999) report that priming (in spoken and written production respectively) is fairly short-lived. On the other hand, other studies report priming effects across longer time interval or more intervening material (cf. Bock & Griffin, 2000; Pickering *et al.*, 2000; Chang *et al.*, 2000).

(ii) the directionality of syntactic priming: Branigan *et al.* (1995) discuss a variety of different studies which, taken all together, support the assumption that syntactic priming can operate from production to production (cf. Bock, 1986; Bock & Loebell, 1990), from comprehension to comprehension (cf. Branigan *et al.*, 1995 for an overview) and from comprehension to production (cf. Branigan *et al.*, 2000; Bock, 2002).

(iii) the grammatical characteristics of the priming verb: Pickering and Branigan (1998) found that (a) syntactic priming is stronger if the priming verb lemma and the target verb lemma are identical (compared to different lemmas in prime and target) and that (b) morphological differences between the priming verb and the target verb (in terms of tense, aspect and number) do not result in strongly varying priming strengths.

(iv) the degree to which syntactic priming is asymmetric and construction-(pair)-specific: From a between-alternations perspective, Bock (1986: Exp. 1) found stronger priming for the two syntactic frames involved in the dative alternation than for those involved in the active–passive alternation in English; a similar prominence of datives over transitives was found for English by Potter and Lombardi (1998: Exp. 3) and for Dutch by Hartsuiker and Kolk (1998). In addition, from a within-alternation perspective, further asymmetries were sometimes obtained: Bock (1986: Exp. 1) found there was stronger priming for ditransitives than for prepositional datives while Potter and Lombardi (1998) report the opposite (and Pickering *et al.*, 2002: 587 mention evidence for symmetric/balanced priming).

(v) the degree to which syntactic priming is language-specific: Hartsuiker *et al.*, (2002) demonstrate syntactic priming from comprehending Spanish to producing English, Salamoura (2002:

Exp. 2) demonstrates priming from Greek (L1) structures to English (L2) structures, and Gries and Wulff (in press) show that German learners of English as a foreign language exhibit priming in an English sentence completion task.

The present study is concerned with the issues raised in (i)–(iv). However, it is different from most others in two respects. First, its main point is that it goes beyond previous works by paying closer attention to the role individual verbs play for priming. Recent studies demonstrated that different verbs exhibit differentially strong associations to particular syntactic patterns or, put differently, constructions. Although the experimental priming studies mentioned above did control for the frequencies of prime constructions and for item-specific effects (in terms of F_1 and F_2 statistics) and, thus, allowed for a clear confirmation of syntactic priming, there appear to be no studies at all which investigated to what degree, if any, the strength of priming effects is conditioned by the prime and target verbs. The main issue of this study is, therefore, the question of whether particular verbs are more responsive or resistant to priming as target verbs such that, across many different prime verbs, they either have a tendency for a particular construction that overrides the prime structure or not. More generally speaking, the present study takes into account the degree to which syntactic priming may be verb-specific.

Second, contrary to most previous works, the present study is based on naturalistic corpus data rather than psycholinguistic experimentation. Given that the first studies reporting syntactic repetition were based on naturalistic data, it may appear somewhat surprising that so little corpus-based work on priming has been conducted, especially since larger corpora and the software necessary for their analysis is so widely available. This absence can probably partly be attributed to the fact that, although Bock's (1990) first example for what she later refers to as syntactic priming is drawn from naturalistic conversation, priming researchers such as Branigan and Pickering have argued against corpus-based approaches to priming by stating that

> there are several nonsyntactic factors which could lead to repetition. [...] Corpora have proved useful as a means of hypothesis generation, but unequivocal demonstrations of syntactic priming effects can only come from controlled experiments (Branigan *et al.*, 1995: 492; cf. also Pickering & Branigan, 1999: 136).

In the general discussion and conclusion, I will discuss this matter in detail. The overall plan of the present paper is as follows: The next section investigates the dative alternation already introduced above. I will first be

Table I. Ditransitives and all Prepositional Datives: MEDIUM × CONSTRUCTION

Data (ICE-GB)	V NP $PP_{for/to}$	V NP/S NP/S	Row totals
spoken	926	1254	2180
written	854	759	1613
Column totals	1780	2013	3793

concerned with general priming effects and their determinants irrespective of the verbs figuring in the constructions, and then I will provide a more fine-grained analysis of some verbs' behavior. I will then turn to the alternation known as particle placement. As before, I will first discuss verb-independent results before I turn to verb-specific details. The last section will conclude.

THE DATIVE ALTERNATION

General Investigation

In order to investigate syntactic priming corpus-linguistically, I first identified all ditransitive constructions and all prepositional datives with *to* and *for* in the British component of the International Corpus of English (ICE-GB). The ICE-GB is a POS-tagged and fully parsed corpus of spoken and written British English of the 1990s; all annotation has been checked manually by several linguists (cf. http://www.ucl.ac.uk/english-usage/ice-gb/index.htm for details). The distribution obtained is represented in Table I.

Out of these 3793 cases, 790 had to be discarded for the priming analysis because they were the first or last construction either in one of the 500 corpus files or in a subtext of a corpus file, leaving 3003 prime-target pairs (i.e. subsequent constructions of either type) for the analysis. Each of these was then coded for a variety of variables:

- MEDIUM: the medium in which prime and target occurred: spoken vs. written (automatically retrieved from the corpus files).
- CPRIME and CTARGET: the constructions of the first and the second of the two constructions constituting a prime-target pair: ditransitive vs. prepositional dative (automatically retrieved from the annotated parse trees within the corpus files).
- CID: the fact whether the constructions in prime and target are identical: yes or no (this coding task was performed semi-automatically with a spreadsheet software applied to the output of the concordancing software).

- DISTANCE: the distance in parsing units between the occurrence of prime and target within each subtext of each file as determined from the annotation of the corpus: 0, ≤1, ≤2, ≤3, ≤4, ≤5, ≤6, ≤7, ≤8, ≤9, ≤10, ≤15, ≤20, ≤25 and >25 (a parsing unit is the basic structural unit of each corpus file; in the majority of cases it corresponds to a clause or sentence).
- VFORMPRIME and VFORMTARGET as well as VLEMMAPRIME and VLEMMATARGET: the exact verb form and the verb lemma of each prime and target (the verb forms in both constructions were retrieved automatically from the corpus files, the lemmatization was done manually by myself).
- VFORMID and VLEMMAID: whether both constructions involved the same verb form and verb lemma: yes or no (this coding task was performed semi-automatically with a spreadsheet software).[3]
- SPEAKERID: whether in the spoken data both constructions were produced by the same speaker or not: yes or no (this coding task was performed semi-automatically with a spreadsheet software applied to the output of the concordancing software).

To provide one example to illustrate this coding process, consider the following brief extract from the ICE-GB (S1A-007 72:1 to 73:1).

(6) a. Speaker B: You gave it to her
    b. Speaker A: That just sh... shows you the policy of keeping things

Applying the above coding scheme results in the data set represented in Table II.

On the basis of the analogous classification of all 3003 prime-target pairs, it is now possible to compare the frequencies of all sorts of configurations of these variables and their impact on the switch rate of CPRIME and CTARGET, i.e. whether CPRIME and CTARGET are identical (cf. Sankoff & Laberge, 1978 for the first approach of this kind).[4] Consider Table III

---

[3] The variable VFORMID is of course nested into VLEMMAID since, if the lemmas of CPRIME and CTARGET are already different, the forms cannot be identical anymore.

[4] Benedikt Szmrecsanyi (p.c.) pointed out to me that collapsing switch rates of different speakers or of different corpus files this way may be dangerous: It is possible that the conflation of, for example, two corpus files in which no priming takes place may result in a summary table in which priming shows up as a statistical artifact. He therefore recommends using scatterplots of the kind used by Sankoff and Laberge (1978), in which — for each speaker or file – the relative frequency of a construction on the x-axis is plotted against the ratio of switches to one construction on the y-axis; to my mind, this is comparable to by-item statistics as used in ANOVAs. It follows that only if most dots are located below the

Table II. Application of the Coding Scheme to Priming from (6a) to (6b)

Variable	Value/level
MEDIUM:	spoken
CPRIME:	prepositional dative
CTARGET:	ditransitive
CID:	no
DISTANCE:	1
SPEAKERID:	no
VFORMPRIME:	*gave*
VLEMMAPRIME:	*give*
VFORMTARGET:	*shows*
VLEMMATARGET	*show*
VFORMID	no
VLEMMAID:	no

Table III. CPRIME × CTARGET: Observed vs. Expected Frequencies ($\chi^2(1) = 202.4$, $p < .001$)

Data (ICE-GB)	CTARGET: V NP $PP_{for/to}$	CTARGET: V NP/S NP/S	Row totals
CPRIME: V NP $PP_{for/to}$	830 (647.1)	549 (731.9)	1379
CPRIME: V NP/S NP/S	556 (762.1)	1068 (861.9)	1624
Column totals	1386	1617	3003

for the most general result, namely the interaction of CPRIME and CTARGET across all other variables; the expected frequencies are provided in parentheses and are not computed on the basis of row and column totals but on the basis of row totals and the overall frequencies of the two constructions as listed in Table I.[5]

main diagonal, switches (from one construction to the other) are rarer than the null hypothesis of the absence of priming would predict. In order to show that the summary tables used in the present data set do not suffer from such an artificial inflation, I also provide corresponding scatterplots; for that of the datives, cf. Fig. (2)

[5] The question may arise why the expected frequencies are not computed the "usual way". The reason for this is the following. If one uses the column totals from Table III for the computation of the expected frequencies, one treats these as given, as an independent variable so to speak, while in the present design the column totals are of course part of the dependent variable, namely the frequency of one (target) construction as a response to some (prime) construction. The more appropriate logic underlying the present way of computation is this: after each prime construction, the speaker has two constructional choices, and the probabilities of each of the two constructional choices are the frequencies with

As is obvious, there is a strong syntactic priming effect such that speakers/writers prefer to use the primed syntactic structure. It is also instructive, however, to look at the strength of the priming effect and to compare it with that of previous experimental results. In the present data, the ratios of the primed structure vs. the non-primed structure are 1.5 and 1.9 for prepositional datives and ditransitives respectively. By comparison, in her classic study, Bock (1986: 364) reports percentages instead of raw frequencies where the corresponding ratios of the percentages are 1.5 and 2.1 for prepositional datives and ditransitives respectively; the differences between her ratios and mine are obviously negligible. This also indicates that ditransitives prime more strongly than prepositional datives.

While this is a first promising result, it is more interesting to look at how the above variables interact. To this end, the variables MEDIUM, CPRIME, VFORMID, VLEMMAID and SPEAKERID and DISTANCE (as a covariate) were entered into a General Linear Model (GLM) analysis with CTARGET as the dependent variable.[6] While the overall correlation between the above independent variables and CTARGET is only moderate (adjusted $R^2 = .17$, $F(18, 2, 984) = 35.6$, $p < .001$), there are some effects worth mentioning. For reasons of space, I will mainly discuss the significant and marginally significant results only; in the interest of readability, I only give p-values here and provide all F-values and effect sizes in Table A.I in Appendix A.

The priming effect already reported above in Table III is of course also reflected in the GLM analysis and CPRIME is the strongest predictor of the constructional choice in the "target slot" ($p < .0001$). While the effect of CPRIME is independent of MEDIUM (i.e., priming was obtained equally strong in speaking and in writing as one might have expected on the basis of previous experimental work), it does enter into noteworthy interactions with the other variables, namely VFORMID, VLEMMAID and SPEAKERID. The significant interactions VFORMID × CPRIME ($p = .0354$) as well as VLEMMAID × CPRIME ($p < .0001$) support Pickering and Branigan's (1998: Exp. 1) results in that they indicate that, when the verb form and/or the verb lemma are identical across prime and target, then priming is considerably stronger than if prime and target are different. In addition, there is a very small and only marginally significant effect ($p = .0563$) such that if the speaker of the prime is the same as that of

which these constructions occur in the corpus (rather than .5 vs .5). Thus, what is needed are the overall frequencies of the two constructions in the corpus, which corresponds to the column totals of Table I.

[6] In terms of interpretation, the results are identical to an analogous analysis with MEDIUM, CPRIME, VFORMID, VLEMMAID and SPEAKERID and DISTANCE as independent variables and CID as dependent variable.

the target, priming is slightly stronger. In other words, production-to-production priming is stronger than comprehension-to-production priming. Finally, let us turn to DISTANCE. Obviously, the distance between prime and target is irrelevant to the constructional choice as operationalized by CTARGET. While this is not surprising, the analogous analysis with CID as dependent variable also results in no significant effect ($F(1, 2, 984) = .411$, $p = .521$). Does this mean that DISTANCE does not have any influence on the strength of the priming effect (as measured by the percentage of cases where CPRIME equals CTARGET)? And if so, would this not invalidate the corpus-based analysis completely (since no effect of DISTANCE would imply the relatively unlikely situation that priming is equally likely across all distances)? A second, closer look at the data, however, shows that this is not so because one has to bear in mind that DISTANCE was entered into a linear model, but that the relation between the distance between prime and target on the one hand and the strength of the priming effect on the other hand need not be linear. In fact, there is evidence that this relation is logarithmic (cf. Gries (in press) for empirical evidence on the basis of Pickering and Branigan's [1998] conditional probabilities measure). Thus, while the linear relation between DISTANCE and the strength of the priming effect is negligible, the logarithmic one is not (adjusted $R^2 = .77$; $R_{1,13} = 44.08$; $P < .001$).[7] priming is in fact long-lasting (again in accordance with recent findings by Bock and Griffin, 2000) and after a decrease from DISTANCE:0 to DISTANCE:1, 'there was no consistent decline in the magnitude of priming, although there were unstable changes at particular lags (i.e., parse units in the present study)' (Bock & Griffin, 2000: 187).

In sum, not only has the corpus-based analysis of syntactic priming revealed significant priming effects for ditransitives and prepositional datives, the results are also strikingly similar to those of previous experimental studies in terms of strength of effects, the influence of morphological characteristics of the verbs, construction-specificity, directionality and distance effects (i.e. the time course of priming). The following section will now provide a more detailed picture of how individual verbs figure in the priming effects.

Verb-specific Investigation

The above investigation has shown that the corpus-derived results are quite similar in nature to those obtained experimentally. However, as has

[7] For this analysis, the DISTANCE values of 0 and >25 were recoded as 1E-06 and 30 respectively; other values for DISTANCE:0 and DISTANCE:>25 yielded identical results in terms of explained variance; the resulting equation is (% of CID = 1) = .625 − .0175ln(DISTANCE).

Table IV. Exemplification of the Null Hypothesis H_0

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	a	b	a+b
CPrime: V NP/S NP/S	c	d	c+d
Column totals	a+c	b+d	a+b+c+d

already been argued above, the results discussed in the previous section (and the results of any other study on syntactic priming I am aware of) did not take into consideration the degree to which priming effects might be sensitive to particular verbs' individual preferences. This is all the more striking since (i) at least Potter and Lombardi (1998: 278) mention, but do not investigate, that individual verbs may affect preferences for particular syntactic patterns and (ii) probabilistic (i.e. frequency-based) properties of words, word senses and words in particular constructions have proven to be relevant to a variety of linguistic and psycholinguistic issues and models. Thus, what is necessary is a first exploratory study of this issue. Such an exploratory study of this issue using experiments would be quite an enormous enterprise: Since it is unclear which verbs to start with in the first place, one would have to use such a large number of different stimuli (and fillers and subjects, etc.) that this seems a daunting task. A more attractive alternative is a corpus-based approach (cf. Branigan *et al.*'s statement on how of corpus approaches can be useful for hypothesis generation, which was quoted above in the introduction), where part of the analysis can be (semi-)automated. In order to look at this in more detail, consider Table IV for an abstraction from the study of the dative alternation.

The null hypothesis (H_0) that has apparently been assumed in experimental studies on syntactic priming is that (the strengths of) the priming effects are independent of the verb(s). More technically, in the experimental paradigms referred to above it was argued that, on the whole, observed a and observed d (henceforth a_{obs} and d_{obs}) should be higher than expected a and d (henceforth a_{exp} and d_{exp}) respectively across all verbs (the same argument was put forward in the preceding section on the corpus-based approach), and the implicit assumption seems the be that this is also true for each individual verb. But rather than take H_0 for granted, let us look at whether this hypothesis is actually borne out by the data. To that end, let us look at one stimulus set of one particularly interesting study, namely Pickering and Branigan (1998). Their experimental items (Pickering and Branigan, 1998: Exp. 1) involve the ten verbs listed in alphabetical order in (7), which

Table V. CPrime × CTarget: Observed vs. Expected Frequencies for *give*

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	85 (126.2)	184 (142.8)	269
CPrime: V NP/S NP/S	51 (183.5)	340 (207.5)	391
Column totals	136	524	660

also occur differently frequently as part of the priming or the target structure in the stimulus set; for example, *offer* is used as a priming verb in both ditransitive and prepositional dative priming contexts, but not as a target verb.

(7) give, hand, lend, loan, offer, post, sell, send, show, throw

If we look at the results for the first of these verbs in the present data set, we obtain the results in Table V, where the expected values of each row are—as above—*not* computed on the basis of the column totals, but on the basis of the overall frequencies of the two constructions in Table I.

Table V indicates that there are 660 occurrences of prime-target pairs with the verb lemma *give* in the target position (where it should be subject to syntactic priming). In 269 of these 660 cases, the prime had a prepositional dative structure, in the remaining 391 cases it had a ditransitive structure. Although we have seen a strong priming effect for the dative alternation across all verbs (cf. Table III), the results for *give* do not reflect this overall tendency. As is obvious, the results are not exactly as predicted by H_0: While d_{obs} is larger than d_{exp} (indicating syntactic priming of the ditransitive construction), no such effect is found for the prepositional dative—by contrast, the ditransitive is preferred even if the prime is a prepositional dative: b_{obs} is higher than b_{exp}. Interestingly, an analogous examination of the second verb listed in (7), *hand*, results in a completely different distribution. Consider Table VI for the results concerning this verb. As is clear, in this case, a_{obs} is higher than a_{exp} (reflecting a priming effect for the prepositional dative), but no such effect is obtained for the ditransitive—rather c_{obs} is higher than c_{exp}.

It is only the third verb listed in (7) which appears to behave in accordance with H_0, namely *lend*. Consider Table VII, where, at last, the priming effect is balanced: a_{obs} and d_{obs} are higher than a_{exp} and d_{exp} respectively.

Interestingly, these are not isolated patterns. Out of the 10 verbs listed in (7), seven occur in both constructions in the corpus (*loan* and *throw*

Table VI. CPrime × CTarget: Observed vs. Expected Frequencies for *hand*

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	7 (3.8)	1 (4.2)	8
CPrime: V NP/S NP/S	9 (5.6)	3 (6.4)	12
Column totals	16	4	20

Table VII. CPrime × CTarget: Observed vs. Expected Frequencies for *lend*

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	10 (5.6)	2 (6.4)	12
CPrime: V NP/S NP/S	2 (7.5)	14 (8.5)	16
Column totals	12	16	28

only occur in the ditransitive, *post* occurs only in the prepositional dative). If we look at these seven verbs, we find that

- *show* and *offer* pattern like *give*, which prefers the ditransitive construction, (cf. Tables (A.2) and (A.3) in Appendix A for details);
- *sell* patterns like *hand*, a verb preferring the prepositional dative (cf. Table (A.4) in Appendix A for the exact figures); and
- *send* patterns roughly like *lend* (and, thus, as predicted by H_0) (roughly because, for *send*, d_{obs} is only about the same as d_{exp}).

While it is important to note that this specific finding does not invalidate the general priming effect, some verbs appear more likely to resist priming. It seems as if they preferred to occur in one construction and the question arises as to how to motivate this discrepancy. One possible explanation for these findings is based on recent general research on subcategorization preferences of verbs (and verb senses).

Most previous approaches to subcategorization preferences just quantify the attraction of some word W to some construction C in terms of the raw frequency of W in C (examples include Connine *et al.,* 1984, Hunston & Francis, 2000, Lapata *et al.*, 2001; and Hare *et al.*, 2003, to name but a few). In a series of publications, Stefanowitsch and Gries developed a family of techniques for quantifying the strengths of association between words and particular (slots of) constructions, the so-called collostructional analysis (cf. for details Stefanowitsch & Gries, 2003; Gries & Stefanowitsch, 2004a, b). These techniques make it possible to identify

Table VIII. The Distribution of give in the Ditransitive and the Prepositional Dative with *to* in the ICE-GB ($p\text{Fisher}_{\text{exact}=1.84\text{E}-120}$)

Data (ICE-GB)	*give*	other verbs	Row totals
ditransitive construction	461 (213)	574 (822)	1035
prepositional dative construction (with *to*)	146 (394)	1773 (1525)	1919
Column totals	607	2347	2954

what they refer to as significant collexemes, i.e., the verbs that are most strongly attracted by the V slot of the, say, ditransitive construction, the passive construction, the verb-particle construction, etc.; fields of application of collostructional analysis include, but are not limited to, the identification and (more precise) measurement of subcategorization preferences, the investigation of semantic properties of constructions and their implications for acquisition, etc. In contrast to the previous raw-frequency approaches just mentioned, collostructional analysis also takes into consideration the overall frequencies of W and C in the corpus to determine whether the distribution of W in the relevant slot of C deviates from the one already expected by chance alone, a precaution that many of the above studies have failed to take.[8] The method most relevant to our purposes is an extension of the investigation of distinctive collocates called distinctive collexeme analysis.[9] It requires to first identify how a verb is distributed across two alternative constructions, as is represented in Table VIII; figures in parentheses are again expected frequencies.

For every such table (one for each verb), Gries and Stefanowitsch compute a Fisher exact test to determine to which construction the verb is more strongly attracted; in the above example, it is immediately obvious that *give* is much more strongly attracted to the ditransitive than to the prepositional dative with *to* (cf. the ratio of observed to expected frequencies in the upper left cell of Table VIII), and corresponding findings can

[8] To obtain an R script that computes all methods constituting collostructional analysis, contact the present author. Cf. Gries, Hampe and Schönefeld (in press a, b) for experimental evidence that demonstrates the superiority of collostruction strength over raw frequency on the basis of comparing the results of a corpus analysis to results of a sentence completion experiment and a self-paced reading-time experiment.

[9] Distinctive collocates are collocates that differentiate between two node words (cf. Church *et al.* 1991; Gries, 2001, 2003b for details).

be obtained for all verbs occurring at least once in at least one of the two constructions under investigation.

For the present purposes, we will restrict our attention to the verbs in (7), and it turns out that they indeed exhibit similar kinds of preferences: Of the verbs used by Pickering and Branigan (1998), *give*, *show* and *offer* are significant collexemes of the ditransitive (all p's $< .1E - 09$) whereas *sell* and *hand* are significant collexemes of the prepositional datives (all p's $< .01$) — *lend* and *send* do not exhibit a significant preference for either construction ($p > .13$); the computations are based on all 3973 ditransitives and prepositional datives mentioned in Table I.[10]

Noting the strong distinctive collostruction strengths of Pickering and Branigan's (1998: Exp. 1) stimulus verbs, we can now explain the findings of Table V–VII by proposing an alternative hypothesis. This alternative to the above null hypothesis, the collostruction-based hypothesis H_1, is that a verb strongly associated with a particular construction resists priming and rather sticks to its associated construction. Again more technically, for collexemes of the ditransitive, b_{obs} and d_{obs} should be higher than b_{exp} and d_{exp}, and for collexemes of the prepositional dative, a_{obs} and c_{obs} should be higher than a_{exp} and c_{exp}. Finally, the verbs without a strong association to a construction, i.e. where no verb-construction association would be expected to block the priming effect, should exhibit the distribution predicted by H_0 as observed for all verbs together in Table III. As is obvious, the results obtained from the corpus data are the ones predicted by the collostruction-based hypothesis H_1.

More specifically, there is a majority of (types of) verbs in the corpus which have no strong association to one of the two constructions and which are thus fully responsive to priming effects;[11] since for many of these the distribution postulated in H_0 is found, the picture that emerges is the overall priming effect of previous studies and of Table III in the present study. On the other hand, a minority of (types of) verbs is strongly associated with a particular construction and these are therefore more resistant to priming, which is why their patterns or priming success rates differ from those of the others. Put differently, the priming rates of these

[10] Differences between the present results and those of Gries (in press) or Gries and Stefanowitsch (2004a) are due to the fact that these earlier studies included only prepositional datives with *to* and/or instances with nominal objects.

[11] Only 86 out of the 316 dative verb types in the ICE-GB (27.2%) have a significant association to one of the two constructions. A yet more extreme distribution is observed for the transitive phrasal verbs to be discussed in the following section: Only 40 out of the 700 transitive phrasal verb types in the ICE-GB (5.7%) have a significant association to one of the two constructions.

latter verbs are influenced by their preferences to occur in particular constructions.[12]

Although no study on priming has so far looked at these issues in detail, this finding should not even strike one as particularly surprising. Previous work within psycholinguistics has so convincingly demonstrated that verbs' subcategorizing preferences play an important role in the ease and speed of lexical access, ambiguity resolution etc. (cf. Garnsey *et al.* 1997; Hare *et al.*, 2003; Stallings *et al.*, 1998 as well as the references cited there) that such results should actually have been anticipated long ago. It would be interesting to test how the above results relate to other data on verb frame preferences; cf., e.g., Connine *et al.* (1984), where the verbs listed here were unfortunately not included.

To summarize, on the one hand, the results from the corpus-based investigation of priming have documented a clear priming effect for both the ditransitive and the prepositional dative, and many characteristics of the corpus-based priming effects clearly resemble those of previous experiments. However, this section has also provided evidence that offers a much more detailed perspective on this global effect by showing that priming effects are verb-specific: Individual verbs' associations to particular constructions as measured by distinctive collostruction strength result in some verbs allowing priming in one particular direction more readily than others. This tendency is masked by the overall priming effects, but taking into account individual verbs' behavior can provide a more precise picture of the processing of the verbs and the structures in which they are used. The following section illustrates the potential of this way of analysis for a different constructional alternation that has so far received little attention in the literature on priming, namely verb-particle constructions.

PARTICLE PLACEMENT

General Investigation

If syntactic priming can indeed be attributed to the processing of a particular structure, then it should be manifested in a variety of differ-

[12] One important point must be clarified here. To some readers, this approach may seem somewhat circular; they might object to my line of reasoning by saying, 'Wait a minute! You start out by using the corpus data to compute priming effects. And then you use the very same corpus data to compute collostruction strengths. No wonder you get such a high correlation of findings — you measure the same thing under two different labels!' In the general discussion below, I will provide evidence why the issue of circularity is unproblematic here.

Table IX. Verb-particle Constructions: MEDIUM × CONSTRUCTION

Data (ICE-GB)	V Prt NP	V NP Prt	Row totals
spoken	698	963	1661
written	553	229	782
Column totals	1251	1192	2443

ent, nearly synonymous constituent structures. As I have mentioned above, however, most, if not all, work on syntactic priming in English has been restricted to the active–passive alternation and the dative alternation discussed above. This paper builds on the work by Gries (in press) and extends the corpus-based approach to priming to particle placement, the alternation of transitive phrasal verbs exemplified in (8).

(8) a. John [$_{VP}$ picked up [$_{NPdirect\ object}$ the book]
b. John [$_{VP}$ picked [$_{NPdirect\ object}$ the book] up]

Just as above, I first extracted all examples of these two constructions from the ICE-GB corpus; since the particles found in verb-particle constructions are tagged as adverbial particles of phrasal verbs, this was done by retrieving all examples parsed as [$_{VP}$ V AdvPrt [$_{NP/S}$]] or [$_{VP}$ V [$_{NP/S}$] AdvPrt]. As a result, I obtained the data set summarized in Table IX; cf. Fig. (3) for the scatterplot representing the switch rates per corpus file.

Out of these 2443 cases, 646 had to be discarded for the priming analysis again because they were the first or last such construction either in a corpus file or in a subtext of a corpus file, leaving 1797 prime-target pairs for the analysis. Each of these was then coded for the same features as the two dative construcions with the addition of analogously coded features for PARTPRIME, PARTTARGETand PARTID as well as PHRASVPRIME, PHRASV-TARGET and PHRASVID (i.e. what is the particle in prime and target and is it identical in both, and the same for the phrasal verb). As above, consider first the most general result concerning the frequencies of CPRIME and CTARGET across all variables in Table X.

Table X. CPRIME × CTARGET: Observed vs. Expected Frequencies ($\chi^2(1) = 183.62$, $p < .001$)

Data (ICE-GB)	CTARGET: V Part NP/S	CTARGET: V NP/S Part	Row totals
CPRIME: V Part NP/S	548 (444)	319 (423)	867
CPRIME: V NP/S Part	300 (476.2)	630 (453.8)	930
Column totals	848	949	1797

The result is again unambiguous: there is a strong tendency for the prime construction to be repeated; the construction with the VP-final particle is the one with the stronger priming effect. While this provides additional support to the general idea of syntactic priming (with a new construction, though), it is again important to look at the more detailed results of a subsequent GLM analysis; cf. Table (A.5) in the Appendix A for the exact results of this multifactorial analysis. Again the above effect of CPRIME is the strongest of all ($p < .0001$), but some other effects are noteworthy, especially given how they differ from those obtained for the datives.

One major difference is the strong influence of MEDIUM on the constructions' frequencies already emerging from Table IX: the construction where the particle is adjacent to the verb is strongly preferred in writing, the other construction is preferred in speaking ($p = .0182$). Then, the interaction MEDIUM × VLEMMAID × CPRIME is significant ($p = .0241$). As is the case with many higher-order interactions, its nature is difficult to describe, but what it boils down to is that, while we in general obtain priming (i.e. the main effect of CPRIME holds across all conditions of MEDIUM and VLEMMAID), priming in writing is much more dependent on the verb lemmas being identical: if they are not identical in prime and target, then priming is still obtained, but it is weaker (than if the verb lemmas are identical).

Finally, the interaction VFORMID × SPEAKERID × CPRIME is significant ($p = .0408$). This effect is due to the fact that, while a general priming effect is obtained and increases when speaker and verb forms are identical across prime and target (again in accordance with Pickering & Branigan's, 1998 results), the tendency to use the same verb form in the same construction is especially strong when the target utterance is by a different speaker. This constellation of factors is frequent in dialogs where the second speaker reuses (part of) the utterance of the first. The effect of DISTANCE is not significant ($p > .5$)—for reasons discussed above—but the correlation between the percentages of successful priming and DISTANCE can best be described by a quadratic equation (adjusted $R^2 = .39$, $F(1, 12) = 3.85$, $p = .051$), i.e. for the range of DISTANCE values included, priming decreases as the distance increases.

The majority of previous studies over the last 15 or so years was concerned with active/passive and datives. As in Hartsuiker *et al.* (1999), however, the present results indicate that priming effects can also be obtained for cases where the alternants consist of the same phrases in different orders. The general findings concerning particle placement are somewhat similar to those of the dative alternation. There is a general priming effect so that constructions are likely to be repeated at the next opportunity.

In addition, both the dative alternation and particle placement exhibit a similar strength of the priming effect, and in both cases one construction primes more strongly than the other. Finally, there are slight effects of the verb form and the verb lemma which, although insignificant, are at least in the same direction as the analogous (experimental and corpus-based) effects for the datives; the same holds for the directionality of priming. While the results are in need of additional evidence, they provide *prima facie* evidence of structural priming for a construction hardly related to syntactic priming in previous work. But let us now see whether particle placement is subject to the same kind of verb-specificity effects as the dative alternation.

Verb-Specific Investigation

By analogy to the discussion of the dative alternation, we now turn to the issue of whether the overall priming effect observed for particle placement needs to be qualified with respect to individual verbs' preferences. Since there is no previous experimental study the stimulus sets of which can be examined in this connection, I have chosen six verbs for analysis from the data discussed in Gries and Stefanowitsch (2004a); the methodology is the same as outlined above for the datives: for each phrasal verb the construction which it 'prefers' has been determined by means of a Fisher exact test on a distribution such as that exemplified by Table VIII. Two of the verbs chosen are significant collexemes of the construction [$_{VP}$ V Part NP/S], two are significant collexemes of the [$_{VP}$ V NP/S Part] construction and two have no association to either construction; cf. (9).

(9) a. [$_{VP}$ V Part NP/S]: *take up*, *find out*
b. [$_{VP}$ V NP/S Part]: *put in*, *take out*
c. no association: *pick up*, *put down*

For reasons of space, I will not discuss the results for particle placement at the same level of detail as before. As it turns out, the findings are quite similar to those for the dative alternation with respect to the verb specificity of priming. For example, *take up* is a verb with a strong collostructional attraction to the construction where the verb and the particle are adjacent, and as Table XI illustrates, priming is correspondingly restricted to this construction; cf. Table (A.6) for analogous results for *find out*.

A similar point can be made for verbs associated with the particle-final construction. A case in point is *put in* in Table XII, where priming is restricted to that construction; cf. also Table (A.7) in Appendix A for the data on *take out*. Note in this connection that *put in* and *take out*

Table XI. CPrime × CTarget: Observed vs. Expected Frequencies for *take up*

Data (ICE-GB)	Target: V Part NP/S	Target: V NP/S Part	Row totals
Prime: V Part NP/S	7 (5.6)	4 (5.4)	11
Prime: V NP/S Part	9 (6.1)	3 (5.9)	12
Column totals	16	7	23

Table XII. CPrime × CTarget: Observed vs. Expected Frequencies for *put in*

Data (ICE-GB)	Target: V Part NP/S	Target: V NP/S Part	Row totals
Prime: V Part NP/S	7 (8.2)	9 (7.8)	16
Prime: V NP/S Part	7 (14.3)	21 (13.7)	28
Column totals	14	30	44

are particularly relevant in this context because—unlike some other previously discussed verbs—they are distinctive for one construction without nearly exclusively occurring in that construction: *put in* occurs in [$_{VP}$ V Part NP/S] and [$_{VP}$ V NP/S Part] 21 and 33 times respectively while *take out* occurs in [$_{VP}$ V Part NP/S] and [$_{VP}$ V NP/S Part] 15 and 26 times respectively. The fact that these verbs' priming effects still exhibit the verb specificity effect illustrates that their priming behavior and collostruction strength are not automatic reflexes of their raw frequencies.

Finally, consider a verb which has absolutely no preference for one verb-particle construction, namely *pick up*. As is evident from Table XIII, priming occurs for both constructions, and the same holds for another unbiased verb, namely *put down* (cf. Table (A.8) in Appendix A).

To summarize, we have again obtained a clear priming effect for both constructions, but also more detailed evidence on the verb-specificity effect: Some verbs' association to a verb-particle construction appear to allow for, or resist, the priming effect much more strongly than others. Given that the two verb-particle constructions are associated with semantically different groups of verbs (cf. Gries 2003a, Gries & Stefanowitsch

Table XIII. CPrime × CTarget: Observed vs. Expected Frequencies for *pick up*

Data (ICE-GB)	Target: V Part NP/S	Target: V NP/S Part	Row totals
Prime: V Part NP/S	15 (13.8)	12 (13.2)	27
Prime: V NP/S Part	16 (21.5)	26 (20.5)	42
Column totals	31	38	69

2004a for details), this even invites inferences as to how semantic properties of verbs correlate with the strength of priming effects.

DISCUSSION AND CONCLUSIONS

Interim Summary

Let me first summarize what I believe to be the two main points of this paper: First, the analysis of syntactic priming on the basis of corpora has made it possible to identify priming effects for two constructional alternatives, the dative alternation and particle placement. What is more, the results for the dative alternation, for which many experimental studies have provided results against which the present results can be compared, are very similar in many respects to the experimental results. Lastly, the results of the corpus-based approach to priming make it possible to address many of the issues that are currently debated (i.e., duration, directionality, the construction-specificity and relative independence of the medium of syntactic priming).

Second, the main result of this study, however, is that the results for both constructions have indicated that the degree to which individual verbs are sensitive to priming differs strongly across verbs. To my knowledge, this is the very first study which has identified this important effect which may be hidden in many previous studies, and future work on these interesting findings and its exact implications are necessary. Ideally, this finding would lead to either re-analyses of existing studies or new experimental approaches where collostruction strength is properly controlled for; one such example will be discussed below.

The Relation between Experimental Data and Corpus Data

The previous sections have illustrated how the repetition of syntactic structures can be investigated from a corpus-based perspective. However, as I mentioned above briefly, Branigan and Pickering have argued against corpus-based approaches to syntactic priming, claiming that the priming effects obtained from naturalistic data may have to be attributed to nonsyntactic reasons. The nonsyntactic factors they mention include "temporary switches to more formal registers at certain points in the interview [... or ...] the well-known facilitatory effects of repeating particular words" (Pickering & Branigan 1999: 136). Also, they briefly refer to discourse-motivated syntactic repetitions. In the light of these potential points of critique, it is necessary to address how corpus data compare to experimental approaches in the analysis of priming.

Let me first state something quite explicitly: It is true that, in general, experimental studies are in a better position to single out particular aspects of priming more easily than corpus-based studies, and the possibility to hold experimental conditions constant across a variety of trials and (combinations of) conditions should not be underestimated. However, the exploratory benefits of corpus data have been mentioned by Pickering and Branigan themselves (cf. above), and from a different perspective, the controlled nature of experimental conditions also has some drawbacks.

First, the priming data are usually collected in a very narrowly defined and artificial setting. While this is desirable from the point of view of delimiting error variance, it does not allow generalizations of the role of register effects on syntactic priming—the corpus data, by contrast, allow for a multifactorial analysis of syntactic repetition in natural settings. In addition, in their discussion of previous experimental approaches to priming, Hartsuiker and Kolk (1998: 148) criticize much previous work for not taking into consideration the overall frequencies of syntactic constructions, which—if not considered properly—may introduce frequency effects into the priming results. In the present approach, the corpus data allow for a natural computation of construction baseline frequencies. Second, not all experimental studies managed to account for all potential explanatory factors. For example, Bock and Loebell's (1990) findings were interpreted as evidence for the irrelevance of thematic utterance characteristics and that function words were irrelevant to priming until Hare and Goldberg's (1999) and Bencini, *et al.*'s, (2002) replications showed that this was not necessarily the case. Of course, this does not invalidate the experimental approach as such, but it points out that the number of factors to be taken into consideration is so high that it is not always possible to hold them all constant. Thus, including such confounding factors into a corpus-based evaluation may sometimes be a useful alternative. Finally, by investigating syntactic priming from a corpus-based perspective, one can determine to what degree it plays a role for grammatical variation, i.e. the phenomenon that in a given discourse situation the speaker may have the choice between two truth-conditionally equivalent, nearly synonymous constructions (e.g. between the two dative constructions, active vs. passive, or the *of*-genitive vs. the *s*-genitive, etc.). Including the priming effects into the research design may make it possible to increase the accuracy of predicting the construction the speaker will choose (subconsciously); cf. Gries (2003a, in press) on verb-particle constructions and Rohdenburg and Mondorf (2003) for a more general perspective.

Apart from these general methodological arguments, some other more specific comments on Pickering and Branigan's nonsyntactic factors are due because not all of these lend themselves to an explanation of the present results (and Pickering and Branigan have not provided empirical evidence for their claims). For example, the fact that one of the two constructions may be predominant in a particular register is taken into account here since (a) the corpus data cover a wide variety of registers and (b) the medium (speaking vs. writing) was included into the analysis. Note also that neither alternation investigated is inherently related to a particular level of formality, and explaining the frequent cases of syntactic priming by hundreds of sudden register/formality changes does not seem very plausible.

Similarly, the effects cannot be straightforwardly reduced to, say, the givenness or semantic characteristics of the direct object's referent: First, both datives have information structure properties (cf. Thompson, 1990), so why should only one result in priming in corpora? Second, one might suggest that the slight priming prominence of the verb-particle construction with a VP-final particle is due to the fact that this construction is associated with a given referent of the direct object (cf. Gries, 2003a, Sect. 6.1.4: Once the referent of the direct object has been introduced, the verb-particle constructions in the subsequent discourse will place it before the particle. However, Gries (2003a, 120–121, 131) found priming effects for VPCs regardless of whether the referent of the direct object NP in the second construction is coreferential with that of the first. Third, the kind of animacy/argument effects that *might* in principle affect datives (such that animacy affects constructional choices) cannot explain the results on VPCs where animacy plays no role (cf. Gries, 2003a, 88–89]) and the particle is often aspectual or idiomatically used and can, thus, not be attributed argument status.

An additional important point is that other non-syntactic factors can also not be held responsible for the present findings. For example, those who would like to attribute the present results to lexical repetition effects would have to explain why, in the case of dative alternation, it is the ditransitive construction that primes more strongly although (i) it is the prepositional dative which allows for the priming of the function words *to* and *for* and (ii) the fact that lexical activation decays too fast makes it unlikely that the long duration of priming effects observed here and in other (experimental studies) is just a lexical memory effect.

In sum, much of the present findings resembles those obtained experimentally so strongly that they cannot be explained away as easily as suggested. While I do not rule out discourse-motivated factors of priming at all, it is hard to explain all the similarities between the different kinds of results and still simply uphold the claim that all this is epiphenomenal. Without doubt, further experimental evidence is necessary, but it seems as if the utility of corpus-based, explorative results should not be underestimated prematurely.

Anticipating Circularity Objections

In the first section on the verb-specificity of the priming effects, I raised the potential objection of the circularity of argument (cf. above note 12). Since this is an important point, let me clarify why this objection is inconsequential here. A first reason is that the computations of the verbs' priming effects on the one hand and their collostruction strengths on the other hand do not use the exact same set of data: The former are computed only from 80% of the full set of constructions, namely those 3003 cases where prime-target pairs are found in the same subtexts of the same corpus files whereas the latter is computed from all 3793 cases. Second, and more importantly, the two measures need not correlate highly. Consider a case where a verb V occurs 46 times in a corpus, 34 times with construction C1 and 12 times with construction C2; the frequencies of C1 and C2 in the corpus are each 1000 times, the corpus size is 138,664 (the number of verbs in the ICE-GB). From this it follows that V is significantly associated with C1 ($p_{\text{Fisher exact}} \approx 0.0007$). Assume further that 6 out of these 46 constructions (13%, i.e. even less then in the actual data) had to be discarded because they were the first constructional occurrences in their respective files. This leaves us with 40 cases, which we assume to be distributed as represented in Table XIV; as usual expected frequencies are parenthesized.

As Table XIV indicates, there is significant priming of verb V in both directions/for both constructions: $a_{obs} > a_{exp}$ and $d_{obs} > d_{exp}$ ($p_{\text{Fisher exact}} = .0144$). But since we have already seen that V is strongly associated with C1, this also shows that strength/direction of priming effects and collostruction strength are not automatically correlated even if computed from the same corpus: A verb can be strongly associated with one construction but still prime the other one and, thus, the argument is not circular.

Apart from these two more theoretical arguments, there is also additional empirical evidence to support my contention that priming effects are verb-specific irrespective of whether collostruction strength is computed from the same corpus as the priming effects. For one thing, collostruction strength turns out to be very robust across (comparable) corpora.

Table XIV. CPrime × CTarget: A hypothetical Data Set

Data (ICE-GB)	CTarget: C1	CTarget: C2	Row totals
CPrime: C1	12 (8)	4 (8)	16
CPrime: C2	0 (2)	4 (2)	4
Column totals	12	8	20

Gries, *et al.* (in press a, b), for example, computed the collostruction strengths of verbs to the *as*-predicative (e.g. *I regard her as clever*) in the ICE-GB and then, for a later study, of the BNC sampler, a subpart of the British National Corpus consisting of 2m words of (spoken and written) English. As it turns out, when the significant collexemes of the *as*-predicative are sorted in each corpus, then the significant collexemes of the *as*-predicative in one corpus are not only also a significant collexeme in the other corpus, but they also tend to occupy similar ranks in the other corpus. For example, 60% of the 30 most significant collexemes in the ICE-GB are also among the 30 most significant collexemes in the BNC sampler. What is more, the correlation between the ranks of *all verbs* occurring in both corpora is highly significant ($\tau = .535$; $z = 6.97$; $p < .001$) as is that between the ranks of *all significant collexemes* ($\tau = .591$; $z = 5.29$; $p < .001$). In other words, given this high correspondence between different corpora, it is very likely that computing verb-specificity from another corpus would not have changed the picture markedly. Once other manually parsed corpora are available, checking the present results will be easy.

Finally, there is also experimental evidence supporting the verb-specificity effect argued for here. Gries and Wulff (in press) replicated Pickering and Branigan's (1998) experiments on syntactic priming in English with native speakers of German to determine whether syntactic priming is also obtained with advanced learners of a foreign language (recall point (v) in the Introduction). In addition to a general priming effect, they found that, just like in the present study, the strength of the priming effect of the seven dative-alternation verbs discussed above is strongly correlated with a general bias of the subjects to use the experimental verbs in particular constructions. In Figure 1, their results are summarized: the *y*-axis portrays the bias of individual verbs to either the ditransitive or the prepositional dative in the corpus data, basically as measured by collostruction strength. The *x*-axis portrays the preference of individual verbs to be completed using either the ditransitive or the prepositional dative in the sentence-completion task. Finally, the strong correlation ($r^2 = .8$; $t(5) = -4.47$; $p = .007$) is indicated by the slope of the regression line, which shows that one can predict the outcome in the priming experiment on the basis of the verbs' preferences as measured on the basis of the corpus data.

Even though these results were not obtained with native speakers, they do point to the fact that experimentally primed sentence completion is strongly sensitive to verb bias. Thus, I submit, this issue is clearly in need of further research of which corpus linguistic methods may play an essential role in determining collostruction strengths for verbs to be tested (cf., e.g., Gries and Stefanowitsch, 2004a on verbs distinctive for actives and passives).

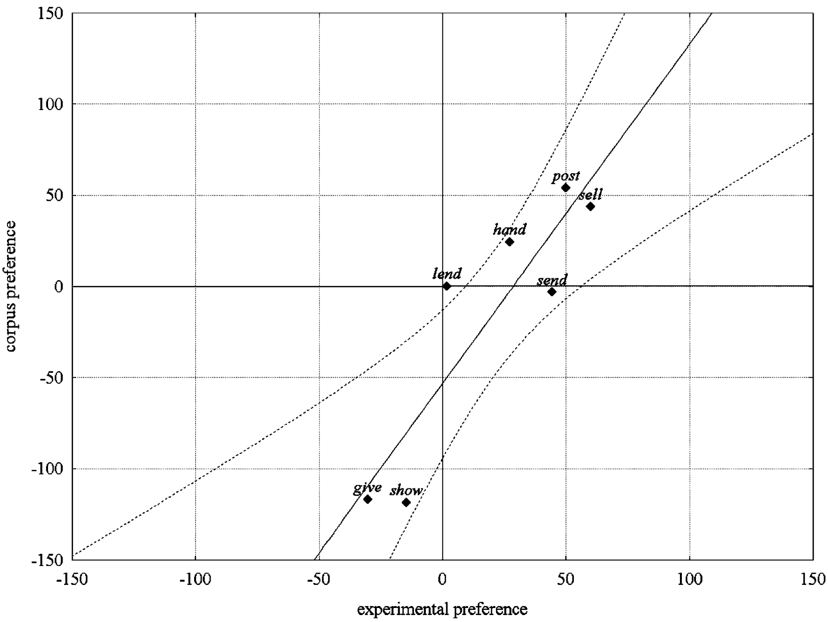

Fig. 1. The verbs' constructional preferences in the corpus data and in thepriming-experiment responses.

Syntactic Priming and its Verb-Specificity in a Psycholinguistic Model

Many previous results have been explained within, say, the psycholinguistic model proposed by Pickering and Branigan (1998). In this model, syntactic priming is accounted for in terms of combinatorial nodes which are activated when a verb is used in a particular construction. When a speaker produces a verb in a particular construction, the lemma nodes of all words produced as well as their feature nodes (representing morphological features such as number, tense, etc.) and the corresponding combinatorial node are activated. Since the activation level of these nodes and the links relating them decays only gradually, the nodes and links that were just used are more likely to be used again when the next opportunity arises; syntactic priming is the result. Since the combinatorial nodes are directly related to the lemma nodes, priming should be stronger when the same verb is used in both prime and target, but the verb form as such should not influence the priming effect.

Since the present findings concerning the dative alternation are so similar to previous experimental work, they can of course be equally well integrated into Pickering and Branigan's model. Remember, for example, that not only priming was found, the priming effect was also stronger when the verb lemmas were identical. In addition, there was also a tendency for identical verb forms to result in a stronger priming effect, and while that was not hypothesized in the above model, similar tendencies were obtained in Pickering and Branigan's (1998: Exp. 5) on singular-vs.-plural form differences. Also, since the model has been argued to involve a shared representation in comprehension and production, the fact that SPEAKERID had no strong effect in this study can be explained naturally. Finally, the fact that the verb-particle constructions exhibit priming supports the idea that order information is encoded within combinatorial nodes.

Given this kind of psycholinguistic model, the second kind of finding of this study, the verb-specificity of priming, can be integrated straightforwardly. Recall that each verb lemma is connected to the combinatorial nodes of the construction in which the verb can be used. Since syntactic priming of a construction C involves the repeated activation of C's combinatorial node (so that its resting level is exceeded), it follows naturally that when the link between a verb and C is stronger, priming of (only) that construction should be stronger. This is exactly what we find: the verbs which are strongly associated with one construction exhibit priming with this construction much more strongly than with the other construction. Thus, we only need to supplement Pickering and Branigan's model with the notion that the links between verb lemmas and combinatorial nodes they postulated anyway can also be differentially strong to reflect their degree of attraction/repulsion to a construction as measured by collostruction strength. This would allow for the model to accommodate the present findings on verb-specificity, but also allows for an economical representation of many of the findings concerning verb subcategorization preferences, verb bias etc. mentioned above.[13] Given the current interest in the issue of whether syntactic priming is best explained as activation patterns or implicit learning (cf. Chang *et al.*, 2000, 2003), it is even conceivable that the network architectures used to test these different conceptions could be somehow enriched with the collostructional information.

All in all, the present findings demonstrate how useful—in spite of some limitations—corpus-based approaches to priming phenomena can be to support and extend findings obtained with other methodologies, promoting once more the ideal of converging evidence.

---

[13] For a comprehensive illustration of how particle placement can be accounted for in a model of this sort, cf. Gries (2003a: ch. 8); for further discussion of this model and others, cf. Hare *et al.*, (2003: 296–297).

APPENDIX A

Table A.1. GLM Results for the Priming of Datives

Effect source	*F*	*p*	Partial η^2
CPrime	161.671	<.0001	.0514
VLemmaID× CPrime	31.946	<.0001	.0106
VFormID × CPrime	4.429	.0354	.0015
SpeakerID × CPrime	3.645	.0563	.0012
VLemmaID	2.509	.1133	.0008
SpeakerID	2.346	.1257	.0008
Medium	1.935	.1643	.0006
Distance	1.867	.1719	.0006
Medium × VFormID × CPrime	.614	.4333	.0002
Medium × VLemmaID × CPrime	.267	.6055	.0001
Medium × VLemmaIDa	.198	.6568	.0001
Medium × CPrime	.101	.7511	0
VFormID × SpeakerID	.099	.7533	0
VLemmaIDa × SpeakerID	.084	.7724	0
VFormID	.043	.8354	0
Medium × VFormID	.039	.8441	0
VFormID × SpeakerID × CPrime	.015	.9011	0
VLemmaID × SpeakerID × CPrime	0	.9983	0

Table A.2. CPrime × CTarget: Observed vs. Expected Frequencies for *show*

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	5 (12.2)	21 (13.8)	26
CPrime: V NP/S NP/S	7 (28.6)	54 (32.4)	61
Column totals	12	75	87

Table A.3. CPrime × CTarget: Observed vs. Expected Frequencies for *offer*

Data (ICE-GB)	CTarget: V NP $PP_{for/to}$	CTarget: V NP/S NP/S	Row totals
CPrime: V NP $PP_{for/to}$	6 (9.4)	14 (10.6)	20
CPrime: V NP/S NP/S	4 (18.3)	35 (20.7)	39
Column totals	10	49	59

Table A.4. CPRIME × CTARGET: Observed vs. Expected Frequencies for *sell*

Data (ICE-GB)	CTARGET: V NP $PP_{for/to}$	CTARGET: V NP/S NP/S	Row totals
CPRIME: V NP $PP_{for/to}$	4 (1.9)	0 (2.1)	4
CPRIME: V NP/S NP/S	5 (2.8)	1 (3.2)	6
Column totals	9	1	10

Table A.5. GLM Results for the Priming of Verb-particle Constructions

Effect source	*F*	*p*	Partial η^2
CPRIME	25.451	<.0001	.0142
MEDIUM	5.586	.0182	.0032
MEDIUM × VLEMMAID × CPRIME	5.094	.0241	.0029
VFORMID × SPEAKERID × CPRIME	4.192	.0408	.0024
PARTID	2.757	.097	.0016
VLEMMAID × CPRIME	2.516	.1129	.0014
VFORMID × CPRIME	2.083	.1491	.0012
PARTID × SPEAKERID	1.234	.2668	.0007
VFORMID × SPEAKERID	1.151	.2836	.0007
VFORMID	1.008	.3155	.0006
MEDIUM × VLEMMAID	.983	.3216	.0006
PARTID × CPRIME	.722	.3955	.0004
MEDIUM × VFORMID × CPRIME	.506	.4769	.0003
MEDIUM × VFORMID	.449	.5031	.0003
MEDIUM × CPRIME	.436	.509	.0002
SPEAKERID	.435	.5096	.0002
PARTID × SPEAKERID × CPRIME	.203	.6523	.0001
DISTANCE	.189	.6639	.0001
MEDIUM × PARTID	.052	.8193	0
MEDIUM × PARTID × CPRIME	.045	.8314	0
SPEAKERID × CPRIME	.004	.9473	0
VLEMMAID	.003	.9541	0

Table A.6. CPRIME × CTARGET: Observed vs. Expected Frequencies for *find out*

Data (ICE-GB)	CTARGET: V Part NP/S	CTARGET: V NP/S Part	Row totals
CPRIME: V Part NP/S	22 (12.8)	3 (12.2)	25
CPRIME: V NP/S Part	13 (7.7)	2 (7.3)	15
Column totals	35	5	40

Table A.7. CPrime × CTarget: Observed vs. Expected Frequencies for *take out*

Data (ICE-GB)	CTarget: V Part NP/S	CTarget: V NP/S Part	Row totals
CPrime: V Part NP/S	7 (7.7)	8 (7.3)	15
CPrime: V NP/S Part	5 (9.7)	14 (9.3)	19
Column totals	12	22	34

Table A.8. CPrime × CTarget: Observed vs. Expected Frequencies for *put down*

Data (ICE-GB)	CTarget: V Part NP/S	CTarget: V NP/S Part	Row totals
CPrime: V Part NP/S	8 (5.1)	2 (4.9)	10
CPrime: V NP/S Part	5 (8.2)	11 (7.8)	16
Column totals	13	13	26

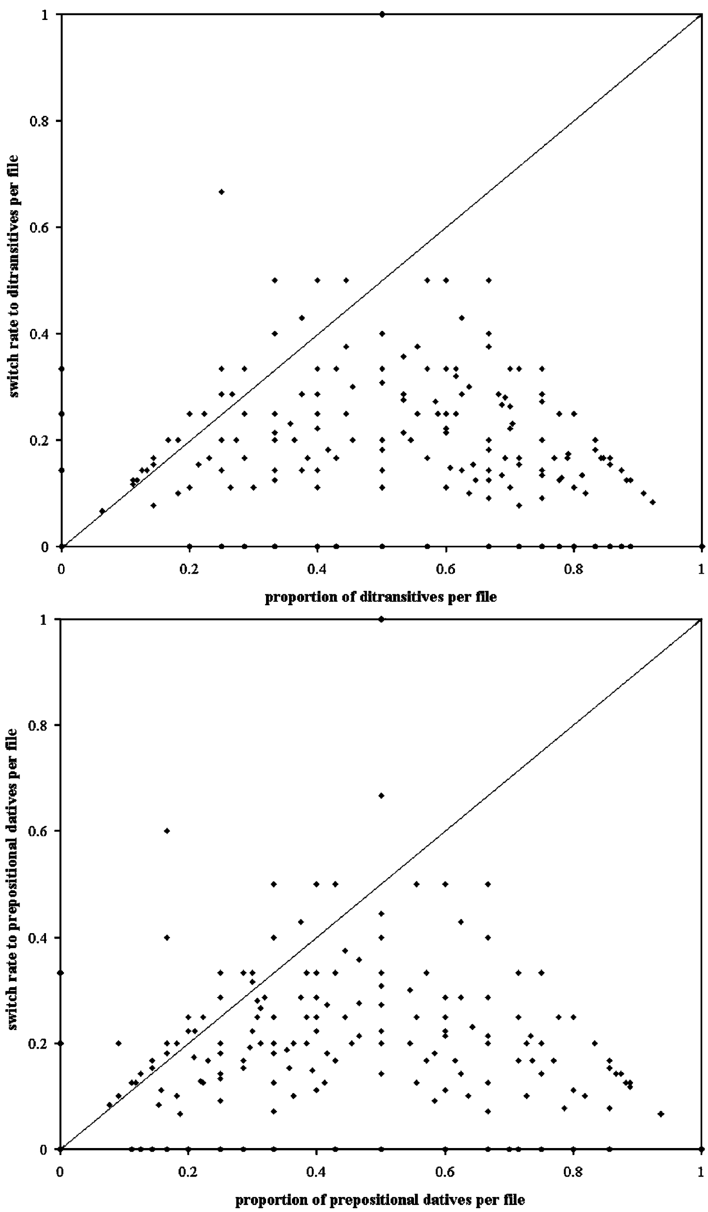

Fig. 2. Relative frequencies of ditransitives and prepositional datives plotted against their switch rates per corpus file.

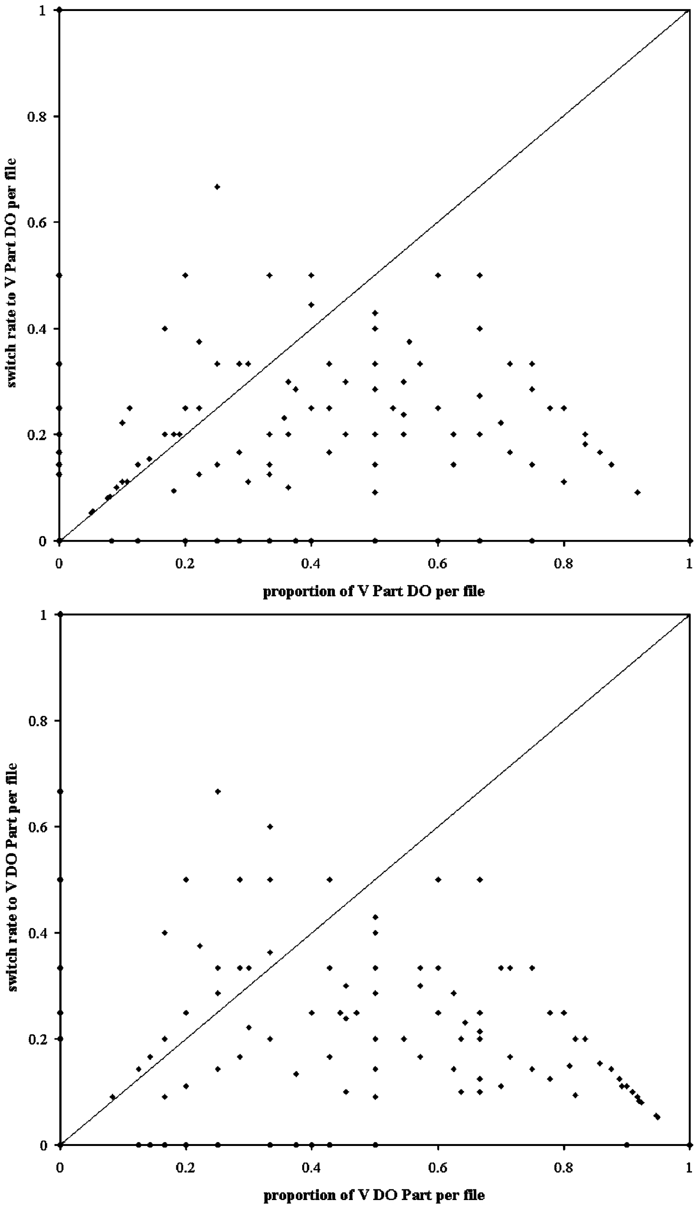

Fig. 3. Relative frequencies of V Part DO and V DO Part plotted against their switch rates per corpus file.

REFERENCES

Bencini, G., Bock, J. K., & Goldberg, A. E. (2002). How abstract is grammar? Evidence from structural priming in language production. Paper presented at the 15th CUNY Conference on Human Sentence Processing.

Bock, J. K. (1986). Syntactic persistence in language production. *Cognitive Psychology 18*, 355–387.

Bock, J. K. (1989). Closed-class immanence in sentence production. *Cognition 31*(2), 163–186.

Bock, J. K. (1990). Structure in language: Creating form in talk. *American Psychologist 45*(11), 1221–1236.

Bock, J. K. (2002). Persistent structural priming from comprehension to production. Paper presented at the 15th CUNY Conference on Human Sentence Processing.

Bock, J. K., & Loebell, H. (1990). Framing sentences. *Cognition 35*(1), 1–39.

Bock, J. K., Loebell, H., & Morey, R. (1992). From conceptual roles to structural relations: Bridging the syntactic cleft. *Psychological Review 99*(1), 150–171.

Bock, J. K., & Griffin, Z. M. (2000). The persistence of structural priming: Transient activation or implicit learning. *Journal of Experimental Psychology: General 129*(2), 177–192.

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (1999). Syntactic priming in written production: Evidence for rapid decay. *Psychonomic Bulletin and Review 6*(4), 635–640.

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic co-ordination in dialogue. *Cognition 75*(2), B13–B25.

Branigan, H. P., Pickering, M. J., Liversedge, S. P., Stewart, A. J., & Urbach, T. P. (1995). Syntactic priming: Investigating the mental representation of language. *Journal of Psycholinguistic Research 24*(6), 489–506.

Branigan, H. P., Pickering, M. J., Stewart, A. J., & McLean, J. F. (2000). Syntactic priming in spoken production: Linguistic and temporal interference. *Memory and Cognition 28*(8), 1297–1302.

Chang, F., Dell, G. S., Bock, J. K., & Griffin, Z. M. (2000). Structural priming as implicit learning: A comparison of models of sentence production. *Journal of Psycholinguistic Research 29*(2), 217–229.

Chang, F., Dell, G. S. & Bock, J. K. (2003). Comprehending structural priming: A connectionist learning account. Paper presented at the 16th CUNY Conference on Human Sentence Processing.

Church, K. W., Gale, W., Hanks, P., & Hindle, D. (1991). Using statistics in lexical analysis. In Zernik Uri, (ed.). *Lexical acquisition: Exploiting On-line Resources to Build up a Lexicon*. Hillsdale, NJ: Lawrence Erlbaum, pp. 115–164.

Connine, C., Ferreira, F., Jones, C., Clifton, C., & Frazier, L. (1984). Verb frame preferences: Descriptive norms. *Journal of Psycholinguistic Research 13*(4), 307–319.

Corley, M. & Scheepers, C. (2002). Syntactic priming in English sentence production: Categorical and latency evidence from an internet-based study. *Psychonomic Bulletin and Review 9*(1), 126–131.

Estival, D. (1985). Syntactic priming of the passive in English. *Text 5*(1), 7–22.

Garnsey, S. M., Pearlmutter, N. J., Myers, E., & Lotocky, M. A. (1997). The contributions of verb bias and plausibility to the comprehension of temporarily ambiguous sentences. *Journal of Memory and Language 37*(1), 58–93.

Gries, St. Th. (2003a). *Multifactorial Analysis in Corpus Linguistics: The Case of Particle Placement*. London/New York: Continuum Press.

Gries, St. Th. (2003b). Testing the sub-test: A collocational-overlap analysis of English *-ic* and *-ical* adjectives. *International Journal of Corpus Linguistics 8*(1), 31–61.

Gries, St. Th., (in press). New perspectives on old alternations. In Cihlar, J. E., L. Franklin, A., Kaiser, D. W., & Kimbara, I. (eds.). *Papers from the 39th Regional Meeting of the Chicago Linguistics Society: Vol. II. The Panels*. Chicago, IL: Chicago Linguistics Society.

Gries, St. Th., & Stefanowitsch, A. (2004a). Extending collostructional analysis: A corpus-based perspective on 'alternations'. *International Journal of Corpus Linguistics 9*(1), 97–129.

Gries, St. Th., & Stefanowitsch, A. (2004b). Co-varying collexemes in the *into*-causative. In Achard, M. & Kemmer, S., (eds.). *Language, Culture, and Mind* (pp. 225–236) Stanford, CA: CSLI.

Gries, St. Th., Hampe, B., & Schönefeld, D. (in press a). Converging evidence: Bringing together experimental and corpus data on the association of verbs and constructions. *Cognitive Linguistics*.

Gries, St. Th., Hampe, B., & Schönefeld, D. (in press b) Converging evidence II: More on the association of verbs and constructions. In J. Newman & S. Rice (Eds.). *Empirical and Experimental Methods in Cognitive/Functional Research*. Stanford, CA: CSLI.

Gries, St. Th., & Wulff, S. (in press). Do foreign language learners also have constructions: Evidence from priming, sorting, and corpora. *Annual Review of Cognitive Linguistics*.

Hare, M. L., & Goldberg, A. E. (1999) Structural priming: Purely syntactic? In Hahn, M., & Stones, S. C. (eds.). *Proceedings of the 21st Annual Meeting of the Cognitive Science Society* (pp. 208–211). Mahwah, NJ: Lawrence Erlbaum.

Hare, M. L., McRae, K., & Elman, J. L. (2003). Sense and structure: Meaning as a determinant of verb subcategorization preferences. *Journal of Memory and Language 48*(2), 281–303.

Hartsuiker, R. J., & Kolk, Herman H. J. (1998). Syntactic persistence in Dutch. *Language and Speech 41*(2), 143–184.

Hartsuiker, R. J., Kolk, Herman H. J., & Huiskamp, P. (1999). Priming word order in sentence production. *The Quarterly Journal of Experimental Psychology 52A*(1), 129–147.

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2002). Is syntax shared between languages? Cross-linguistic syntactic priming Spanish/English bilinguals. Paper presented at AMLap 2002.

Hartsuiker, R. J., & Westenberg, C. (2000). Word order priming in written and spoken sentence production. *Cognition 75*(2), B27–B39.

Levelt, W. J. M., & Kelter, S. (1982). Surface form and memory in question answering. *Cognitive Psychology 14*(1), 78–106.

Pickering, M. J., & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language 39*(4), 633–651.

Pickering, M. J., & Branigan, H. P. (1999). Syntactic priming in language production. *Trends in Cognitive Sciences 3*(4), 136–141.

Pickering, M. J., Branigan, H. P., Cleland, A. A., & Stewart, A. J. (2000). Activation of syntactic information during language production. *Journal of Psycholinguistic Research 29*(2), 205–216.

Pickering, M. J., Branigan, H. P., & McLean, J. F. (2002). Constituent structure is formulated in one stage. *Journal of Memory and Language 46*(3), 586–605.

Potter, M. C., & Lombardi, L. (1998). Syntactic priming in immediate recall of sentences. *Journal of Memory and Language 38*(3), 265–282.

Rohdenburg, G. & Mondorf, B. (eds.). *Determinants of Grammatical Variation in English*. Berlin, New York: Mouton de Gruyter.

Salamoura, A. (2002). Cross-linguistic structural priming and bilingual models of production. Paper presented at AMLap 2002.

Sankoff, D. & Laberge, S. (1978). Statistical dependence among successive occurrences of a variable in discourse. In Sankoff, D. & Laberge S. (eds.). *Linguistic Variation: Methods and Models*. (pp. 119–126). New York: Academic Press.

Scheepers, C. & Corley, M. (2000). Syntactic priming in German sentence production. In: Gleitman, L. & Joshi A. K. (eds.). *Proceedings of the 22nd Annual Meeting of the Cognitive Science Society* (pp. 435–440) Mahwah, NJ: Lawrence Erlbaum.

Smith, M. & Wheeldon, L. (2001). Syntactic priming in spoken sentence production: An online study. *Cognition 78*(2), 123–164.

Stallings, L. M., MacDonald, M. C., & O'Seaghdha, P. G. (1998). Phrasal ordering constraints in sentence production: Phrase length and verb disposition in Heavy-NP Shift. *Journal of Memory and Language 39*(3), 392–417.

Stefanowitsch, A. & Gries, St. Th. (2003). Collostructions: Investigating the interaction between words and constructions. *International Journal of Corpus Linguistics 8*(2), 209–243.

Szmrecsanyi, B. (2005). Persistence phenomena in the Grammar of Spoken English. Doctoral dissertation, University of Freiburg.

Thompson, S. A. (1990). Information flow and Dative Shift in English discourse. In: Edmondson, J. A., Feagin, C. & Mühlhäusler, P. (eds.). *Development and Diversity: Language Variation Across Time and Space*. (pp. 239–253). Dallas: SIL and University of Arlington, TX.

Weiner, E. J. & Labov, W. (1983). Constraints on the agentless passive. *Journal of Linguistics 19*, 29–58.

Yamashita, H., Chang, F. & Hirose, Y. (2002). Separating functions and positions: Evidence from structural priming in Japanese. Paper presented at the 15th CUNY Conference on Human Sentence Processing.