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Do you what I say? People reconstruct the syntax of anomalous utterances

Iva Ivanova[a,1], Holly P. Branigan[b], Janet F. McLean[b2], Albert Costa[c,d], Martin J. Pickering[b]

[a]Departament de Psicologia Bàsica, Universitat de Barcelona, Spain

[b]Department of Psychology, University of Edinburgh, United Kingdom

[c]Departament de Tecnologies de la Informació i les Comunicacions, Universitat Pompeu Fabra, Spain

[d]Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain

[1] Corresponding author, now at Department of Psychology, University of California, San Diego, La Jolla, CA 92093-0109, USA, Tel.: +1 858 246 1278, Fax: +1 858 246 1284, iva.m.ivanova@gmail.com.

[2] Now at Division of Psychology, Abertay University, United Kingdom.

Abstract

We frequently experience and successfully process anomalous utterances. Here we examine whether people do this by ‘correcting’ syntactic anomalies to yield well-formed representations. In two structural priming experiments, participants’ syntactic choices in picture description were influenced as strongly by previously comprehended anomalous (missing-verb) prime sentences as by well-formed prime sentences. Our results suggest that comprehenders can reconstruct the constituent structure of anomalous utterances – even when such utterances lack a major structural component such as the verb. These results also imply that structural alignment in dialogue is unaffected if one interlocutor produces anomalous utterances.

Keywords: language comprehension, sentence processing, structural priming, reconstruction, anomalous sentences, missing verbs.

Do you what I say? People reconstruct the syntax of anomalous utterances

Everyday language is far from consistently orderly or well-formed. Disfluencies occur in 6 to 10 percent of the words we hear (Bortfeld, Leon, Bloom, Schober, & Brennan, 2001), and we all hear and produce utterances with missing or ungrammatical elements (e.g., in speech or hastily-written emails or texts). Anomalous utterances do not seem to cause communication breakdown, but how do people comprehend them? Do they ignore or do they repair ungrammaticalities? We investigate this question in a structural priming paradigm, focusing on whether comprehenders repair the abstract syntactic structure of utterances with no verbs.

Processing anomalous input[3]

For the past four decades, much research has been dedicated to how people comprehend language, including how they process difficult but ultimately grammatical sentences (e.g., Ferreira & Clifton, 1986; Frazier & Rayner, 1982; MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell, Tanenhaus, & Garnsey, 1994; Tyler & Marslen-Wilson, 1977). But true anomalies do not go undetected; for example, the brain is sensitive to violations of meaning (Kutas & Hillyard, 1980; see Kutas & Federmeier, 2000, for a review) and grammar (e.g., Kutas & Hillyard, 1983; Neville, Nicol, Barss, Forster, & Garrett, 1991; Osterhout & Holcomb, 1992). Comprehenders can also interpret sentences containing anomalies (e.g., Bates & MacWhinney, 1982; Ferreira, 2003; Gibson, Bergen, & Piantadosi, 2013). But how do they process such anomalies to arrive at an interpretation?

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[3] The focus of this study is the possible reconstruction, in the absence of a verb, of abstract syntactic representations which are independent of modality (spoken or written). We thus cite, throughout, evidence from the comprehension of both written and spoken sentences.

Consider the utterance *The waitress the book to the monk*: It has no verb. The comprehension of such an utterance might proceed as follows. *The* signals a noun phrase (NP) and creates the expectation of a head noun, which *waitress* satisfies. The meaning of *waitress* might also be retrieved and relevant scenarios (e.g., of a restaurant) might be activated (Sanford & Garrod, 1998). The most likely constituent after a sentence-initial NP is presumably a verb phrase so, at this point, a verb might be predicted (see Chang, Dell, & Bock, 2006; Levy, 2008a). Instead, there comes another NP (*the book*). The utterance is now inconsistent with the verb-phrase analysis so comprehenders might abandon this analysis (or assign it a very low probability). Instead, they might assume that *The waitress the book* is the beginning of an object relative clause (e.g., *the waitress the book was given to*) and thus (again) predict a verb. But, contrary to expectations, there comes a prepositional phrase (*to the monk*), and the utterance ends. Now what? Comprehenders presumably construct a final interpretation of the utterance. In doing so, do they "repair" the syntactic anomaly, or do they not?

Comprehenders might recover the meaning of an utterance such as *The waitress the book to the monk* without reconstructing its full constituent (syntactic) structure (henceforth *syntactic non-reconstruction account*). For our example, comprehenders can access the meaning of all the nouns (waitress, book, monk) and other words (in particular the preposition *to*), their order of mention, and the constituent structure of the individual phrases (NP, NP, PP). They might also construct what we refer to as *partial* constituent structure – the constituent structure of the post-verbal constituents (e.g., [NP PP]). Comprehenders might use this information together with world knowledge (e.g., from the scenarios they activate) to construct a thematic role representation.[4] They could do this by taking into account cues such as the number of entities mentioned, their animacy, and their order of mention (cf. Bates & MacWhinney, 1982). Thus, they would arrive at a thematic representation whereby the first-mentioned animate entity (*the waitress*) acts in some way on the inanimate entity (*the book*) such that it reaches (preposition *to*) the second animate entity (*the monk*) – in other words, the waitress transfers the book to the monk (even though the precise manner of transfer is unclear). At this point, they have arrived at a plausible interpretation for the utterance, which is presumably the goal of sentence comprehension; thus, they do not need to do anything else. Syntactic reconstruction might be effortful and bring no additional benefits. Thus, in this account, comprehenders would *not* construct a well-formed constituent structure representation such as a prepositional object dative for utterances with no verb. They might construct a partial constituent structure representation from the post-verbal constituents, and a full thematic role representation – but, crucially, not a full constituent structure representation containing a verb phrase and a verb category (such as S[NP VP[V NP PP]]).

The syntactic non-reconstruction account is consistent with evidence for shallow processing in comprehension (Sanford & Sturt, 2002). First, work in computational linguistics suggests that fully specified representations are not always needed for processing, and that the extent of specification depends on the processing goals. For example, automatic generation of indexes for large texts may be possible with *shallow parsing*, whereas machine

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[4] As part of this process, comprehenders might construct an anomalous constituent structure representation such as S[NP NP PP] or S[NP VP[NP PP]], or they might simply draw on the structure of the phrasal constituents (NP NP PP) without combining them into a sentential representation. Importantly, none of these possible representations corresponds to the representation of a grammatical sentence such as S[NP VP [V NP PP]].

translation requires full parsing (Ramshaw & Marcus, 1995). Second, comprehenders do not always use fully specified representations of word meaning (Frazier & Rayner, 1990). When asked "After an air crash, where should the survivors be buried?", half of the participants provided inappropriate answers such as "Bury them where their relatives want" (Barton & Sanford, 1993). They may have first activated an air-crash scenario (where people usually die), and interpreted the sentence based on this scenario, thus failing to fully access the meaning of *survivors*. (Literal interpretations were much more likely in a bicycle-crash scenario, where mortality is not as likely.) Such results suggest that comprehenders can interpret sentences by activating a scenario based on world knowledge and incorporating sentence entities into it without fully accessing their meaning.

Third and most relevant, plausibility can sometimes override syntactic analysis if the two yield different interpretations. Ferreira (2003) found that comprehenders misinterpreted structurally complex implausible sentences such as *The dog was bitten by the man* (understanding that the dog *bit* the man) a quarter to a third of the time. This suggests that interpretations are at least sometimes derived using shallow processing based on simple semantic heuristics (e.g., first entity refers to agent) instead of constructing the appropriate syntactic representation and then deriving the associated meaning. A similar account can explain why people fail to interpret complex implausible sentences such as *No head injury is too trivial to be ignored* (Wason & Reich, 1979).

But it is also possible that comprehenders reconstruct the syntax of utterances with no verb (henceforth *syntactic reconstruction account*). To do this, they first need to diagnose the problem, which they seem to be able to do when recovering from misanalyses (see Fodor & Inoue, 1994, on diagnosis and repair in comprehension). In this process, comprehenders presumably assume that their own perception was imperfect (e.g., they did not hear the verb) or that the speaker made an error (see e.g. Gibson et al., 2013, for a model of comprehension assuming rational comprehenders). Syntactic repair could then be done in many different ways (we discuss two such possibilities below), but the end result would be a structural representation which is not compatible with a linguistic analysis of the actual input, and which would be the same as the representation of a grammatical utterance such as *The waitress gives the book to the monk*: a prepositional object dative (S[NP VP[V NP PP]]).

One way in which comprehenders might reconstruct the missing verb category is to revisit a well-formed syntactic analysis that they had initially activated but then abandoned after not encountering an expected verb. That is, after the first noun phrase (*the waitress*), comprehenders would predict a verb; instead, they would encounter another noun phrase (*the book*). When they reach the end of the sentence without encountering a verb, comprehenders might then revisit (or (re)assign highest probability to) the verb phrase analysis, which might have retained some residual activation (Christianson, Hollingworth, Halliwell, & Ferreira, 2001; Slevc & Ferreira, 2013; Van Gompel, Pickering, Pearson, & Jacob, 2006). Incorporating all available constituents into this initially predicted analysis (treating the missing verb as phonologically null but syntactically present) would yield a full constituent structure representation of a well-formed prepositional object dative (S[NP VP[V NP PP]]). The reconstructed constituent structure would aid the construction of a thematic structure, or the two would be constructed in parallel, and both would aid in deriving a final interpretation of the anomalous sentence.

Another way to reconstruct the verb category would be to activate a well-formed syntactic representation that included a verb category *on the basis of* an initially constructed thematic representation (e.g., on the basis of a link between abstract thematic and syntactic representations, as in Construction Grammar; Goldberg, 1995, 2006). This would be different from the non-reconstruction account, in which comprehenders construct a thematic representation and at most a partial constituent structure representation (e.g., [NP PP]) but do *not* construct a full syntactic representation containing a verb phrase and a verb category. Although requiring an extra step, deriving a full constituent structure representation from the thematic representation would presumably help derive a more robust interpretation of the sentence.

There are several reasons to believe that comprehenders sometimes reconstruct language structure. First, they reconstruct missing sounds (Samuel, 1997). Second, they reanalyze or repair their initial analysis of grammatical sentences upon evidence that this analysis is incompatible with the actual input (Ferreira & Clifton, 1986; Fodor and Inoue, 1994; Frazier & Rayner, 1982; Sturt, Pickering, & Crocker, 1999; Trueswell, Tanenhaus, & Garnsey, 1994). Third, comprehenders can process disfluent sentences that are anomalous because of repeated or corrected words (e.g., *The waitress put- threw the ball*) where there is no prosodic indication of a problem until the correction is produced (Levelt & Cutler, 1983). Comprehenders might process such disfluent utterances by replacing the analysis of the reparandum with the analysis of the repeated or substituted elements when it becomes clear that they cannot be integrated into the overall structure built until that point (Ferreira, Lau, & Bailey, 2004; see Ferreira & Bailey, 2004, for an overview). But it is not clear how such a model could handle utterances with missing instead of repeated constituents.

Finally and most relevantly, recent work suggests that comprehenders might reconstruct anomalous syntactic structure (in addition to inferring intended meaning). In the 'noisy channel' account (Gibson et al., 2013), people realize utterances can be ill-formed, and interpret them based on a combination of plausibility and quantity of perceived noise (see Traxler, 2014). Participants read implausible sentences that were formed by one or two string edits (insertions or deletions) of plausible sentences (e.g., inserting *to* in *The mother gave the daughter* [to] *the candle*). Such sentences were interpreted literally less often in a context including noise (syntactic errors in filler sentences) than in a context without noise (i.e., when noise became more likely). But they were interpreted literally more often in a context including additional implausible sentences (i.e., when implausibility became more likely) than when it did not. Non-literal interpretations were also more likely when producing an implausible sentence would result from one rather than two edits (e.g., inserting only the preposition *to* between *the daughter* and *the candle*). These results suggest that people are able to reconstruct implausible sentences into plausible ones, and that whether they do so depends on how likely the speaker had been to utter an implausible sentence and the context's perceived noise.

However, sentence interpretation in such contexts could involve the reconstruction of only meaning but not syntax (though see Slevc & Momma, 2015, for some preliminary evidence). Also, syntactic reconstruction might be harder or impossible when it is verbs that are missing. Verbs are important carriers of syntactic information because they encode the number and type of arguments in a sentence. Verbs' structural preferences can significantly affect comprehension by creating a bias towards a particular structural analysis of a sentence (Britt, 1994; Garnsey, Pearlmutter, Myers, & Lotocky, 1997; Snedeker & Trueswell, 2004). Thus, it is not clear whether comprehenders can reconstruct syntactic structure when a major structural component is missing, such as the verb.

To summarize, the syntactic non-reconstruction account assumes that processing anomalous sentences with no verb such as *The waitress the book to the monk* does not involve constructing a full syntactic representation containing a verb phrase and a verb category (even though it might involve constructing a partial syntactic representation of the post-verbal constituents). Conversely, the syntactic reconstruction account assumes that processing such anomalous sentences involves constructing a full syntactic representation - the same as for a grammatical sentence containing a verb (a prepositional object dative: S[NP VP[V NP PP]]). Note that the critical difference between the accounts lies in the abstract constituent structure representations that people construct. The accounts do not make different claims about the final interpretations of anomalous sentences, and hence cannot be distinguished by investigating their assigned meanings. Nor do they differ with respect to the use of heuristics. The accounts differ with respect to syntactic representations, and so must be distinguished by a method that is sensitive to syntactic representations. We therefore turn to structural priming.

Structural Priming from Anomalous Sentences

Structural priming in language production (henceforth *structural priming*) is the tendency of people to repeat the structure of previous utterances. Bock (1986) showed that participants were more likely to produce prepositional object target descriptions after repeating aloud a prepositional object prime sentence (e.g., *The rock star sold some cocaine to an undercover agent*) than after a double object dative prime (e.g., *The rock star sold an undercover agent some cocaine*). Structural priming taps into modality-independent representations, of interest here: It occurs in, and across, spoken and written production and comprehension (Cleland & Pickering, 2006). Structural priming has been observed for different constructions and languages (e.g., Cai, Pickering, Yan, & Branigan, 2011; Salamoura & Williams, 2006; Scheepers, 2003; Bernolet, Hartsuiker, & Pickering, 2007), and in natural speech as well as experiments (Gries, 2005; Jaeger & Snider, 2013; Szmrecsanyi, 2005; see Pickering & Ferreira, 2008, for a review). Most relevantly, structural priming has already been used to study well-formed sentences involving missing elements (Cai, Pickering, & Sturt, 2013), as well as the processing of anomalous sentences (Ivanova, Pickering, Branigan, McLean, & Costa, 2012; Slevc & Momma, 2015).

Importantly for our purposes, much evidence indicates an abstract (lexically-independent) syntactic component to structural priming that is not contingent upon the repetition of content words (Pickering & Branigan, 1998), function words (Bock, 1989), or prosody (Bock & Loebell, 1990), and cannot be fully explained by conceptual, thematic role, or information structure repetition (e.g., Bernolet, Hartsuiker, & Pickering, 2009; Bock & Loebell, 1990).

Furthermore, a number of studies suggest that verbs form an integral part of the representations giving rise to priming. That is, the structural priming effects reported in the literature do not seem to result from post-verbal constituents alone (e.g., from the post-verbal noun phrase and prepositional phrase (e.g., *the book to the monk*) for prepositional object datives, or from the two post-verbal noun phrases (e.g., *the monk the book*) for double object datives). First, the structural preferences of verbs *alone* are sufficient to prime constituent structure. When participants were presented with single (German or Dutch) verbs restricted to the prepositional object construction, this construction was then more likely to persist in participants' subsequent descriptions (and likewise for the double object construction; Melinger & Dobel, 2005; see also Salamoura & Williams, 2006). The fact that isolated verbs can prime a constituent structure implies that verbs' structural preferences contribute to the magnitude of priming effects.

Second, the structural preferences of verbs presented in sentences influence the magnitude of structural priming (Bernolet & Hartsuiker, 2010; Jaeger & Snider 2013; Kaschak, 2007; Kaschak & Borreggine, 2008). For example, Bernolet and Hartsuiker (2010) showed that participants were more likely to produce double-object target picture descriptions after a double-object prime (relative to a non-dative baseline prime) when the prime verb was biased towards the prepositional object structure. Such results are explained by theories assuming that speakers adapt their expectations for a syntactic structure after processing a prime sentence, and the structural priming effect is sensitive to the prediction error experienced while processing the prime (Chang, Dell, & Bock, 2006; Dell & Chang, 2014; Jaeger & Snider, 2013). Specifically, after encountering a verb, speakers predict upcoming constituents based on its structural preferences (how likely a particular construction is to occur after this verb). When the actually-encountered post-verbal construction does not match the one predicted based on verb bias, the language system needs to make adjustments which are larger than when the construction matches verb bias, to make this construction more expected in the future. In sum, verbs' structural preferences are taken into account by the mechanisms that give rise to priming effects; thus, verbs have an integral part in determining the magnitude of such effects.

Third, the magnitude of structural priming is modulated by verb position. Chang, Baumann, Pappert, and Fitz (2015) found that German-speaking participants showed stronger priming effects when constructing verb-second sentences from a list of words (e.g., *uberreichen Pförtner Schlüssel Mitarbeiter* [hand doorman key co-worker]) after listening to prime sentences that were also verb-second (e.g., *Die Großmutter schickt ihrem Enkel ihr Testament* [The grandmother sends her grandson her will] than after prime sentences that were verb-final (*Die Großmutter hat ihrem Enkel ihr Testament geschickt* [literally, The grandmother has her grandson her will sent]. That is, the priming effect was larger when verb position matched between prime and target than when it mismatched. This pattern would not be expected if dative priming arose from the post-verbal constituents alone. Taken together, these three sets of results suggest that the verb position and structural preferences modulate structural priming effects, and hence that verbs must form part of the representations which give rise to priming.

In all, structural priming seems suitable to determine whether syntactic reconstruction occurs for anomalous utterances involving missing verbs. In two experiments, participants read anomalous and well-formed ditransitive prime sentences (Examples 1-3), decided whether they described a subsequent picture, and then described an unrelated target picture depicting a transfer event. We observed whether the structure of participants' target descriptions was affected by the structure of the prime sentences. Our predictions are based on the assumption that partial constituent structure (e.g., [NP PP]) would produce weaker priming effects than a full constituent structure (e.g., S[NP VP[V NP PP]]). This is because verb structural preferences and verb position seem to play a role in the magnitude of structural priming effects, as discussed above. Following this logic, under the syntactic non-reconstruction account comprehenders do not construct equivalent constituent structure representations for anomalous and well-formed sentences; in this account, only well-formed sentences receive full constituent structure which specifies the verb category. Thus, in the non-reconstruction account, anomalous primes without a verb should structurally prime the production of well-formed sentences to a lesser extent than well-formed primes. Conversely, under the syntactic reconstruction account, comprehenders construct full constituent structure representations for missing-verb sentences, which are equivalent to the ones they construct for grammatical sentences (and which include a verb category). Therefore, in this account, anomalous sentences should prime to the same extent as grammatical sentences.

We note that there are several ways in which a sentence such as *The waitress the book to the monk* might prime the production of a prepositional object dative sentence, without reconstruction. Structural priming might be due to the nature and order of constituents (NP PP vs. NP NP), the order of thematic roles (theme-recipient vs. recipient-theme), the order of animate vs. inanimate elements (inanimate-animate vs. animate-inanimate), or the nature and order of grammatical functions (direct object-oblique object vs. indirect object-direct object). If any of these factors lead to priming that is as strong as constituent-structure priming, then we could not distinguish the syntactic non-reconstruction and reconstruction accounts by comparing the priming from primes such as *The waitress the book to the monk* with the priming from primes such as *The waitress gives the book to the monk*.

However, the results of many studies suggest that these factors produce weaker priming than constituent structure priming (Cai, Pickering, & Branigan, 2012; Chang, Bock, & Goldberg, 2003). In fact, some may never produce priming (e.g., order of animacy; Bernolet et al., 2009; Huang, Pickering, Yang, Wang, & Branigan, in press; though cf. Bock, Loebell, & Morey, 1992), and others may only lead to priming in the absence of a constituent structure alternation (i.e., constituent structure priming tends to override thematic priming; Bock & Loebell, 1990; Messenger, Branigan, McLean, & Sorace, 2012). Taken together, these results suggest that anomalous and well-formed prime sentences would produce equivalent priming effects only if the full constituent structure constructed for them is the same.

Both experiments in our study were disguised as a game involving communication via an automatic speech transcriber (Ivanova et al., 2012). Participants were told that their oral descriptions would appear as text on their (imaginary) partner's screen and their partner's oral descriptions would appear as text on their own screen. In fact, participants were tested individually and the primes were pre-generated. This cover story simulated a dialogue setting, which might enhance priming effects (for preliminary evidence, see Ivanova & Ferreira, 2014; see also Reitter & Moore, 2014), but avoided the use of a confederate producing exceptionally strange utterances, and instead provided a plausible reason why the primes might contain errors. It turned out to be credible to almost all participants (see Results).

Constituent structure reconstruction of a sentence without a verb requires two operations: identifying the verb position, and supplying the verb category. Syntactic reconstruction might occur only when verb position can be easily identified. Thus, in Experiment 1, the missing-verb position was indicated; in Experiment 2 it was not. To ensure that we could detect variations in priming magnitude, both experiments included grammatical primes that had the same and different verbs to the target; priming is larger with repeated verbs (the *lexical boost*; Pickering & Branigan, 1998).

Experiment 1: Structural priming from sentences with hash marks instead of verbs

Method

Participants. Thirty-six participants from the University of Edinburgh community, all native English speakers, were paid to participate.

Materials. There were 36 experimental items (see Appendix) and 108 filler items. An item comprised a prime sentence, a picture to be verified against the prime sentence (*match picture*), and a target picture.

The 36 target pictures (6 for each of the 6 target verbs) depicted transfer events (Figure 1a). An upper-case present-tense verb appeared under each. Each experimental prime sentence had 6 versions (Examples 1-3), yielded by crossing the factors Prime Verb (Same vs. Different vs. No Verb-Hash) and Prime Construction (Prepositional Object vs. Double Object).

1a. The waitress gives the book to the monk. (Same Verb, Prepositional Object)

1b. The waitress gives the monk the book. (Same Verb, Double Object)

2a. The waitress flings the book to the monk. (Different Verb, Prepositional Object)

2b. The waitress flings the monk the book. (Different Verb, Double Object)

3a. The waitress ##### the book to the monk. (No Verb-Hash, Prepositional Object)

3b. The waitress ##### the monk the book. (No Verb-Hash, Double Object)

In the Same Verb condition (1a,b), the prime-sentence verb and verb printed on the target picture were the same (*flings, gives, lends, sells, sends,* and *throws*). The Different

Verb condition (2a,b) used the same set of prime verbs but combined differently so that each prime verb occurred twice with three different target verbs (e.g., the prime verb *throw* occurred in 2 items with each of the target verbs *give*, *sell*, and *send*). In the No Verb-Hash condition, the order of constituents was preserved but the prime verbs were substituted with 5 hash marks (3a,b). Note that participants read and responded to the prime sentence before being exposed to the target picture, hence could not be influenced by the target action or verb.

There were 36 match pictures, depicting a person either performing an action on another person holding an object (Figure 1b), or using an object to perform an action on another person (e.g., a cowboy hitting a swimmer with a hammer). Thus, these pictures all required a “no” response (but see below for filler items). They depicted a different event type than the prime sentence to discourage specific interpretations or reconstruction of the missing prime verbs. The match picture was always the same across all prime sentence conditions.

There were also 108 fillers with the same structure as experimental items, involving 18 monotransitive verbs and corresponding monotransitive events (e.g., a waitress chasing a monk). Eighteen filler match pictures were of the same type as the experimental match pictures. In total, seventy-eight of the filler match pictures required a “yes” response, so that half of all match pictures in the experiment required a “yes” response.

To lend credence to the ‘automatic speech transcriber’ cover story and disguise the experimental manipulation, 1/3 of the fillers were anomalous. Twelve had a misspelt word (e.g., *docter*, *polisman*), twelve had an article replaced by five hash marks (e.g., *The dancer kicks ##### doctor*, *##### pirate chases the waitress*), and twelve had one content word replaced by hash marks (e.g., *The dancer ##### the doctor* or *The ##### lifts the ball*), such that 4 sentences lacked the verb, 4 lacked the first noun and 4 lacked the second noun.

Figure 1a. An example of a target picture. The colour of the frame (pink or green) served to remind participants of the appropriate task (describe or match).

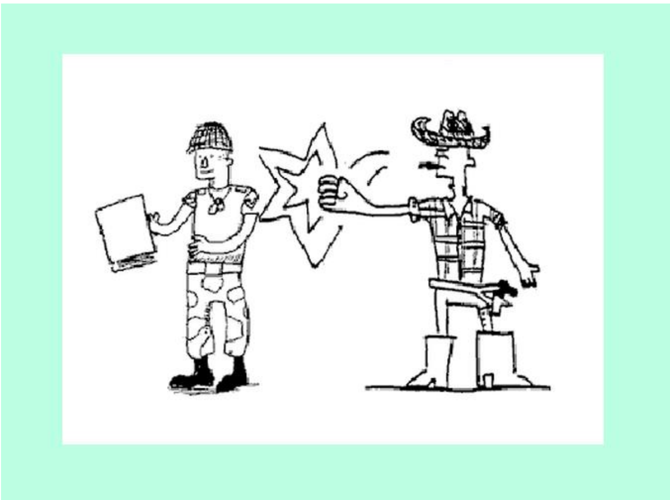

Figure 1b. An example of a match picture, corresponding to the prime sentences *The waitress (gives/ flings/ #####) the book to the monk/ the monk the book.*

There were six lists of items, each containing one version of each item, and six items from each condition, together with all the fillers. Order of presentation was randomized for each participant, with the constraints that between two and four fillers separated experimental items, and preceded the first item.

Procedure. Participants were tested individually on a PC. They read instructions stating that they were participating in a communication study and would play a picture-matching game with another participant via an automatic speech transcriber. They were informed that the transcriber sometimes cut words out, but that the other participant's picture descriptions would actually be similar to their own; this was done to discourage participants from interpreting the anomalous sentences as lists of phrases.

An experimental trial had the following sequence (Figure 2): 1) An array of white dots appeared on a black background (4400ms or 4600ms for the first 40 trials; 3800ms or 4200ms for the remaining trials). Different timings were used to simulate the time for "the other participant" to describe a picture and the speech transcriber to convert it into text, with reduced timing after 40 trials to simulate practice effects. 2) The prime sentence, beginning with an uppercase letter and ending with a period, appeared (4500ms). 3) A match picture appeared (2500ms or until a key-press response). 4) A target picture appeared (5000ms). Participants were told they must describe the picture (using the supplied verb) within five seconds. 5) An empty pink frame appeared (randomly between 1000 and 1400ms for the first 40 trials, between 800 and 1100ms for remaining trials), to simulate the time for the other participant to give a response.

Before the experiment, each participant completed six practice trials. The experiment was presented with the DMDX software (Forster & Forster, 2003). Participants wore a headset microphone and the program recorded their spoken responses. After the experimental session, participants completed a questionnaire verifying they were native English speakers and unaware of the experimental manipulation, and probing their belief in the cover story. The first part of this questionnaire contained 17 questions about participants' language history (specifically age of acquisition, proficiency, percent average daily use, and patterns of use of the languages they know, as well as place of birth and places they had lived in). The second part of the questionnaire (reproduced in Appendix B) contained a number of questions about the imaginary partner (numbered 10 to 16), the automatic speech transcriber (numbered 18 to 22), and the mistakes and omissions in the prime sentences (numbered 5 to 9 and 24).

The study procedures were approved by the the Psychology Research Ethics Committee (PREC) at the University of Edinburgh.

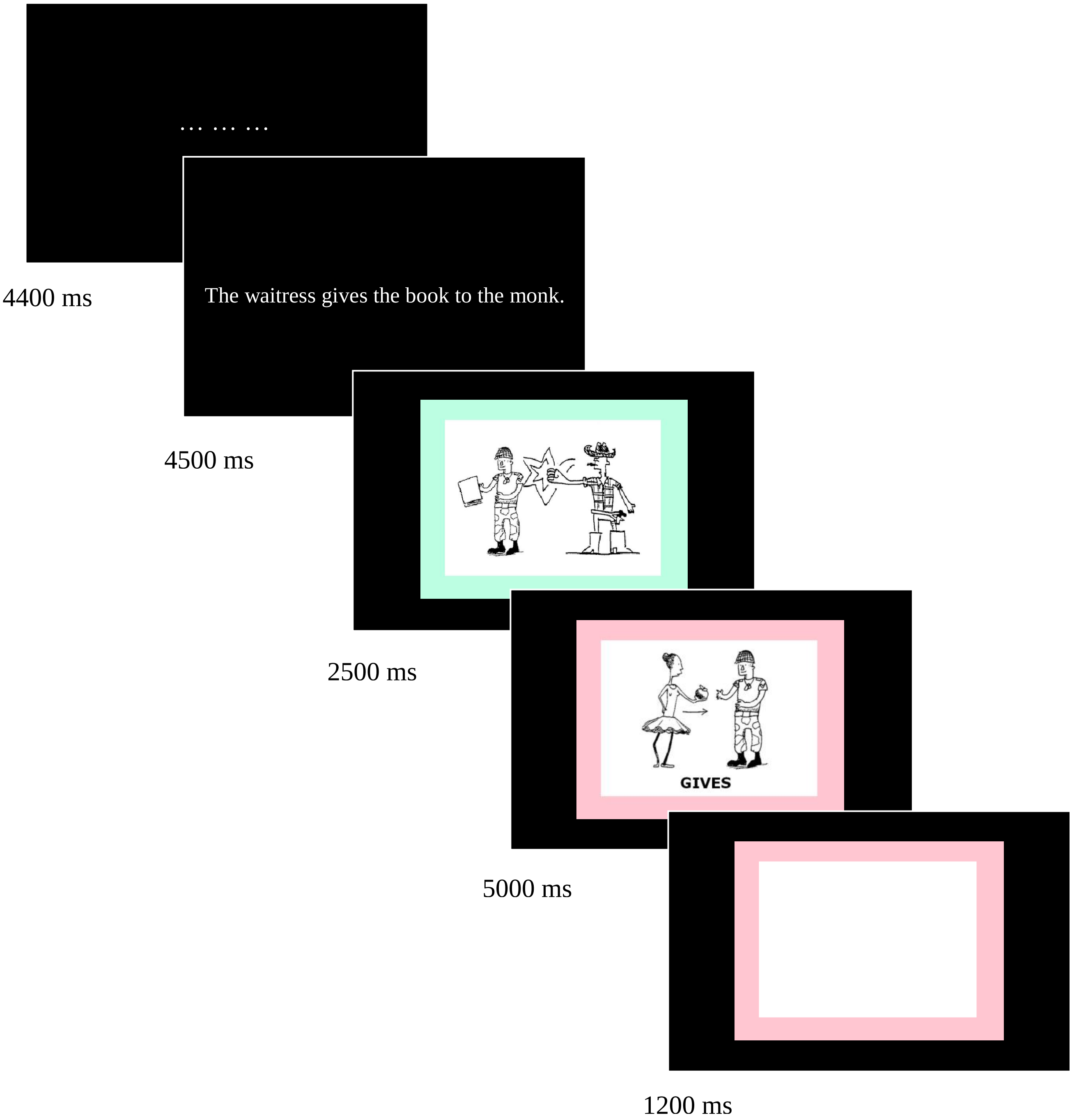

Figure 2. An example trial.

Scoring. All participants' responses were transcribed and manually coded as a: *prepositional object* if the theme of the action immediately followed the verb and was followed by the preposition *to* and the beneficiary; *double object* if the beneficiary immediately followed the verb and was followed by the theme; and *other* otherwise. Other responses included trials on which participants did not produce any description or did not use the presented verb.

Data analysis. We analyzed the data using logit mixed effects regression (LMER) modelling (Jaeger, 2008) in R (Version 2.15.3). We report models on the data from all participants. We also ran models excluding participants that produced only one type of construction (e.g. only prepositional object) throughout the experiment. These models produced similar results to the ones we report. All models included the maximal random effects structure as justified by the design (Barr, Levy, Scheepers, & Tily, 2013) unless otherwise stated. When a model with the maximal random effects structure did not converge or led to singular convergence, we simplified the model by step-wise removal of the random effects explaining least variance (this was done in one case in each of the two experiments, and is reported in footnotes). We explain the fixed effects structure of each model before presenting its outcome in the Results sections, and we provide the formulas for all models in Appendix C.

Results

There were 1296 responses, of which 935 (72.1%) were prepositional objects, 302 (23.3%) were double objects, and 59 (4.6%) were others. Three participants doubted they were interacting with another participant. Their responses were not excluded from the models because they were unaware of their structure choices during picture description, and because belief about participation in dialogue was not crucial for our hypotheses. Models excluding these participants from the analyses did not change the pattern of results.

Table 1 shows the mean proportions of double object target responses in each condition together with the priming effects; Figure 3 shows the priming effects, calculated as the proportion of double object target responses following double object primes minus the proportion of double object target responses following prepositional object primes (the choice of double object responses was arbitrary).

Table 1

Mean proportions of double object target descriptions out of all prepositional object and double object target descriptions in each condition in both experiments.

Experiment	Condition	Prime Construction		Priming Effect
		Double object	Prepositional Object	
Experiment 1	Same Verb	.44	.09	.35
	Different Verb	.29	.18	.11
	No Verb-Hash	.32	.17	.15
Experiment 2	Same Verb	.38	.12	.26
	Different Verb	.22	.25	-.03
	No Verb	.24	.15	.09

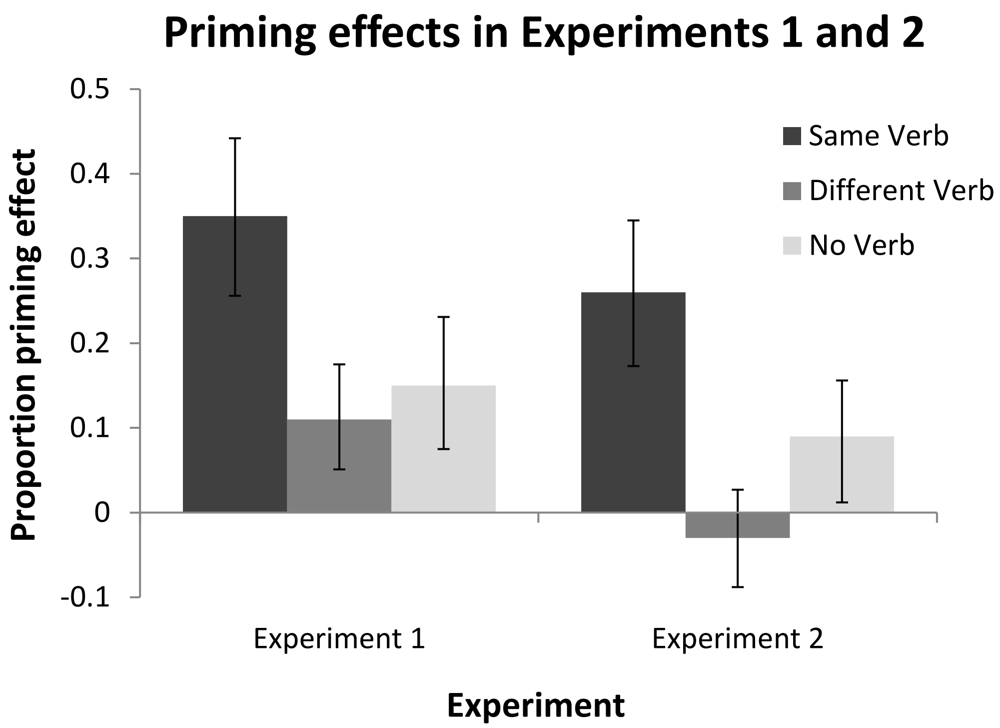

Figure 3. Mean by-subject proportion priming effects in each condition in Experiments 1 and 2. Error bars represent 95% confidence intervals.

To investigate the presence of a lexical boost, we first compared the Same Verb condition to the Different Verb and No Verb-Hash conditions together. For this purpose, we ran a model with Prime Verb as a two-level predictor (Same Verb versus the other two conditions; the Same Verb condition was coded as 0.5, and the Different Verb and No Verb-Hash conditions, both as -0.25), Prime Construction, and their interaction (see Table 2). In this analysis, Prime Construction was a significant predictor, indicating that there were more double object responses following double object primes than following prepositional object primes. Furthermore, the interaction between Prime Verb and Prime Construction was also significant, indicating that the priming effect was larger in the Same Verb condition than in the Different Verb and No Verb-Hash conditions taken together.

A further model comparing the Different Verb and No Verb-Hash conditions (in which the Same Verb condition was coded as 0, and the Different Verb and No Verb-Hash conditions, as 0.5 and -0.5, respectively) showed that the interaction between the Different Verb and No Verb-Hash conditions was not significant, suggesting that the priming effect was similar in these two conditions (Table 2).

Finally, a model targeting simple effects (specified by removing the Prime Construction factor, thus leaving Prime Verb as a three-level factor, and the Prime Verb x Prime Construction interaction) indicated that more double object responses were produced after double object primes than after prepositional object primes (i.e. significant priming effects) in all conditions.[5]

Table 2

LMER results for Experiment 1

Model	Predictors	*Estimate*	*SE*	*z*	*p*
Same vs. Diff. and No Verb-Hash	Intercept	-2.28	.43	-5.29	< .001
	Prime Verb	.41	.33	1.25	.21
	Prime Construction	2.00	.25	8.03	< .001
	Prime Verb * Prime	1.94	.77	2.53	.01
Diff. vs. No Verb-Hash	Intercept	-2.14	.39	-5.43	< .001
	Prime Verb	-.36	.24	-1.47	.14
	Prime Construction	1.98	.24	8.37	< .001
	Prime Verb * Prime	.39	.51	.77	.44
Simple effects model					
	Same verb	-3.02	.38	-7.87	< .001
	Different Verb	-1.36	.40	-3.38	< .001
	No Verb-Hash	-1.26	.35	-3.58	< .001

[5] The interaction between Prime Verb and Prime Construction was removed from the items random slopes because of singular convergence of the full model (see Appendix C).

Other responses ranged from 7 (3.2%) to 15 (6.9%) per condition. There were more such responses in the Different (18) and No Verb-Hash (24) conditions (Mean: 21) than in the Same Verb condition (17) [*Estimate* = -1.93, *SE* = .66, *z* = -2.91, *p* = .004]. A comparison of Other responses in the Different versus No Verb-Hash condition showed more Other responses after double object (15) than prepositional object primes (9) in the No Verb-Hash condition, but the same number after double object and prepositional object primes (9) in the Different Verb condition [Interaction: *Estimate* = 2.40, *SE* = .88, *z* = 2.73, *p* = .006].

Discussion

Structural priming had a similar magnitude following well-formed different-verb primes and anomalous primes with hash marks replacing the verb. Following the predictions of the syntactic reconstruction account, this suggests that people syntactically reconstructed No Verb-Hash primes (3a,b) to well-formed dative sentences. In addition, structural priming was larger when the verb was repeated between prime and target than when it was not, indicating that our paradigm was sensitive to differences in the magnitude of priming.

Experiment 2: Structural priming from sentences with no verbs

Method

Participants. Forty-two further participants from the same population as Experiment 1 participated for payment.

Materials. The materials were identical to Experiment 1, except that the No Verb-Hash condition was replaced with a No Verb condition, in which the prime verb was completely missing (4a, b).

4a. The waitress the book to the monk. (No Verb, Prepositional Object)

4b. The waitress the monk the book. (No Verb, Double Object)

The hash marks were also removed from all fillers containing them in Experiment 1.

Procedure, scoring and data analysis: These were as in Experiment 1.

Results

Of the 1512 responses, 1105 (73.1%) were scored as prepositional objects, 322 (21.3%) were scored as double objects (see Table 1 and Figure 3), and 85 (5.6%) were scored as others. We did not exclude data from two participants who doubted they were interacting with another participant; analyses without them produced the same pattern of results.

We conducted the same statistical analyses as in Experiment 1 (Table 3). Specifically, again we first compared the Same Verb condition to the Different Verb and No Verb-Hash conditions together, by running a model with Prime Verb as a two-level fixed predictor (Same Verb versus the other two conditions), Prime Construction, and their interaction. Prime Construction was a significant predictor, indicating that there were more double object responses following double object primes than following prepositional object primes. The interaction between Prime Verb and Prime Construction was also a significant predictor, indicating that the priming effect was larger in the Same Verb than in the Different Verb and No Verb conditions together.

In the second model comparing the Different Verb and No Verb conditions directly, the interaction term was also significant, reflecting the fact that the priming effect was larger in the No Verb than in the Different Verb condition.

The model targeting simple effects further indicated that there were significant priming effects in the Same Verb and No Verb conditions (more double object responses were produced after double object primes than after prepositional object primes). However, in the

Different Verb condition, there was a small negative priming effect (more double object responses were produced after prepositional object primes than after double object primes)[6].

Table 3

LMER results for Experiment 2

Model	Predictors	*Estimate*	*SE*	*z*	*p*
Same vs. Diff. and No Verb	Intercept	-2.73	.45	-6.08	< .001
	Prime Verb	-.48	.41	-1.17	.24
	Prime Cons.	1.57	.24	6.52	< .001
	Prime Verb * Prime Cons.	5.01	.76	6.63	< .001
Diff. vs. No Verb	Intercept	-2.38	.40	-5.93	< .001
	Prime Verb	-.004	.25	-.02	.98
	Prime Construction	1.34	.22	6.06	< .001
	Prime Verb * Prime Cons.	-.93	.44	-2.13	< .05
Simple effects model					
	Same verb	-2.71	.34	-7.94	< .001
	Different Verb	.96	.37	2.60	< .01
	No Verb	-1.03	.34	-2.98	< .01

Other responses ranged from 7 (2.8%) to 20 (7.9%) per condition. There were significantly fewer such responses in the Same Verb condition (14) than in the Different (29) and No Verb (26) conditions (Mean: 28) [*Estimate* = -3.24, *SE* = .81, z =-3.99, $p < .001$]. There were more other responses after prepositional object (Mean: 14.5) than double object primes (Mean: 13) in the Different and No Verb conditions, but a similar number after prepositional object (7) and double object primes (7) in the Same Verb condition [Interaction:

[6] The interaction between Prime Verb and Prime Construction was removed from the items random slopes because of singular convergence of the full model (see Appendix C).

Estimate = -3.00, *SE* = 1.42, *z* = -2.12, *p* = .03]. There were no significant differences in Other responses across the Different and No Verb conditions.

To investigate whether overall priming differed when the position of the verb was indicated versus when it was not, we also compared the overall magnitude of priming across the two experiments, collapsing across the Prime Verb conditions. The statistical model (see Appendix C) had Prime Construction (Prepositional Object, Double Object) and Experiment (Experiment 1, Experiment 2) as fixed predictors. In this model, the interaction between Prime Construction and Experiment was significant [*Estimate* = -.72, *SE* = .29, *z* =-2.45, *p* = .01], indicating that the magnitude of the overall priming effect in Experiment 2 was smaller relative to Experiment 1. To investigate whether priming was consistently smaller in all or only some conditions in Experiment 2 relative to Experiment 1, we conducted separate between-experiment comparisons of each condition. To do so, we ran three further models, each with Prime Construction and Experiment as fixed predictors; in the Experiment predictor of these three models, the respective condition (Different Verb, Same Verb, No Verb) was coded as -0.5 for Experiment 1, and 0.5 for Experiment 2; the remaining two conditions were coded as 0. These comparisons suggested that the difference in priming between experiments was driven entirely by the Different Verb condition. That is, the interaction between Prime Construction and Experiment was only significant in the analysis of the Different Verb condition [*Estimate* = -1.41, *SE* = .45, *z* = 3.16, *p* = .001], but not in the analyses of the Same Verb or No Verb conditions [both *p*s > .8]. These last three models thus indicated that the priming effect was smaller in Experiment 2 relative to Experiment 1 only in the Different Verb but was similar across experiments in the Same Verb and No Verb conditions.

To further investigate how the magnitude of priming in the No Verb condition relates to different-verb priming, we ran another model comparing the No Verb condition from Experiment 2 with the Different Verb condition from Experiment 1 (the two Different Verb conditions were identical across experiments). This model was the same as the other cross-experiment comparisons by condition described above, except that the Experiment predictor coded the Different Verb condition from Experiment1 as -0.5, and the No Verb condition from Experiment 2 as 0.5 (the remaining conditions were coded as 0). The interaction between Prime Construction and Experiment was not significant [$p = .65$], indicating that there was no difference between the No Verb condition from Experiment 2 and the Different Verb condition from Experiment 1. In sum, we found no evidence that priming from missing-verb sentences was affected by whether the position of the verb was indicated or not.

Discussion

We found significant priming following primes containing no verb, and a small negative priming effect (.03) after different-verb primes. Importantly, additional analyses showed that no-verb priming (.09) did not statistically differ from either no-verb-hash priming (.15) or different-verb priming (.11) in Experiment 1. We thus take this outcome to support the syntactic reconstruction account. As in Experiment 1, we also found larger priming when primes and targets shared a verb than in the other two conditions.

The small negative priming effect in the Different Verb condition in this experiment was unexpected; we return to it in the General Discussion. Based on the results of Experiment 1, and three very similar conditions in studies using the same method that investigated the processing of anomalous sentences reported in Ivanova et al. (2012), we suspect that this result was due to chance. All of the relevant experiments had an identical structure (a same-verb condition, a different-verb condition, and an anomalous condition). All but the current Experiment 2 produced a positive (facilitatory) different-verb priming effect, with an average effect of .12 (.11 in Experiment 1, and .14, .12, and .10 in Ivanova et al.). This suggests that the negative different-verb priming in Experiment 2 is exceptional. Moreover, the unexpected pattern in the Different Verb condition did not extend to the other two conditions: The priming effects in the Same and No Verb conditions were statistically indistinguishable between Experiment 1 and Experiment 2.

General Discussion

In this study we asked whether comprehenders reconstruct the syntactic structure of utterances with missing verbs, and addressed this question using a comprehension-to-production structural priming paradigm. In our experiments, missing-verb sentences primed the production of well-formed dative sentences, both when the position of the verb was indicated and when it was not. Such priming was at least as large as priming from well-formed different-verb sentences (though smaller than priming from well-formed, same-verb sentences). We interpret these results as suggesting that comprehenders reconstruct the constituent structure of anomalous utterances with missing verbs, and, hence, comprehend them using the same structural representations (e.g., S[NP VP[V NP PP]]) as when they comprehend similar well-formed utterances (e.g., prepositional object datives). We find it particularly noteworthy that such reconstruction occurred in the absence of a verb since verbs are major carriers of structural information.

Reconstruction might not occur automatically but instead depend on context (Gibson et al., 2013). Our cover story made anomalies, and specifically missing words, expected, and, in practice, one-third of our sentences were anomalous, of which three-quarters were missing a word. Reconstruction might not regularly occur if the context does not involve such anomalies. But our experiments demonstrate that reconstruction of constituent structure (and not only of semantics) does occur, under at least some circumstances. Is it noteworthy that syntactic reconstruction occurred when participants expected that the original utterance was well-formed? We think it is, for two reasons. First, such an expectation of well-formedness would be natural in real-life conversations, and thus represents the default situation rather than an exception: comprehenders expect that speakers intend to produce well-formed language rather than deliberately producing anomalous utterances (see Levy, 2008b, Levy, Bicknell, Slattery, & Rayner, 2009; Gibson et al., 2013). Second, in our experiments, comprehenders did not need to reconstruct structure to infer the speaker's intended meaning, which we presume – as rational agents – was their goal; yet, we have shown that they nevertheless did so.

But how do comprehenders determine the target structure for reconstruction? Why did they assume that *The waitress the book to the monk* should be reconstructed to a dative? We suggest that both the current utterance and the context can provide cues. In Gibson et al.'s (2013) terms, omitting a dative verb involves one deletion on the part of the speaker, and so comprehenders might be more likely to assume that this is what the speaker did, rather than assume that the speaker produced an anomalous utterance involving multiple insertions or deletions. In addition, the context in our experiments (other utterances and pictures) includes many datives, and could give rise to event-structure priming (Bunger, Papafragou, & Trueswell, 2013).[7]

Our findings have implications for language use during dialogue. Dialogue partners tend to mirror each other's linguistic choices at many representational levels, which aids mutual understanding (Reitter & Moore, 2014; see also Pickering & Garrod, 2004). Our

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[7] In additional analyses, we divided the data from each experiment into four parts and compared priming in the No Verb condition in the first versus the fourth part combining the data from the two experiments; priming remained unchanged across parts [*Estimate* = -.32, *SE* = .68, z =-.47, p = .64]. This result rules out the possibility that priming from missing-verb sentences was due to cumulative structural priming from well-formed sentences.

findings imply that speakers would align with their interlocutors at some level of structure even when the latter produce anomalous utterances (while not necessarily producing anomalous utterances themselves; Costa, Pickering, & Sorace, 2008).

The main goal of our study was to investigate whether comprehenders are able to fill in syntactic elements when those elements are anomalously missing from the input. More broadly, we aimed to shed light on the nature of the abstract syntactic representations that comprehenders build for anomalous sentences. We manipulated verb presence because verbs are pivotal carriers of structural information in a sentence, and as such, this manipulation provided a strong test of our hypotheses. Note, however, that our study makes no claims about the actual frequency of occurrence of missing elements, and verbs in particular, in spontaneous speech or typing.

In the following, we consider alternative possible interpretations of our findings. First, is it possible that the locus of priming we observed, for both well-formed and missing-verb sentences, was representations of the post-verbal constituents (NP-PP or NP-NP) rather than representations including the verb (reconstructed or not)? This possibility seems unlikely in view of a number of findings suggesting that verbs' structural preferences and verb position influence the magnitude of the priming effect (Bernolet & Hartsuiker, 2010; Chang et al., 2014, Jaeger & Snider, 2013: Melinger & Dobel, 2005; Salamoura & Williams, 2006). Second, is it possible that missing-verb sentences prime less than different-verb sentences but our experiments were insensitive to differences between conditions? This possibility seems unlikely given that, in both experiments, we observed a significant lexical boost (and, in Experiment 2, missing-verb sentences primed *more* than different-verb primes; see below). Third, is it possible that our results were due to priming of a semantic level of representation? This possibility seems unlikely given that constituent structure yields strong priming (see Pickering & Ferreira, 2008), whereas priming based on the identity or order of thematic roles alone is much weaker, and may only occur when there is no choice of constituent structure (e.g., Bock & Loebell, 1990; Chang et al., 2003; Messenger et al., 2012). Therefore, to conclude that the priming effects we found for both missing-verb and well-formed sentences come only from thematic representations would be at odds with the structural priming literature.

A further issue is why missing-verb sentences primed significantly more than well-formed different verb sentences in Experiment 2. As already discussed, we suspect that the unusual negative priming effect for different-verb sentences in this experiment was due to chance (given additional analyses, and previous related experiments using the same method that reliably produces facilitatory priming; Ivanova et al., 2012). It thus seems premature to conclude that missing-verb sentences prime more than well-formed sentences. However, we tentatively consider some potential explanations (that are not mutually exclusive) for why priming might have been stronger for missing-verb sentences than for well-formed different-verb sentences, though we emphasise that they remain speculative without further work replicating this effect.

First, larger priming for missing-verb sentences could reflect a larger prediction error for such sentences relative to well-formed sentences containing a verb, assuming that comprehenders predict upcoming constituents and subsequently adjust their language systems to more accurately reflect the actual input (e.g., Dell & Chang, 2014). Specifically, comprehenders might predict a verb after the first noun phrase and, when they do not encounter it, a verb after the second noun phrase (under a relative clause reading, e.g., *The waitress the book* [*amused*], as in *The waitress the book amused was laughing*). Alternatively or in addition, larger prediction errors could come from vaguer biases of general meaning classes of verbs (e.g., transfer, as would be recovered in our missing-verb sentences), relative to the verb biases of concrete verbs in the well-formed, different-verb sentences. It is also possible that missing-verb sentences produced larger priming because they were less expected and thus more attended to (i.e., processed more deeply) than sentences with verbs (see Branigan, Pickering, McLean, & Cleland, 2007)[8]; it is, however, unclear why this was not the case also for sentences with novel and incongruous verbs (Ivanova et al., 2012; Ivanova, Pickering, McLean, Costa, & Branigan, 2012). Again, we note that these possibilities remain entirely speculative without further evidence.

In conclusion, people often encounter utterances that are not well-formed. But such utterances do not usually appear to cause them undue difficulty. Our experiments show that people can comprehend them by reconstructing not only their meaning but also their syntactic structure to well-formed representations, and that they use those reconstructed representations when planning their own, well-formed, contributions.

[8] We thank Florian Jaeger for suggesting this possibility.

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Appendix A

Experimental items in Experiments 1 and 2

The prepositional object prime sentences are before the slash, and the post-verbal constituents of double-object primes, after the slash. The prime verbs in the two experiments are given in brackets in the following order: Experiments 1 and 2, Same Verb/ Experiments 1 and 2, Different Verb/ Experiment 1, hash marks. In Experiment 2, there was nothing at the place of the verb, so that prime sentences had the form *The prisoner the cake to the burglar/ the burglar the cake*. The target picture is described in the order agent, verb, beneficiary, theme (e.g., DANCER GIVE SOLDIER APPLE is designed to elicit the descriptions *The dancer gives the apple to the soldier* and *The dancer gives the soldier the apple*).

1. The prisoner (flings/ sells/ #####) the cake to the burglar/ the burglar the cake. TEACHER FLING SAILOR BOOK
2. The waitress (flings/ sells/ #####) the gun to the dancer/ the dancer the gun. POLICEMAN FLING MONK HAT
3. The policeman (flings/ lends/ #####) the apple to the sailor/ the sailor the apple. PRISONER FLING DOCTOR JUG
4. The chef (flings/ lends/ #####) the cup to the soldier/ the soldier the cup. DANCER FLING BOXER BALL
5. The monk (flings/ gives/ #####) the ball to the cowboy/ the cowboy the ball. ARTIST FLING WAITRESS CAKE
6. The pirate (flings/ gives/ #####) the hat to the clown/ the clown the hat. NUN FLING BURGLAR BANANA
7. The artist (gives/ throws/ #####) the cake to the swimmer/ the swimmer the cake. DANCER GIVES SOLDIER APPLE
8. The teacher (gives/ throws/ #####) the ball to the nun/ the nun the ball. MONK GIVE BURGLAR BOOK
9. The pirate (gives/ flings/ #####) the cup to the boxer/ the boxer the cup. TEACHER GIVE CLOWN GUN

10. The waitress (gives/ flings/ #####) the book to the monk/ the monk the book. PRISONER GIVE SWIMMER BALL
11. The chef (gives/ sends/ #####) the jug to the burglar/ the burglar the jug. COWBOY GIVE NUN CAKE
12. The policeman (gives/ sends/ #####) the banana to the dancer/ the dancer the banana. ARTIST GIVE DOCTOR HAT
13. The burglar (lends/ flings/ #####) the apple to the waitress/ the waitress the apple. NUN LEND DOCTOR BANANA
14. The nun (lends/ flings/ #####) the gun to the pirate/ the pirate the gun. BURGLAR LEND BOXER HAT
15. The monk (lends/ sends/ #####) the hat to the soldier/ the soldier the hat. CHEF LEND NUN APPLE
16. The teacher (lends/ sends/ #####) the banana to the swimmer/ the swimmer the banana. DANCER LEND PIRATE BOOK
17. The prisoner (lends/ sells/ #####) the cake to the clown/ the clown the cake. POLICEMAN LEND WAITRESS GUN
18. The artist (lends/ sells/ #####) the jug to the cowboy/ the cowboy the jug. BURGLAR LEND SAILOR CUP
19. The dancer (sells/ throws/ #####) the cup to the monk/ the monk the cup. COWBOY SELL WAITRESS JUG
20. The cowboy (sells/ throws/ #####) the gun to the sailor/ the sailor the gun. ARTIST SELL CLOWN BALL
21. The prisoner (sells/ flings/ #####) the apple to the boxer/ the boxer the apple. BURGLAR SELL SOLDIER CAKE
22. The waitress (sells/ flings/ #####) the jug to the swimmer/ the swimmer the jug. TEACHER SELL DANCER CUP
23. The policeman (sells/ lends/ #####) the book to the doctor/ the doctor the book. MONK SELL PIRATE APPLE
24. The artist (sells/ lends/ #####) the hat to the nun/ the nun the hat. CHEF SELL COWBOY BANANA
25. The monk (sends/ throws/ #####) the book to the boxer/ the boxer the book. PIRATE SEND COWBOY CAKE
26. The pirate (sends/ throws/ #####) the cup to the doctor/ the doctor the cup. CHEF SEND MONK GUN

27. The nun (sends/ lends/ #####) the jug to the dancer/ the dancer the jug. WAITRESS SEND CLOWN CUP
28. The chef (sends/ lends/ #####) the ball to the pirate/ the pirate the ball. POLICEMAN SEND SWIMMER HAT
29. The cowboy (sends/ gives/ #####) the gun to the burglar/ the burglar the gun. TEACHER SEND DOCTOR APPLE
30. The artist (sends/ gives/ #####) the banana to the soldier/ the soldier the banana. PRISONER SEND SAILOR JUG
31. The chef (throws/ sends/ #####) the banana to the clown/ the clown the banana. POLICEMAN THROW NUN CUP
32. The policeman (throws/ sends/#####) the book to the soldier/ the soldier the book. PRISONER THROW DANCER BALL
33. The nun (throws/ sells/ #####) the ball to the sailor/ the sailor the ball. WAITRESS THROW PIRATE BANANA
34. The teacher (throws/ sells/ #####) the hat to the waitress/ the waitress the hat. CHEF THROW BOXER GUN
35. The dancer (throws/ gives/ #####) the cake to the doctor/ the doctor the cake. PIRATE THROW SOLDIER JUG
36. The burglar (throws/ gives/ #####) the apple to the swimmer/ the swimmer the apple. COWBOY THROW CLOWN BOOK

Appendix B

Part 2 of the post-experimental questionnaire (Part 1 asked about language history)

1. If you had to describe the experiment to someone else, what would you say?

2. What do you think the experiment was trying to measure?

3. Overall, how do you feel you did (1 means “very badly” and 10 means “very well”)?

1	2	3	4	5	6	7	8	9	10
very badly									very well

4. How did you find the task (1 means “very difficult” and 10 means “very easy”)?

1	2	3	4	5	6	7	8	9	10
very difficult									very easy

5. How would you describe the written text you saw?

6. How well-formed did you find the text?

1	2	3	4	5	6	7	8	9	10
badly formed									well-formed

7. Did you notice any mistakes in it?

8. Please list the TYPES of mistakes you noticed (if any), with one example of each:

9. If the answer to the previous question was “yes”, what percentage of the time roughly were there mistakes?

10. Was there anything your partner did that made it easier for you? If so, what was it? Thinking about it, is there anything else they could have done to make it easier, but didn’t?

11. If you had to assess the overall ability of your partner in performing the task, what would your rating be?

1	2	3	4	5	6	7	8	9	10
low ability									high ability

12. How well do you think your partner described the pictures?

1	2	3	4	5	6	7	8	9	10
very badly									very well

13. How did you find your partner’s behaviour?

1	2	3	4	5	6	7	8	9	10

very unusual very usual

14. How did your partner express him/ herself?

1	2	3	4	5	6	7	8	9	10
very badly									very well

15. While you were doing the experiment, did you get any idea of where you partner comes from? (It's all right if you didn't think about this at all – just please be honest!)

16. Was there anything else about your partner worth mentioning?

17. Was there anything that made it easier, or more difficult, to match cards sometimes than at other times? If so, what was it?

18. Have you had any experience with automatic speech transcribers before? If so, what was it?

19. What do you think an automatic transcriber serves for?

20. How efficient did you find the transcriber?

1	2	3	4	5	6	7	8	9	10
very inefficient									very efficient

21. How do you find communicating via an automatic transcriber?
    a. Does it make it easier, or more difficult, if you compare it to chatting (you have to type)?
    b. Does it make it easier, or more difficult, if you compare it to speaking on the phone (you hear the voice of the other)?

22. If you could improve anything about the automatic transcriber, what would you improve?

23. Was there any difference in your behaviour throughout the experiment:

a) No difference
b) For certain parts of the experiment (which?)
c) On particular trials (which?)

If so, what was it that you were doing in a different way?

24. If you noticed any mistakes in the written text you saw, what do you think was causing the mistakes?

THANK YOU VERY MUCH FOR YOUR HELP!!! ☺

Appendix C

Statistical model formulas

The models run on the data of Experiment 1 are provided below. The models on the data of Experiment 2 were identical, except for the data source.

Model 1. Same Verb condition vs. Different Verb and No Verb conditions. Prime Verb here is a two-level predictor:

noVerbExp1.1 <- lmer(data ~ primeVerbSamevsDiffNo*primeConstruction+ (1 + primeVerbSamevsDiffNo *primeConstruction|subj) + (1 + primeVerbSamevsDiffNo *primeConstruction|item),data=nv1,family=binomial)

Model 2. Different Verb condition vs. No Verb condition. Prime Verb here is a two-level predictor:

noVerbExp1.2 <- lmer(data ~ primeVerbDiffvsNo*primeConstruction + (1 + primeVerbDiffvsNo*primeConstruction |subj) + (1 + primeVerbDiffvsNo*primeConstruction |item),data=nv1,family=binomial)

Model 3. Simple effects of Prime Verb. Prime Verb here is a three-level predictor. In both experiments, the Prime Verb x Prime Construction interaction term was removed from the item random slopes because of convergence issues:

noVerbExp1Sim <- lmer(data ~ primeVerb + primeVerb:primeConstruction + (1 + primeVerb + primeVerb:primeConstruction | subj) + (1 + primeVerb | item), data=nv1,family=binomial)

Models run on the combined data from Experiments 1 and 2.

Model 4. Overall priming effect in Experiment 1 versus Experiment 2 (collapsing across Prime Verb conditions). The Experiment predictor is not included as a subjects random effect because the two experiments included different participants:

```
noVerbExp1_2.1 <-  lmer(data ~ primeConstruction *experiment + (1 +
primeConstruction |subj) + (1 + primeConstruction*experiment
|item),data=nv12,family=binomial)
```

The three models separately comparing the priming effect between experiments in each of the three conditions were identical to Model 4, except that the Experiment predictor was coded contrastively (-0.5 for Experiment 1, 0.5 for Experiment 2) for only the respective condition (Different Verb, Same Verb, No Verb); the remaining conditions were coded as 0.

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