Structural priming across languages*

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Abstract

In structural priming, the structure of one sentence is echoed in the structure of a second sentence that may be otherwise unrelated to the first. It can occur without the intention to create syntactic parallelism and without specific pragmatic, thematic, and lexical support across utterances. To explore whether it can also occur without specific language support, when the source of priming is an utterance in a different language, we investigated structural priming in fluent German-English bilinguals. After producing a designated sentence in either their first (German) or second (English) language, speakers extemporaneously described an unrelated pictured event in the other language. The primed constructions were datives (prepositional and double-object datives) and transitives (actives and passives). The results showed that the production of German dative sentences primed the subsequent use of English datives, and the production of English datives primed German datives. German and English passives with different structures did not prime one another. The results offer evidence for a structural source of priming and suggest a common psycholinguistic scaffolding for the bilingual phenomena of codeswitching and transfer. More broadly, they support the argument for basic psycholinguistic continuities among language learning, normal and bilingual language use, and language change.

Introduction

The repetition of structural patterns is a familiar phenomenon in normal language use. Systematic, nonrandom recurrence seems to operate in spontaneous speech at all levels of linguistic structure, ranging from phonological and metrical patterns through phrases and sentences to the organization of discourse, conversation, and ritual (DuBois 1986; Schenkein 1980; Tannen 1987). It happens in children (Kempen 1977)

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as well as adults. Confirmation of these tendencies comes from analyses of conversational interaction (Estival 1985; Weiner and Labov 1983), from speech errors (Cutler 1980), and from controlled experimental investigations (Bock 1986, 1990; Bock et al. 1992; Kelly and Bock 1988; Pickering and Branigan 1998; Sevald et al. 1995; Smith and Wheeldon 2001). In short, structural repetition is pervasive. In this paper, our goal is to evaluate and extend an explanation for structural repetition in the syntax of clauses and sentences to bilingual language production.

The existence of structural repetition in syntax is at best peculiar when viewed from the perspective of modern formal linguistics, with its emphasis on the productivity of language and, in language acquisition, on the learning that supports such a productive capacity: learning to speak and understand a language means, among other things, learning how to produce and comprehend specific sentences never before encountered. From neither a linguistic nor an acquisition standpoint is there much reason to see functional value in a tendency to repeat structures from one sentence to another. Indeed, the roles of imitation in language acquisition and transfer in second-language learning have been looked at askance on very similar grounds. Why, then, does structural repetition happen?

One possibility is that speakers do it on purpose. People sometimes repeat themselves or others intentionally, and such repetitions can serve stylistic, social, and rhetorical purposes (Giles and Powesland 1975; Tannen 1987). At the same time, some kinds of repetition appear to be so subtle and effortless that it is hard to ascribe them completely to intention or artifice. This is obvious in the case of unwitting repetitions that yield errors or other infelicities of speech, such as *once you're in it, you can't get out it* (when *out of it* was intended). It also seems unlikely for repetitions of the kinds of linguistic structures whose abstractness and complexity puts them outside the purpose-driven capabilities of most speakers. Take this example from the Switchboard corpus (Godfrey et al. 1992):

(1) Speaker 1: "Repeating patterns is what you have to check for when you buy your paper."
Speaker 2: "Yes … that's what I needed and I didn't think about that. I got a Mickey Mouse print is what I got."

Here the topic is the ins and outs of wallpaper hanging (and not the types of repeating patterns of interest in the present paper!). In the concluding *I got a Mickey Mouse print is what I got*, the emphatic *is what I got* appears superfluous and somewhat awkward. But in the immediately preceding conversation, there are two occurrences of similar

constructions, initially in the first speaker's *is what you have to check for* and in the second speaker's own *'s what I needed*. Though a linguist could describe the relevant structural similarities, from the perspective of ordinary language users the only readily discernible repetition is lexical, the word *what*.

Structural repetition is not readily explained as a simple memory phenomenon, either. One of the most robust findings in psycholinguistics is that people cannot reliably recall sentence structures (Bock and Brewer 1974) or even distinguish repetitions of structures from changes to them after more than a few seconds, unless the change creates a difference in meaning (Johnson-Laird and Stevenson 1970; Lombardi and Potter 1992; Sachs 1967). This would seem to disfavor above-chance structural repetition even in successive sentences. Yet structural repetition spans fairly long stretches of intervening material. In analyses of sociolinguistic interviews, Weiner and Labov (1983) found significant repetition of passives after as many as five intervening sentences. In a controlled experimental task, Bock and Griffin (2000) found it for other structures over ten intervening trials. Boyland and Anderson (1998) reported repetition after a twenty-minute delay. This dramatically distinguishes structural repetition from the time course of normal sentence memory. Along with the fact that the repetition of structure flies in the face of one of the cardinal virtues of human language — its productivity — is hard to find a natural account of structural repetition within the familiar theoretical frameworks of linguistics and cognitive psychology.

Structural repetition can, however, be straightforwardly explained in terms of implicit learning, a long-lasting result of *priming*. On this view, structural repetition is not repetition in the usual sense of purposeful replication. Implicit learning is a kind of incidental, procedural learning in which cognitive or perceptual processing operations are tuned. It does not serve to store the outcomes of the operations (e.g. in language use, such outcomes might be utterances produced or meanings comprehended). Instead, it changes the fluency or efficiency of the operations themselves (Cohen and Eichenbaum 1993). Other tasks that make use of the same operations are then performed differently, perhaps faster or better, and other tasks that CAN make use of the same operations may be more likely to do so. It is, in short, a byproduct of practice, but tacit practice of a cognitive operation.

Classic demonstrations of the unintentionality of implicit learning come from studies of anterograde amnesia. Anterograde amnesics are typically unable to remember events from their lives that occur after the time of their injury, making them incapable of recalling or recognizing newly encountered information beyond more than a few seconds or minutes.

One consequence is that an encounter with a novel task (e.g. trying to read mirror-imaged words) can be forgotten from one day to the next, with patients giving no evidence of remembering the effort from the day before. Paradoxically, however, the performance of patients on the task improves gradually, both for repeated words and for words newly presented, and improves at the same rate as that of normal individuals (Cohen and Squire 1980).

Language-relevant tasks, including the learning of artificial grammars, also appear susceptible to implicit learning (see Schacter and Curran 2000 for review). In an overview and evaluation of research, Seger (1994) sketched a working definition that identified implicit learning with processes that, in addition to being preserved in cases of anterograde amnesia, are inaccessible to consciousness, fairly complex and abstract, and incidentally engaged in task performance.

Structural repetition, or *structural priming*, seems to have all of these characteristics (the first included; Bock et al. [n.d.]). This makes plausible some of the unintentional recurrences of structure in normal language use, as well as reconciling structural repetition with the normal inability to explicitly recognize or recall the forms of the sentences one encounters (Potter and Lombardi 1998; Sachs 1967). What happens in structural repetition does not require conscious access to the details of a previous sentence's form. Rather, the hypothesis is that even a single use can strengthen the structural procedures or operations that are adequate for the expression of some message type. The consequence of this strengthening is that subsequent messages of the same type are more likely to be channeled through the same structural procedures, incidentally giving them the structural features of earlier utterances. In line with this, Chang et al. (2000) demonstrated that structural repetition can be implemented within a computational model that was designed to learn how to produce structures in the first place.

On the implicit-learning characterization, structural priming can be argued to reflect the operation of psycholinguistic mechanisms that, by retrieval and computation, convert abstract sentence representations into structures with hierarchical and linear properties. The evidence for this comes from a series of studies designed to assess the linguistic properties of the priming mechanism (Bock 1986, 1989, 1990; Bock and Loebell 1990; Bock et al. 1992). In these experiments, structural priming was observed in the absence of repeated content words and repeated closed-class elements (see also Pickering and Branigan 1998, Experiment 2), and without topical or pragmatic similarities between priming sentences and subsequent utterances. More strikingly, priming occurred when the thematic roles in the priming sentences differed from those in later utter-

ances: primes in which the roles of the noun phrases were agent and location, respectively (e.g. *The minister was praying by the broken stained glass window*) were just as effective in priming the production of passives (e.g. *The woman is being knocked over by a wave*) as were primes that were genuine passives with patients and agents, respectively (e.g. *The minister was cut by the broken stained glass window*). This implicates priming from the structural configuration itself. Priming sentences with similar metrical structures were insufficient, on their own, to create this kind of priming, as were sentences with similar word orders that lacked similar phrase structures (Bock and Loebell 1990, Experiment 3).

These results indicate that the scope of priming is broad, and that it does not depend on lexical repetition or the repetition of details of sentence meaning. Although structural repetition is considerably enhanced by the addition of lexical repetition (Pickering and Branigan 1998), by similarities in the meanings of words in parallel sentence positions or structural functions (Bock et al. 1992), and by pragmatic and topical similarities (Branigan et al. 2000), it remains to be established whether the same sources and types of priming are involved in all of these effects. More importantly, these similarities do not appear to be necessary for structural priming to occur. This makes it plausible that the underpinnings of structural repetition in spontaneous speech include a basic structural mechamsm.

The possibility of priming does appear to depend on the existence of structurally different ways of saying the same thing (Ferreira 2001). This means that if the input to the production process meets the conditions for two different sets of procedures at the level of clause structure (with the conditions assumed to be stated in terms of general semantic properties rooted in the number of arguments and their ontology [Bock et al. 1992]), a primed set of structural procedures may be more likely to control production than an alternative. It is important to emphasize that we are here referring to the priming of clause-level alternatives (such as active or passive and prepositional- or double-object dative structures), and that it is possible to observe priming in these structures in the absence of repetition of the details of lower-level phrase structures (such as the internal structure of verb or noun phrases). Though the details of phrase structure can themselves be primed (Smith and Wheeldon 2001), priming of these details is not needed to create priming of the broader structural configuration. Because the structural configuration can be primed even when its details change, it is possible to regard the mechanism of priming as one that supports generalization to different utterances of the same constructional type.

The extent of these generalizations is unknown, although existing evidence suggests that priming can operate at a sufficiently abstract level to support structural generalizations over a fairly broad range. One strong test is whether structural priming works across languages, making a structure from one language more likely to occur after its analogue is used in another language. The feasibility of this kind of priming is enhanced by studies of bilingualism, prominently including work on codeswitching and transfer, which provide evidence that structures in both of the languages of a bilingual speaker can be simultaneously active or actually shared (Myers-Scotton 1993; Romaine 1995; Woolford 1983). If so, common structures from a bilingual's known languages may have a common psycholinguistic substrate, so that structurally similar forms are created in procedurally similar ways. They could then originate in the same operations, but with links to different lexical or morphological inventories. This possibility is of more than theoretical relevance because, if priming occurs, it may be a key to the broad category of learning phenomena associated with language contact, including second-language acquisition and language change.

To test the cross-language generalization hypothesis, we investigated the occurrence of priming in fluent German-English bilinguals. We used fluent speakers to minimize the likelihood of translation from one language to another, and thereby to strengthen the inference that any priming observed could be a natural byproduct of normal language use. This language use was, however, arranged to occur in a controlled experimental setting that ruled out, as much as possible, the effects of pragmatic, topical, or lexical factors on the occurrence of any repetition.

Because of the role that structural factors seem to play in within-language priming, we used two types of structures that both show priming in English (Bock 1986). In one type the structures were the same in German and English and in the other type they differ. Specifically, we compared ditransitive and prepositional datives (which have the same structural configurations in English and German) and transitives (where one form, the active, had the same structural configuration in English and German and the other form, the passive, did not).

The dative constructions that we employed correspond to the prepositional and double-object (ditransitive) forms in English. The structural configuration of a double-object dative such as (2a) corresponds to the German (2b).

(2) a. The boy sent his pen pal a letter.
    b. Der Junge schickte seinem Brieffreund einen Brief.

The prepositional dative in English (3a) likewise corresponds to the German (3b).

(3) a. The boy sent a letter to his pen-pal.
b Der Junge schickte einen Brief an seinen Brieffreund.

Note that (3b) has the same structure and meaning as the English version, although it lacks the dative inflection on *seinem Brieffreund* in sentence (2b). With this inflection, the prepositional structure in (3b) would be unacceptable (Kufner 1962). However, to underscore the correspondence between the English and German forms, we will refer to both as prepositional datives.

The English transitive active (4a) also corresponds to the German (4b).

(4) a. The janitor cleans the floors daily.
b. Der Hausmeister reinigt die Böden täglich.

German passives, however, can be formed with the main verb in final position in the sentence. So, the English (5a) is naturally expressed in German as (5b)

(5) a. The floors are cleaned daily by the janitor.
b. Die Böden werden täglich von dem Hausmeister gereinigt.
(literally: 'The floors are daily by the janitor cleaned').

Thus *gereinigt*, the past participle of the verb *reinigen* 'to clean', occurs at the end of the sentence. If overlap of phrase structure is crucial to priming — more crucial than the matrix language itself — then cross-linguistic syntactic priming would be expected for datives and actives, but not for these passive constructions (Bock and Loebell 1990).

An overview of the experiment

To investigate these questions, we used an adaptation of an experimental paradigm developed by Bock (1986) for the investigation of structural priming. In this paradigm, priming trials involve hearing and immediately repeating a sentence in a particular structure (for example, the double-object dative structure shown as the prime in Figure 1, *The lawyer sent his client the contract*) and then describing a pictured event. The pictured events were designed to be thematically unrelated to the priming sentences and to be unlikely to elicit the same content words as the priming sentences. The events could, however, be naturally described in the primed structure or the alternative to the primed structure (such as a prepositional dative). These alternative structures both served as primes, and individual participants received both structures in the course of an experiment (although they never received the alternative versions of the same priming sentence). Other participants received the alternative version of the prime,

PICTURE TRIAL (FILLER, DESCRIBED IN GERMAN)

SENTENCE TRIAL (ENGLISH FILLER)

SENTENCE TRIAL (ENGLISH FILLER)

priming trial

SENTENCE TRIAL (ENGLISH PRIME)

AUDITORY SENTENCE PRESENTATION:

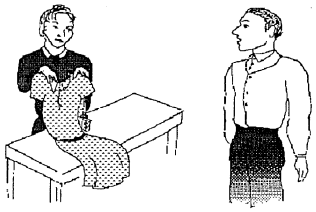
The lawyer sent his client the contract

SPEAKER REPEATS:

"The lawyer sent his client the contract"

AND MAKES RECOGNITION DECISION ("NO")

PICTURE TRIAL (GERMAN TARGET ELICITATION)



SPEAKER DESCRIBES DEPICTED EVENT:

(E.G., *"Eine Frau zeigt einem Mann ein Kleid"*)

AND MAKES RECOGNITION DECISION ("NO")

PICTURE TRIAL (FILLER, DESCRIBED IN GERMAN)

SENTENCE TRIAL (ENGLISH FILLER)

Figure 1. *Sequence of events on an English-to-German structural priming trial*

accompanying the same picture. This made it possible to examine the effect of the structural variation when the meanings of the priming sentences were essentially the same (as in *The lawyer sent his client the contract* and *The lawyer sent the contract to his client*) and the event described was the same.

To reduce the likelihood of speakers using the primed structures intentionally or noticing the possibility of reusing the primed structures when describing the events, two important features of the paradigm were designed to camouflage the relationship. The first was the use of a large number of filler sentences and filler pictures. Participants performed the same tasks on the fillers (sentence repetition and event description) as on the experimental items. However, the arrangement of the fillers eliminated any regular alternation of sentences and pictures. Filler items occurred in a quasi-random order between the priming trials, so that all sentences and pictures appeared to be individual, unrelated items in a continuous, haphazardly arranged list. The filler sentences and pictures also elicited structures other than the target structures, and in a wider variety. Consequently, from the perspective of experimental participants, nothing set the individual items on priming trials apart from the items on other trials.

The second feature of the paradigm that camouflaged the priming manipulation was the use of a primary task that was only incidentally related to the goal of the experiment. Speakers were told that there would be repetitions of sentences and pictures in the course of the session (and there were, among the fillers). They were instructed to indicate after each sentence or picture whether it had occurred previously in the course of the session, by saying YES or NO. This provided something to pay attention to apart from talking, and also offered a rationale for the repetition and description tasks, as ostensible memory aids.

We made one change to the task for the purpose of looking at cross-language priming. Sentences were always presented and repeated in one language, whereas pictures were always described in the other language. In one session, half of the participants performed the experiment with German sentences and English picture descriptions, and the other half with English sentences and German picture descriptions. In a second session, the original arrangement was reversed.

The question was whether the structures of priming sentences produced in one language would be used when producing subsequent sentences in a different language. For datives, in both the prepositional and double-object forms, and for active transitives, the cross-language structural-generalization hypothesis predicts that the German structures should prime the English and vice versa, because the structural configurations of the sentences in both languages are the same. For passives, where the structures differ, priming should be absent.

There are two additional twists to these predictions. One has to do with the relative strength of priming from a native to a second language. Although all of the participants were fluent English speakers living in

the United States, all of them were nonetheless native German speakers. If the native or dominant language carries more sway within the language processing system, one might expect to see more priming from German to English than vice versa.

The second twist has to do with restrictions on what we are calling the prepositional dative in German. The uses of this structure are more restricted than in English, limited to certain verbs. As a result, judgments of the acceptability of individual sentences in this form appear to vary widely, perhaps in conjunction with dialect variations. Conversely, the double-object form is more restricted in English, likewise subject to lexical and dialectal variation. To the degree that speakers avoid these forms, the magnitude of priming from them to the cross-language forms may be reduced.

Method

Participants. The participants were 48 native German speakers living in southeastern Michigan. Each one received $10 for taking part in two experimental sessions.

In order to qualify for the experiment, the speakers had to have lived a minimum of two years in the United States and be able to converse fluently in both German and English. Their language histories were assessed using an adapted version of a questionnaire developed by Schwanenflugel and Rey (1986). The questionnaire was administered orally, in German, and the responses, also in German, were recorded. Appendix A gives an English translation of the questionnaire with a summary of all responses.

The median age of the participants was 39 years (range 18–66) with a median length of residence in English-speaking countries of 16 years (range 2–36). Most had also studied English extensively in school prior to emigrating to the United States. More than half (56%) could not specify which language was stronger. At home, 42% used English exclusively and an additional 30% used both English and German. Asked to subjectively rate their levels of competence in their languages on a scale from 1 (rather bad) to 7 (native-like), the participants' mean ratings of their German and English skills were 6.8 and 6.5, respectively, reflecting a high level of perceived bilingual competence.

Materials. The priming materials for each language consisted of sixteen sets of dative sentences and sixteen sets of transitive sentences. Every sentence set was paired with a picture of the corresponding type (dative

or transitive), with the same pairings employed in both languages. The pairings of sentences with pictures were random, but constrained to exclude pairings that created narrative or semantic relationships and pairings in which similar content words were likely to be employed when describing the pictured events. Appendix B lists the 32 sentence sets in both their English and German versions and descriptions of the 32 pictures.

Each of the sixteen dative sentence sets included a prepositional dative (e.g. *The girl bought a newspaper for the blind woman*) and the corresponding double-object form (*The girl bought the blind woman a newspaper*). The accompanying pictures showed actions that involved an agent, a patient, and a beneficiary (e.g. children handing flowers to a teacher), which could be naturally described in either the prepositional or the double-object construction. In half of the pictures the action was depicted as proceeding from left to right (the agent on the left side of the picture and the beneficiary on the right side of the picture) and in the other half from right to left. All of the pictures (including the transitive and filler pictures described below) were simple line drawings, printed black on white, and most were taken from the materials used by Bock (1986).

The sixteen transitive sentence pairs include an active (e.g. *The engine turned the wheel slowly*) and a corresponding full passive form (*The wheel was turned slowly by the engine*). Each sentence was paired with one of sixteen pictures that could be described with a sentence in either an active or a passive form. All the transitive pictures depicted events involving an agent and a patient. The agent was always animate. Half of the patients were animate and half inanimate. The pictures were equally divided between those that showed the agent on the left, and those that showed the agent on the right.

In addition to the priming materials, there were forty filler sentences and forty filler pictures, each of which occurred twice in an experimental session. The filler sentences were composed in a variety of constructions that excluded the priming forms, but included locatives, reflexives, and predicate adjectives, all with corresponding natural translations in German. Sentences with language-specific words (e.g. names that occur exclusively in one language) were avoided. Most of the filler pictures depicted actions or states that are typically described with intransitive sentences (e.g. a cat sleeping, two girls running).

Four lists of 224 items each were assembled from these materials, two lists with German sentences and two with English sentences. All lists had identical sequences of filler pictures, filler sentences, and priming trials. On each list there were 32 priming trials, equally divided among the four constructions (double-object dative, prepositional dative, active, and

passive) and representing all of the 32 priming-sentence sets. Between the two lists for each language, both of the priming-sentence forms from an individual set occurred just once each, so that every version of every priming sentence occurred only once, and all forms from every sentence set occurred exactly once across the four lists. Sentences from the same set appeared in parallel locations in all lists.

The priming trials consisted of a priming sentence immediately followed by its paired picture (see Figure 1 for illustration). Priming trials were always separated by five filler items, and priming trials for the two different sentence types (transitives and datives) alternated throughout the lists. Consequently, twelve sentence and picture events separated the trials for the different sentence types. There were no more than three consecutive sentences or pictures of any kind, and care was taken to ensure that successive items were semantically and narratively unrelated. One sixth of the filler items were repeated in the first third of each list, another third of the fillers were repeated in the next third of each list, and the remaining half of the filler items occurred as repetitions in the last third of the list. Outside of these constraints, the arrangement of filler items and their repetitions was random.

The lists were prepared for presentation on 15×22.5 cm index cards, with a single picture or sentence event per card. The pictures for each list were photocopied and glued to the cards. Blank index cards occupied all list positions where sentences were presented auditorily. A parallel set of cards was used by the experimenter, containing the sentences in their appropriate list positions, to be read aloud.

The German sentences were translations of the English primes and fillers, many of which were in turn taken or adapted from Bock (1986). The translations were made by the first author and checked by two other native German speakers for naturalness and grammaticality.[1]

Procedure. The experiment was divided into two sessions for each participant. Both sessions took place in the participants' homes. Half of the initial sessions were conducted in German, and the other half in English, with the subsequent session in the other language. Different forms of the lists were used in the two sessions, so that the list presented in the second session was never the translation-equivalent of the list from the first session, but rather its alternative from the opposite-language lists. The two sessions were separated by a minimum of one week. All sessions were conducted by the first author and recorded on audio tape.

Instructions were presented in German. The participants were told that the experiment would test the influence of their two languages on picture and sentence memory. They were instructed to examine each picture

and listen to each sentence carefully, in order to be able to recognize them later. They indicated after each picture and each sentence whether they had encountered that particular item before in the session. This recognition-memory test was treated as the primary task, with other components of task performance as secondary, in order to minimize the participant's self-consciousness about his or her speech. For this reason, the instructions emphasized that sentence repetition and picture description serve as memory aids. Three practice trials were administered to establish that the procedure was clear.

Participants turned the index cards at their own pace. When they reached a picture, they described what was happening in the picture in one sentence without using personal pronouns, and then said YES or NO depending on whether they remembered the picture as having occurred previously within the session. The picture descriptions were given in the opposite language, so that pictures within lists containing English sentences were described in German, and vice versa.

Whenever participants encountered a blank card, the experimenter read a sentence aloud, at a normal rate and with normal intonation. Participants were instructed to repeat the sentence after the experimenter and to indicate (by saying YES or NO) whether they had heard the sentence previously in the current session. When repetition errors occurred, the experimenter repeated the entire sentence, and the participant said it again. In the rare cases when a participant was unable to retrieve a word needed to describe a pictured object, the experimenter supplied the relevant word. The experimenter provided feedback after each experimental item to indicate whether the yes/no recognition response was correct.

After the first experimental session, the participants responded to the language history questionnaire. The questions were presented orally, in German, and the participants' responses, also in German, were recorded. After the second session, participants were asked, in English, whether they had recognized any similarities between the sentences and the pictures, whether they had mentally translated from one language to the other, whether the sentences appeared to be in any way unusual, and whether they thought the sentences they had heard and repeated influenced their picture descriptions. There were no reports of mentally translating from one language to the other before responding, of noticing structural similarities between the priming sentences and their picture descriptions, or of finding the sentences unusual.

Scoring. The descriptions of the experimental pictures were transcribed from the audio tapes and scored for syntactic form. Only the first full sentence in each picture description was scored. All responses in the

categories described below had to include a complete clause without personal pronouns, except for omissions of articles and the copula. Only those picture descriptions were scored for which the alternative primed form was also possible. For example, to be counted as an English active, a sentence had to have an acceptable passive counterpart with its subject as the *by*-phrase object and its direct object as the subject. This constraint helps to ensure that the meanings of the utterances counted within each priming condition do not exclude the use of the alternative form, and thereby serves as a rough control across priming conditions for the kinds of messages that initiated the production process among the analyzed utterances.

In English, dative picture descriptions were scored as prepositional datives when the the patient of the event served as the direct object immediately after the verb, and the beneficiary followed the direct object as the object of the prepositional phrase. Descriptions were scored as double-object datives when the beneficiary was the direct object and the patient was the second object. Transitive picture descriptions were scored as active when the description included the agent of the depicted action in subject position and the patient in direct object position. Passives were scored when the patient was in subject position, the agent was in object position within a *by* phrase, and the main verb was preceded by a form of *be* or *get*.

In German, the criteria for prepositional datives, double-object datives, and actives were the same as in English. However, for passives, the main verb occurred at the end of the sentence, following the agent. Patients appeared in subject position, the agent in object position within a prepositional phrase (after *von*), and the verb was preceded by a form of *werden* (roughly corresponding to English *be*).

All other utterances were scored as "other" and omitted from the analyses. Those cases when a participant asked for word-finding help before producing a sentence were also scored as "other."

Design and data analysis. Every participant described eight pictures within each of the eight conditions representing the combination of the four prime types (double-object dative, prepositional dative, active, passive) with each cross-language trial type (German primes with English picture descriptions or English primes with German picture descriptions). Each pictured event was seen twice by all 48 participants. Within the two event types (transitive or dative), every event was presented twelve times in the four combinations of priming forms (either active or passive within the transitive condition, and double-object or prepositional dative within

the dative condition) with cross-language trial type. Thus, every participant and every event contributed equally to all experimental conditions.

Analyses of variance were performed on the numbers of responses. One set of analyses treated participants as the random factor, and a second set treated items (pictured events) as the random factor. Separate analyses were done for the two types of dative utterances, one treating the double-object responses as the dependent variable and the other treating prepositional responses as the dependent variable, and similarly for the two types of transitive utterances. Effects were treated as significant at an alpha level less than or equal to 0.05.

Results

The totals for each utterance type within the cross-language conditions are presented in Table 1. Figure 2 displays the overall proportions of utterances produced in the primed forms for both combinations of languages for the datives and passives. Proportions greater than 0.50 indicate increased use of a particular form after priming; correspondingly, proportions less than 0.50 indicate decreased use of the form after priming.

For datives, there was a general tendency for the form of the utterance to match the form of the prime, regardless of language. This effect was strongest for the double objects. The number of double-object utterances

Table 1. *Number of utterances produced in the dative and transitive priming conditions with counter-language primes*

	Prime-target language combination	
Utterance type	German primes, English targets	English primes, German targets
Double-object dative		
priming form same	79	211
priming form different	52	196
Prepositional dative		
priming form same	210	42
priming form different	185	39
Active		
priming form same	98	89
priming form different	94	89
Passive		
priming form same	132	105
priming form different	140	117

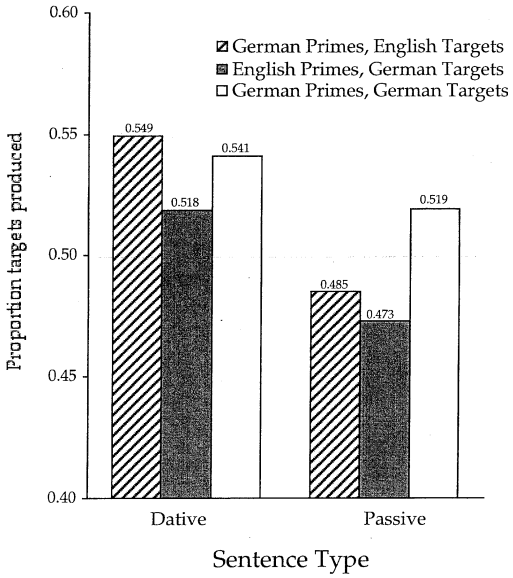


Figure 2. *Proportions of utterances produced in primed forms after cross-language and within-language priming. Proportions greater than 0.50 indicate increased use after priming; proportions less than 0.50 indicate decreased use after priming*

was significantly higher when the prime was a double-object form than when the prime was a prepositional form ($F[1,47] = 5.31$ for participants and $F[1,15] = 4.84$ for items). For prepositional dative utterances the pattern was the same, and was marginally significant over participants ($F[1,47] = 2.79$, $p = 0.10$) but not items ($F[1,15] = 2.75$, $p = 0.12$).

The only significant language-related difference for datives was that, overall, more prepositional dative utterances were produced in English than in German ($F[1,47] = 110.47$ for participants; $F[1,15] = 85.13$ for items) and more double-object datives in German than in English ($F[1,47] = 91.52$ for participants; $F[1,15] = 75.41$ for items). Despite a trend toward more priming from German to English than in the opposite direction (0.55 to 0.52), there were no significant interactions between language and priming condition ($F[1,47] = 1.34$, $p > 0.10$ for participants and $F < 1$ for items in the analysis of double-object datives, and $F(1,47) = 1.90$, $p > 0.10$ for participants and $F < 1$ for items in the analysis of prepositional datives).

For transitives, the results were different. There was no clear influence of the priming sentence in one language on the syntactic form of the picture description in the other language (for actives all $Fs < 1$; for

passives $F[1,47] = 2.34$, $p > 0.10$ for participants and $F[1,15] = 1.24$, $p > 0.10$ over items). Interactions with language were also nonsignificant (all $Fs < 1$).

Discussion

Fluent German-English bilinguals exhibited the effects of structural priming in their speech. They did so when the sentences that they produced differed from the priming sentences not only in words and meanings, but in language. The effects were clearest for double-object datives, which have the same general structural configurations in German and in English. The results for prepositional datives were in the same direction, but more weakly, perhaps because the prepositional form is used more restrictively in German. Even so, the proportional magnitude of prepositional-dative priming from English to German was identical to that for the double-object datives.

The results for transitives differed, especially for the passives. For actives, which are structurally similar in the two languages, there was a numerical trend toward producing more English active constructions after priming by German actives, but for passives there was no tendency at all to use the same form. The effect was actually reversed (with fewer passives produced after passive primes), but not significantly so. The weakness of the effects for actives is consistent with evidence that priming is generally less likely to influence a favored or higher-frequency form than a lower-frequency alternative (Bock and Griffin 2000). The unambiguous absence of the effect for passives, however, can be better explained in terms of the structural difference between English and German passives: if the vehicle of priming is the procedural implementation of a sentence's phrase structure, grammatically enforced differences between the structures of the prime and target sentences may block priming.

The claim that the structural difference was responsible for the absence of passive priming makes an obvious prediction: there should be within-language priming of German passives. To test this, 48 monolingual German speakers living in Germany were run on the German priming lists. The experimental procedures were the same as before except that the pictured events were also described in German. The results from this within-language replication are shown in Table 2 and, for comparison with the results from cross-language priming, in Figure 2. The magnitude of the priming effects for datives within German was comparable to that in cross-language priming, and for the passives the trends were in the

Table 2. *Number of utterances produced in the dative and transitive priming conditions after same-language German primes*

Utterance type	Number of utterances produced
Double-object dative	
priming form same	146
priming form different	128
Prepositional dative	
priming form same	12
priming form different	6
Active	
priming form same	115
priming form different	106
Passive	
priming form same	93
priming form different	86

same direction as for the datives, and not reversed as they were in cross-language priming. Although none of the within-language effects achieved significance (unsurprisingly, since the power of the within-language study was just half that of the cross-language experiment), the pattern of results converges with similar within-language investigations of priming in English (Bock 1986).

The existence of cross-language structural priming is evidence in favor of an implicit-learning account of structural priming, as well as evidence for continuity in the processes of language use and learning in bilinguals and monolinguals alike. The restriction of the effects to structurally similar cross-language utterances argues that one locus of sentence-level priming is a sentence's structural configuration or the procedures that create it, and that this source of priming can be effective across successive utterances in the face of topic differences, meaning differences, wording differences, and as shown here, even language differences.

Accounting for cross-language priming

The implicit-learning account of structural priming (Bock and Griffin 2000; Chang et al. 2000) entails that the use of linguistic procedures for creating sentence structures causes the procedures to become more accessible for subsequent use. There is evidence that this effect arises not only in previous episodes of production, but works also between prior comprehension and production (Branigan et al. 2000; Potter and Lombardi 1998) and just as effectively (Bock et al. 2002). This suggests

that the relevant learning is not modality-specific in nature. Extended to cross-language priming, the implicit-learning explanation implies that whenever languages share common procedures for building sentence structures, the use of the shared procedure in one language makes it more accessible to the other.

Other explanations of cross-language priming are in various respects more unwieldy. A translation account might be proposed, according to which speakers tacitly translated priming sentences from one language to the other, effectively creating within-language priming. There are several objections to such a story. First, it offers no ready explanation for the absence of priming in passives: translation in this condition should have yielded priming, too. Second, the general bilingual fluency of the speakers, as well as their fluency within the experiment proper, makes even tacit translation an unlikely priming vehicle.

A second alternative can be derived from Pickering and Branigan's (1998) verb-subcategorization–based explanation of priming. On this hypothesis, the use of a verb in a particular subcategorization frame serves to prime the representation of the frame. If verbs of the same type share frames, priming may be observed from one verb of that type to another (and if the same verb is used, increased priming is observed). For cross-language priming, it might be argued that verbs from different languages with the same subcategorization frames in fact share frames. This might be especially likely when the verbs share important constructional features (Goldberg 1995). Accordingly, cross-language priming should be observed when using a verb with a subcategorization frame that is shared with a verb from a priming sentence.

This account makes most of the same predictions as a procedural account and, at least formally, is indistinguishable from it. However, there is a feature of cross-language priming that could constitute a challenge, along with two general reservations. To the degree that dative-like verbs in German lack a prepositional subcategorization, such forms should not be primable. In our data, the direction of the priming effect ran counter to this prediction, but so weakly that the question must remain open for further study. More generally, allowing subcategorization frames to be shared across languages requires abandoning the normal assumption that such frames are learned as part of the lexicon, and are language-specific. From a processing perspective, the difficulty with a representational account stems from the presumption that representations should be accessible to explicit memory. If they are, the disparity between the time-course of structural priming and the time-course of explicit memory for sentence form (Bock and Griffin 2000; Lombardi and Potter 1992) remains a puzzle.

The tendency toward greater priming from the speakers' first language (German) to their second (English) than vice versa might seem to suggest that a stronger language is stronger in a specific cognitive sense as well as in the usual evaluative senses. Specifically, the use of a stronger language may produce more effective implicit learning. Alternatively, there may be more to be gained by the weaker language than by the stronger. This must remain a question for the future, however, because the statistical uncertainty of the asymmetry in our results makes further investigation essential for resolving such issues.

Although we have assumed that structural procedures for assembling clauses are the primary locus for the cross-language priming we observed, this should not be taken to exclude other sources of priming that yield structural effects. There is evidence for other loci of priming with structural consequences, at least within languages. These include, and are surely not limited to, lexical priming (Levelt and Kelter 1982; Pickering and Branigan 1998), word-order priming (Hartsuiker et al. 1999; Hartsuiker and Westenberg 2000), and priming that stems from conceptual or linguistic-functional assembly processes (Bock et al. 1992; Heydel et al. 1998).

If structural priming is genuinely a form of learning, it would be surprising if it were absent from the language of children, and indeed it is not. The best evidence comes from Brooks and Tomasello (1999). They found that under-three-year-olds (who virtually never use passives in their spontaneous speech) reliably produced passive forms after priming with passives, using a nonce verb earlier encountered only in an active sentence (see also deVilliers 1980; Whitehurst et al. 1974). Although it is still uncertain how the kind of learning that yields priming relates to the first-language acquisition process, suggestions of its potential effectiveness in infants can be found in the findings of Saffran et al. (1996).

The implicit-learning account of structural priming thus offers a common foundation for elements of language use, learning, and change. In the remainder of this paper we spell out some of the implications of this for bilingual language use and contact-induced language change.

Bilingual language use

The existence of syntactic structural influences from one language to another has long been controversial in research on bilingualism, second-language learning and use, and language change. Several linguistic presuppositions, beyond those mentioned in the introduction, help to make the possibility of syntactic influence appear remote. One venerable idea

is that syntax forms the core of a language, and is thereby the least vulnerable of all linguistic systems to external influence. Müller (1965 [1861]: 75) appeared to endorse this view when he wrote of English that "the grammar, the blood and soul of the language, is as pure and unmixed in English as spoken in the British Isles, as it was when spoken on the shores of the German ocean." Similarly, Romaine (1995) points out that syntax is often regarded as the least readily diffused or borrowed aspect of language. The occurrence of cross-language syntactic priming challenges these ideas, as does the increasingly abundant evidence for syntactic effects from one language to another in bilingual language use and language contact situations (Myers-Scotton 1993; Thomason and Kaufman 1988).

More positively, structural priming is a cognitive mechanism for syntactic influence that serves to bridge various phenomena that often receive separate theoretical treatments in the literature on bilingualism. They include codeswitching, code alternation (Thomason 1997), and transfer.

Codeswitching occurs when a bilingual speaker inserts material from what is nominally another language into a sentence frame in a host or matrix language (Myers-Scotton 1993, 1997). In many bilingual communities, codeswitching is the norm rather than the exception in everyday language use (Grosjean 1982). Such switches are far from random in their placement, inasmuch as most switches exhibit structural contraints that put them at points where there is no syntactic conflict between the two languages (Pfaff 1979). For example, English-Spanish code-switches such as

(6) I put the knives *en la mesa*.
'I put the knives on the table'.

are much more likely than

(7) He ran to the house *chiquita*.
'He ran to the little house'.

In the former, the relevant structures are the same in both languages, whereas in the latter they differ, because Spanish requires the adjective to follow the noun in this case. The strength of the constraint can be seen in an analysis of recorded interviews with a Puerto Rican-American woman (Poplack 1980, 1981). The analysis showed that out of 400 recorded instances of codeswitching, only one did not satisfy either English or Spanish surface constraints. The remaining 399 instances obeyed the structural rules of both languages. This suggests that the structural constraints from both languages are not only accessible but in simultaneous operation when codeswitching occurs.

Code alternation (Thomason 1997) is a common pattern among those bilingual speakers who, sometimes because of residence in a community where one of their languages is not spoken, use that language primarily with visitors or on occasional trips. On these occasions, fluent speakers sometimes experience unwelcome intrusions from their other language (even when that "other language" is neither their native nor even their dominant language), as when one of us said, in English, "I think that the wine in the refrigerator might be," following the Germanic pattern of putting the verb at the end of the subordinate clause. Linguistically aware acquaintances may readily note the effects of disuse in deviations from normal phonology, intonation, or syntax in otherwise fluent speech.

Naturally enough, the source of such deviations may be the interim language of custom. This is the province of language transfer and its close relative, interference, which together can be broadly characterized as the influence of "similarities and differences between the target language and any other language that has been previously (and perhaps imperfectly) acquired" (Odlin 1989: 27). Syntactic transfer is most evident when a structure characteristic of one language yields errors in another. For instance, in producing the deviant German *Bringen Sie mir ein Glas von Bier* 'Bring me a glass of beer' (Kufner 1962), a native English speaker appears to have been influenced by the English *glass of beer*, yielding a departure from the normal German construction *Glas Bier*, which lacks a proposition. Likewise, differences in adjunction and complementation cause native German speakers to use incorrect English verb forms, such as *It has stopped to rain* (Mack 1986). The German equivalent *Es hat aufgehört zu regnen* takes a nonfinite form of *regnen* 'rain' along with *zu* 'to' after the main verb.

In work on bilingualism, the construct of transfer has been controversial for both historical and theoretical reasons, but it is hard to deny that it exists (Odlin 1989). The question is when it occurs, and why.

Explaining structural transfer. Transfer, in its broad characterization, can be seen as the paradigm case of cross-language influence, and one of its vehicles may be the implicit learning of structure within the linguistic system. As a natural byproduct of normal language use, this kind of learning would both facilitate and impede the comprehension and production of same-language and different-language structures. Because its time-course is extended (Bock and Griffin 2000), its effects may be discernible long after a source of competition (or cooperation) was last instated. In bilingual situations, its probability should increase when relevant information from two different languages is simultaneously available, and in syntactic transfer, it should be particularly evident when the

speaker has fluent access to roughly equivalent procedures for the realization of an utterance (Felix 1982). Its effects should be positive if the procedures are the same in both languages (in which case there may be just one procedure used by both systems [see, e.g., Woolford 1983]) and negative if the procedures conflict.

On this proposal, transfer supports the structural regularities of code-switching (promoting switches at structurally congruent positions) as well as the structural interference that may be evident in situations of code alternation. It originates within the normal mechanisms of language production and comprehension (Myers-Scotton 1993; Romaine 1995; Sridhar and Sridhar 1980), which undergo a form of learning — a sort of fine-tuning — during normal use. Of course, this learning is also the proposed mechanism of structural priming, as revealed in structural repetition (Bock and Griffin 2000; Chang et al. 2000).

Language change

The continuity between language use and language learning suggested by the implicit learning of structure also has consequences for language change. Codeswitching and code alternation are facets of the bilingual language experience that have been proposed as vehicles of change (Myers-Scotton 1993; Thomason 1997), and both of them would tend to enhance and promote the use of shared structures via priming. The likelihood of this sort of priming also leading to language change gains credence to the degree that fully acceptable forms in one language (e.g. German double-object datives; English prepositional datives) can influence the production of more restricted forms in a speaker's other language (e.g. English double-object datives; German prepositional datives).

The scenario for such a change is straightforward. If lexically governed restrictions on existing structures can be bridged by priming and other performance factors that promote nonce use, the structure may become imperceptibly more accessible for subsequent, less restricted use. Take the English double-object dative (*John gave Mary a book*) as an illustrative case. Many dative verbs in English cannot comfortably appear in the double-object form (characteristically, those with Latinate origins): *John recommended Mary a book* is a far less likely formulation than *John recommended a book to Mary*. However, when the indirect object is light (a pronoun, for example), even Latinate verbs appear sporadically in the double-object form (e.g. in the overheard *Barbara recommended me her dentist*). Priming of such forms from the same or another language may provide an impetus for their further use, increasing their acceptability

(Luka and Barsalou 1998), and, given the right circumstances, paving the way for broader acceptance in a community of speakers. There is an obvious role for it in the process that Harris and Campbell (1995) called EXTENSION in language change.

We must emphasize that priming would be a suitably weak and subtle force in such changes: it is no hegemon. It is therefore very unlikely on its own to surmount the array of social, pragmatic, conceptual, lexical, and phonological factors behind the normal use of structures in a language, or their temporal and distributional properties. But because structural repetition itself is much more in evidence with explicit pragmatic and lexical support (Pickering and Branigan 1998; Branigan et al. 2000), it makes sense that such support could also serve to enhance or promote the process of structural change in language.

Further implications and extensions

Other questions concern different measures or effects of priming that may operate across languages. Most existing investigations of within-language priming have used categorical measures of the kind employed in this experiment. However, there is suggestive evidence that priming may also affect fluency, increasing the speed with which utterances are produced (Corley and Scheepers 2002; Smith and Wheeldon 2001) and decreasing hesitations during speech (Bock and Loebell 1990).

A study by MacKay and Bowman (1969) hints that this might occur across languages, too. They had bilinguals produce a practice sentence in one language at a maximal rate, and subsequently had them produce either a word-for-word translation-equivalent sentence (a literal equivalent) or a semantically equivalent sentence in a different word order. Speech rates were higher when the translations were literal equivalents as compared to semantic equivalents. Of course, the literal equivalents shared much more than the structure of the original sentences, so it is far-fetched to attribute the enhancement of fluency to structural factors alone. Consideration is nonetheless warranted for the idea that structural factors were also at work in creating the increased fluency of the literal equivalents. Such factors could have effects over and above those arising from the contextually dependent integration of the meanings of individual words suggested by MacKay (1982).

The existence of cross-language priming is hard to reconcile with any notion of the languages of the bilingual being psycholinguistically independent entities. Given the considerable evidence for potential cross-language interaction (see Romaine 1995, chapter 3 for review), a more

pressing question may be how proficient bilingual speakers manage to keep their languages functionally apart. Perhaps they are never fully successful at this. Yet many are successful enough, often enough, that the nature of the monitoring required to achieve effective language segregation in performance becomes increasingly interesting as the avenues of cross-language interaction appear to widen.

Conclusion

In 1971, Gumperz and Wilson described the remarkable case of a community in which three different languages (Kannada, Marathi, and Urdu) from two different language families (Dravidian and Indo-European) were used with common structures but three separate lexicons. Though the community was heavily bilingual, social forces served to maintain the languages as separate entities, at least in terms of their lexicons and morphosyntax, while the syntactic structures nonetheless converged. Related findings have been reported from other languages (Muysken 1997; Scollon and Scollon 1979). This is dramatic evidence that the structures of different languages can converge in the absence of convergence in their vocabularies.

In this paper we proposed a basic psycholinguistic mechanism that could mediate lexically unsupported structural changes in language, and experimentally tested its effectiveness between English and German. Structural priming, arguably as a form of implicit learning, served to increase the production of shared structures in fluent bilinguals even when the possibilities for semantic transfer were minimal. This suggests a cognitive scaffolding for the several phenomena of structural transfer in bilingualism, and points to an underlying continuity among the processes of language use, language learning, and language change.

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Appendix A. Language history questionnaire (translated from German) with summary of responses

1. What is your age?
   Mean = 39 years
   Range = 18–66

2. At what age did you learn English?
   Mean = 12.0 years
   Range = 4–35
3. Did you learn English in a formal (school, books) or informal (by living in the country) setting?
   Informally = 12.5%
   Both = 87.5%

4a. What language is spoken in your home?
   English = 41.6%
   German = 14.6%
   Both languages = 29.1%

4b. Which language are you more comfortable speaking?
   English = 14.6%
   German = 29.1%
   Equally comfortable = 56.2%

5. On a scale from 1 (rather bad) to 7 (very good) how would you rate your English skills? Mean = 6.5
   German skills? Mean = 6.8
6. When you talk to other people who know both German and English, do you often mix languages?
   no mixing = 17.4%
   frequent mixing = 82.5%
7. How much do you read in English and in German? Approximately how many hours per day do you read
   English? Mean = 1.5 hours
   German? Mean = 0.6 hours
8. Do you know other languages besides German and English? How many years did you study them (or were you exposed to them)?
   84.9% one or more languages besides German and English
   15.1% no other languages
   (All of the additional languages were learned in school. Three of the 48 participants indicated that they were able to converse with near-fluency in another language besides German and English.)

Appendix B. Priming sentences (English and German) and pictures

Dative priming sentences (a = prepositional dative; b = double-object dative)

(1) a. The girl bought a newspaper for the blind woman.
   Das Mädchen kaufte eine Zeitung für die blinde Frau.
   b. The girl bought the blind woman a newspaper.
   Das Mädchen kaufte der blinden Frau eine Zeitung.

(2) a. The little boy wrote a letter to his pen pal.
Der kleine Junge schrieb einen Brief an seinen Brieffreund.
b. The little boy wrote his pen pal a letter.
Der kleine Junge schrieb seinem Brieffreund einen Brief.

(3) a. The grandmother sewed a dress for her granddaughter.
Die Großmutter nähte ein Kleid für ihre Enkeltochter.
b. The grandmother sewed her granddaughter a dress.
Die Großmutter nähte ihrer Enkeltochter ein Kleid.

(4) a. The old man left the valuable coin collection to his nephew.
Der alte Mann hinterließ die wertvolle Münzsammlung für seinen Neffen.
b. The old man left his nephew the valuable coin collection.
Der alte Mann hinterließ seinem Neffen die wertvolle Münzsammlung.

(5) a. The woman handed the screaming baby to her husband.
Die Frau reichte das schreiende Baby an ihren Mann.
b. The woman handed her husband the screaming baby.
Die Frau reichte ihrem Mann das schreiende Baby.

(6) a. The rich farmer bought a horse for his son.
Der reiche Bauer kaufte ein Pferd für seinen Sohn.
b. The rich farmer bought his son a horse.
Der reiche Bauer kaufte seinem Sohn ein Pferd.

(7) a. The lawyer sent the contract to his client.
Der Rechtsanwalt schickte den Vertrag an seinen Klienten.
b. The lawyer sent his client the contract.
Der Rechtsanwalt schickte seinem Klienten den Vertrag.

(8) a. The father promised a car to his daughter.
Der Vater versprach ein Auto an seine Tochter.
b. The father promised his daughter a car.
Der Vater versprach seiner Tochter ein Auto.

(9) a. The musician sold some cocaine to the undercover agent.
Der Musiker verkaufte etwas Kokain an den Agenten.
b. The musician sold the undercover agent some cocaine.
Der Musiker verkaufte dem Agenten etwas Kokain.

(10) a. The landlady rented three rooms to the couple.
Die Hausbesitzerin vermietete drei Zimmer an das Ehepaar.
b. The landlady rented the couple three rooms.
Die Hausbesitzerin vermietete dem Ehepaar drei Zimmer.

(11) a. The young woman made a cup of tea for her aunt.
Die junge Frau machte eine Tasse Tee für ihre Tante.
b. The young woman made her aunt a cup of tea.
Die junge Frau machte ihrer Tante eine Tasse Tee.

(12) a. The architect built a new house for his mother.
Der Architekt baute ein neues Haus für seine Mutter.
b. The architect built his mother a new house.
Der Architekt baute seiner Mutter ein neues Haus.

(13) a. The man baked a cake for his wife.
Der Mann backte einen Kuchen für seine Frau.
b. The man baked his wife a cake.
Der Mann backte seiner Frau einen Kuchen.
(14) a. The hostess fixed some dessert for her guests.
Die Gastgeberin bereitete einen Nachtisch für ihre Gäste.
b. The hostess fixed her guests some dessert.
Die Gastgeberin bereitete ihren Gästen einen Nachtisch.
(15) a. The wealthy widow left her money to the church.
Die reiche Witwe vermachte ihr Geld an die Kirche.
b. The wealthy widow left the church her money.
Die reiche Witwe vermachte der Kirche ihr Geld.
(16) a. The young man wrote an apology to his fiancee.
Der junge Mann schrieb eine Entschuldigung an seine Verlobte.
b. The young man wrote his fiancee an apology.
Der junge Mann schrieb seiner Verlobten eine Entschuldigung.

Dative Pictures (gloss of pictured event; all events admitted alternative construals allowing different verbs, including *sell* instead of *show*, *present* instead of *give*, etc.)

1. Girl tossing ball to another girl
2. Boy giving present to girl
3. Girl giving flowers to teacher
4. Woman showing dress to man
5. Librarian giving book to boy
6. Salesman showing car to couple
7. Boy handing plate to boy
8. Girl handing mug to boy
9. Girl handing paintbrush to boy
10. Girl reading book to boy
11. Boy and girl giving flowers to man
12. Policeman giving ticket to man
13. Boy handing letter "K" to girl
14. Woman tossing bone to dog
15. Boy and girl showing picture to teacher
16. Nurse handing stethoscope to doctor

Transitive experimental sentences (a = active; b = passive)

(1) a. Many people attended the concert.
Viele Leute besuchten das Konzert.

b. The concert was attended by many people.
Das Konzert wurde von vielen Leuten besucht.

(2) a. A dog found the frightened child.
Ein Hund fand das verängstigte Kind.
b. The frightened child was found by a dog.
Das verängstigte Kind wurde von einem Hund gefunden.

(3) a. The chemical waste poisoned the river.
Der chemische Abfall vergiftete den Fluss.
b. The river was poisoned by the chemical waste.
Der Fluss wurde von dem chemischen Abfall vergiftet.

(4) a. The customs official opened the suspicious suitcase.
Der Zollbeamte öffnete den verdächtigen Koffer.
b. The suspicious suitcase was opened by the customs official.
Der verdächtige Koffer wurde von dem Zollbeamten geöffnet.

(5) a. The picture on the wall concealed the safe.
Das Bild an der Wand verbarg den Safe.
b. The safe was concealed by the picture on the wall.
Der Safe wurde von dem Bild an der Wand verborgen.

(6) a. The artist painted the nude woman.
Der Künstler malte die nackte Frau.
b. The nude woman was painted by the artist.
Die nackte Frau wurde von dem Künstler gemalt.

(7) a. A gang of teenagers mugged the salesman.
Eine Gruppe Jugendlicher überfiel den Verkäufer.
b. The salesman was mugged by a gang of teenagers.
Der Verkäufer wurde von einer Gruppe Jugendlicher überfallen.

(8) a. The sun warmed the streets.
Die Sonne wärmte die Straßen.
b. The streets were warmed by the sun.
Die Straßen wurden von der Sonne erwärmt.

(9) a. The engine turned the wheel slowly.
Der Motor drehte langsam das Rad.
b. The wheel was turned slowly by the engine.
Das Rad wurde langsam von dem Motor bewegt.

(10) a. The telephone call confused the young woman.
Der Telefonanruf verwirrte die junge Frau.
b. The young woman was confused by the telephone call.
Die junge Frau wurde von dem Telefonanruf verwirrt.

(11) a. The police car forced the truck driver off the road.
Das Polizeiauto drängte den Lastwagenfahrer von der Straße.
b. The truck driver was forced off the road by the police car.
Der Lastwagenfahrer wurde von dem Polizeiauto von der Straße gedrängt.

(12) a. A policeman found the crying child.
Ein Polizist fand das schreiende Kind.
b. The crying child was found by a policeman.
Das schreiende Kind wurde von einem Polizisten gefunden.

(13) a. The bright light blinded the tennis player.
Das grelle Licht blendete den Tennisspieler.
b. The tennis player was blinded by the bright light.
Der Tennisspieler wurde von dem grellen Licht geblendet.
(14) a. A helicopter pursued the fleeing bankrobber.
Ein Hubschrauber verfolgte den fliehenden Bankräuber.
b. The fleeing bankrobber was pursued by a helicopter.
Der fliehende Bankräuber wurde von einem Hubschrauber verfolgt.
(15) a. The author discovered some old manuscripts.
Der Autor entdeckte einige alte Manuskripte.
b. Some old manuscripts were discovered by the author.
Einige alte Manuskripte wurden von dem Autor entdeckt.
(16) a. The janitor cleans the floors daily.
Der Hausmeister reinigt die Böden täglich.
b. The floors are cleaned by the janitor daily.
Die Böden werden täglich von dem Hausmeister gereinigt.

Transitive pictures (gloss of pictured event; all events admitted alternative construals allowing different verbs)

1. Lightning striking church
2. Lightning striking golfer
3. Fire hydrant squirting firefighter
4. Fly swatter killing fly
5. Tornado demolishing barn
6. Missile shooting down airplane
7. Truck towing car
8. Baseball hitting boy
9. Train hitting bus
10. Wave capsizing boat
11. Torpedo hitting ship
12. Ambulance hitting policeman
13. Tank running over soldier
14. Train about to run over woman
15. Avalanche burying skiers
16. Crane wrecking building

Notes

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1. Since this experiment was completed, we have found that native German speakers living in Germany uniformly find the German version of sentence 8a in Appendix B unacceptable. The remaining prepositional forms are judged more variably (as expected), but none are rejected by all speakers.

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