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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 45(45)

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Publication Date
2023

Peer reviewed

Does *he hears a* prime *I prefer the*?
Testing a novel chunk-based perspective on structural priming

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Abstract

Repetition of linguistic structure plays a role in both language comprehension and production. Previously encountered structures are processed faster, and speakers tend to reuse them in new utterances—a phenomenon known as *structural priming*. According to one well-established interpretation of structural priming, linguistic input activates an underlying mental representation based on *constituents*, a syntactic unit derived from rule-based grammars (e.g., $[[\text{he}]_{NP}$ $[\text{hears}$ $[\text{a sound}]_{NP}]_{VP}]_{S}$). Here we ask whether structural priming can occur for non-constituent parts-of-speech fragments, such as *pronoun verb determiner* (e.g., *he hears a*). Across two preregistered phrasal decision experiments, we show that structural priming can occur at the level of three-word parts-of-speech sequences and in the absence of constituents. Using corpus analysis, we further show that structural priming of non-constituents also occurs in real-life dialogue. These results imply that constituent structure is not a necessary prerequisite for structural priming and provide a challenge to contemporary approaches to grammar.

Keywords: structural priming; multiword chunks; parts of speech; phrase structure; syntactic representation

Introduction

A long tradition in linguistic research has held that the structure of language—and its mental representation—is governed by rules (e.g., Pinker, 1999; Ullman, 2001, 2004). Research into multiword chunks, however, has begun to challenge the rule-based approach (see Contreras Kallens & Christiansen, 2022, for a review) with criticism coming from both functional (Wray, 2012) and generative perspectives (Culicover et al., 2017). A hitherto unchallenged line of evidence in favor of the rule-based approach comes from structural priming, whereby the processing of a sentence is facilitated by the previous presentation of a structurally similar sentence (e.g., Branigan & Pickering, 2017; Pickering & Ferreira, 2008). In this paper, we elicit structural priming at the level of non-constituent multiword chunks that cut across standard rule-based phrase structure representations. Indeed, we find that three-word parts-of-speech sequences (e.g., *conjunction determiner adjective*) can trigger structural priming in both language comprehension and production.

Structural Priming

Structural priming refers to the reuse or facilitated processing of recently processed syntactic structures (Pickering & Ferreira, 2008; Tooley & Traxler, 2010). In a classic demonstration, Bock (1986) had participants read aloud either a prepositional object sentence (e.g., *the boy gave the book to the girl*) or a double object sentence (e.g., *the boy gave the girl the book*). Afterwards, when participants described an unrelated picture, they tended to reuse the sentence structure they had just produced. Subsequent experiments seemed to confirm that the effect was due to abstract structural similarities between the sentence, discarding possible confounds such as the repetition of closed-class words (e.g., *to*; Bock, 1989), overlapping semantic features (e.g., animacy; Bock et al., 1992) or prominent thematic roles (e.g., patient; Bock & Loebell, 1990, but see Hare & Goldberg, 1999).

Since then, structural priming has been studied extensively (see Mahowald et al., 2016, for a meta-analysis). Priming has been demonstrated for different constructions, such as genitives (Bernolet et al., 2013), transitives and intransitives (van Gompel et al., 2012), as well as actives and passives (Bock et al., 1992). The effect occurs both in production and comprehension (Potter & Lombardi, 1998; Tooley & Traxler, 2010), and is found in multiple languages (e.g., Cai et al., 2012)—indeed, structural priming has even been observed from one language to another (Loebell & Bock, 2003).

In general, it has been claimed that the existence of priming between stimuli implies that they share some aspect of their mental representation (see Branigan and Pickering, 2017). Pickering and Ferreira (2008) construe the mental representations underlying structural priming in terms of phrase structure rules (see also Branigan et al., 1995; Pickering et al., 2002; Pickering & Branigan, 1998; Branigan & Pickering, 2017). Such rules can be used to successively break down a sentence into its constituents (see Figure 1). For example, the rule VP → V NP PP states that a verb phrase (VP) may be broken down into a verb (V), a noun phrase (NP), and a prepositional phrase (PP). Accordingly, the verb phrase *gave the book to the girl* may be analyzed as $[\textit{gave}]_{V}$ $[\textit{the book}]_{NP}$ $[\textit{to the girl}]_{PP}$. Pickering and Ferreira (2008) suggest that "structural priming can be viewed as providing evidence for the psychological reality of something like phrase structure rules, at least ones that refer to 'overt' constituents alone" (p. 435). Although there are competing explanations (e.g., implicit learning, see the General Discussion), the notion that phrase structure rules underlie structural priming has exerted a wide influence on the field.

In M. Goldwater, F. K. Anggoro, B. K. Hayes, & D. C. Ong (Eds.), *Proceedings of the 45th Annual Conference of the Cognitive Science Society*.

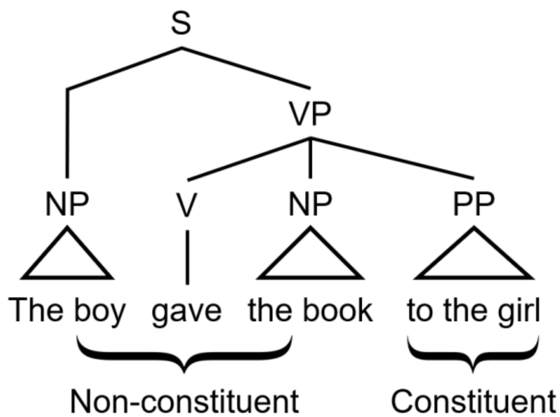

Figure 1: Phrase structure tree depicting a prepositional object sentence, with markers illustrating constituent and non-constituent structures.

The Challenge from Multiword Chunks

The approach taken by Pickering and Ferreira (2008) aligns with the traditional linguistic distinction between words and rules (e.g., Pinker, 1999: Ullman, 2001, 2004). This so-called *words-and-rules* approach envisions two types of linguistic knowledge: a lexicon of individual words containing information about their use in sentences, such as their part of speech, and a grammar of lexically independent rules used to combine words into sentences. However, the fundamental distinction between words and rules has been challenged by recent research into multiword chunks (see Contreras Kallens & Christiansen, 2022, for a review). Multiword chunks, such as idioms (*kick the bucket*), collocations (*heavy rain*), and lexical bundles (*in accordance with*) are ubiquitous in natural language, with estimates of their prevalence ranging from 20% to 50% (Nelson, 2018; see also Jackendoff, 1997). Such chunks have a processing advantage, evident in quicker reading times (Tremblay et al., 2011; Carrol & Conklin, 2020), better recall (Tremblay & Baayen, 2010), and phonetically reduced production (Arnon & Cohen Priva, 2013). This processing advantage is even apparent in early ontogeny, as young children are better at repeating frequent multiword sequences (Bannard & Matthews, 2008) and producing the correct irregular plural in the context of frequently used chunks (*brush your teeth*; Arnon & Clark, 2011). Taken together, these results imply that multiword chunks are both prevalent and psychologically real.

Multiword chunks pose a problem for the words-and-rules approach by not fitting into either category (Contreras Kallens & Christiansen, 2022; Snider & Arnon, 2012). Crucially for this paper, not all multiword chunks are constituents (see Figure 1). For instance, the lexical bundle *in the middle of the* (Tremblay et al., 2011) contains part of a prepositional phrase, but is lacking the entirety of the noun phrase implied by the corresponding phrase structure rule (i.e., PP → P NP). Such non-constituents are less studied, but seemingly no different in kind to other multiword chunks, as they likewise elicit faster reading speed (Tremblay et al., 2011) and phonetic reduction (Arnon & Cohen Priva, 2013). Like other chunks, non-constituents also show an effect of meaningfulness, that is, non-constituents rated as more meaningful tend to be processed quicker (Jolsvai et al., 2020).

Because non-constituent chunks are misaligned with phrase structure rules, they provide an opportunity to test whether non-rule-based structures can elicit structural priming. To our knowledge, only one study has previously explored this question. In an analysis of the Switchboard corpus, Reitter and Keller (2007) found that parts-of-speech bigrams (e.g., *noun preposition*) crossing syntactic boundaries were less likely to be repeated in conversation than bigrams sitting within syntactic boundaries (e.g., *determiner noun*). This finding seems to suggest that structural priming is based on constituent structure, as argued by Pickering and Ferreira (2008). However, these results are not fully conclusive. First, despite finding no short-term priming effect, Reitter and Keller did find evidence of long-term priming (from the first half of a conversation to the second half) between bigrams crossing syntactic boundaries. Second, the investigation only considered bigrams, which may not be large enough to capture a structural representation. Finally, Reitter and Keller only classify non-constituents based on whether they cross syntactic boundaries and not on whether they are fragment of a larger constituent (e.g., *a different* ____ in the context of an NP).

Overview of the Present Studies

We present two experiments (Studies 1 and 2) and a corpus analysis (Study 3), testing structural priming of non-constituent parts-of-speech fragments instantiated by three-word sequences. Following Reitter and Keller (2007), we operationalize structure as sequences of parts of speech (e.g., *with a great* reflects the structure *conjunction determiner adjective*). In Studies 1 and 2, we elicit structural priming in a phrasal decision task (Swinney & Cutler, 1979). In Study 3, we investigate priming in dialogues from the Switchboard corpus (Godfrey et al., 1992). Studies 1 and 2 were preregistered and received prior ethical approval from an internal review board at Cornell University (#IRB0143718). All preregistrations, data, analysis scripts, and materials are available on the Open Science Framework (OSF; https://osf.io/ymndq/?view_only=1b597e60b7f84c149e77cddceefbce6c).

Study 1: Non-Constituent Priming

Methods

Participants We planned to sample from 36 up to 70 participants or until the Evidence Ratio (ER)[1] of associated with our hypothesis reached a value of 10 (constituting "strong evidence"; Andraszewicz et al., 2015) in favor of

[1] In our preregistrations, we refer to "Bayes Factors" and not "Evidence Ratios." For directional hypotheses with priors symmetric around zero these terms are equivalent (Marsman & Wagen-makers, 2017).

either the null or the alternative hypothesis (Rouder, 2014). Four participants were excluded due to being non-native speakers or inattentiveness (chance-level accuracy and impossibly fast reaction times). The final sample comprised 40 (11 male, 29 female; 23 monolingual; age: M = 19.92, SD = 1.12) Cornell University undergraduates participating in exchange for course credit. Participants could complete the experiment in-person (n = 4) or online (n = 36). All participants reported being native English speakers without any auditory or visual disabilities.

Materials The stimuli were extracted from the Corpus of Contemporary American English (COCA; Davies, 2008–). The COCA consists of more than 1 billion words collected from spoken language, fiction, popular magazines, newspapers, academic texts, TV, movie subtitles, and web pages between 1990 and 2019. We extracted the most frequent three-word sequences and annotated them for parts of speech using *udpipe* (Straka & Straková, 2017) and the *universal dependencies* tagset (Nivre et al., 2020). The prime stimuli used in the experimental and control trials (see Procedure) were matched individually on their semantic similarity to the target, their length in letters, as well as their trigram, bigram, and unigram frequencies, $|t|\text{s} \leq 0.99$, $|d|\text{s} \leq 0.12$, $r\text{s} \geq .93$. Importantly, all the three-word stimuli were non-constituents—that is, they either straddled a constituent boundary (e.g., *noun verb determiner*) or consisted of a fragment of a constituent, (e.g., *verb determiner adjective*). No prime–target pairs had any overlapping words. The targets spanned 40 different parts-of-speech sequences.

Procedure The experimental task comprised an uninterrupted sequence of phrasal decisions (Swinney & Cutler, 1979) in which the subject has to determine—as quickly and accurately as possible—whether a string of three words is possible as part of an English sentence (*with a great*) or not (*under while scar*). The tasks included 320 three-word sequences, half of which were impossible sequences, all presented with a 0.5 second ISI. In 64 instances, two consecutive trials served as primes and targets (see Figure 2). The primes either had the same parts-of-speech sequence as the target (experimental trials) or not (control trials). For instance, in an experimental trial, the participant might be presented with *in a short* followed by *of the best*—both chunks with the parts of speech *preposition determiner adjective*. In the corresponding control trial, another participant would have the same target (*of the best*) preceded by an unrelated parts-of-speech sequence *conjunction pronoun auxiliary verb* (*and I must*). Experimental and control primes were counter-balanced across two lists. Participants used their dominant hand to answer "yes."

Analytic strategy We used a Bayesian linear mixed effects model with weakly regularizing priors (Sorensen et al., 2016). To account for the skewed shape of reaction time data, we used a shifted lognormal likelihood function (cf. Lo & Andrews, 2015). We included both by-participant and by-item random intercepts for each condition (i.e., the maximal random effects structure; Barr et al., 2013).[2] We report the posterior mean and 95% credibility intervals (CI) based on quantiles. Model quality checks are reported on the OSF.

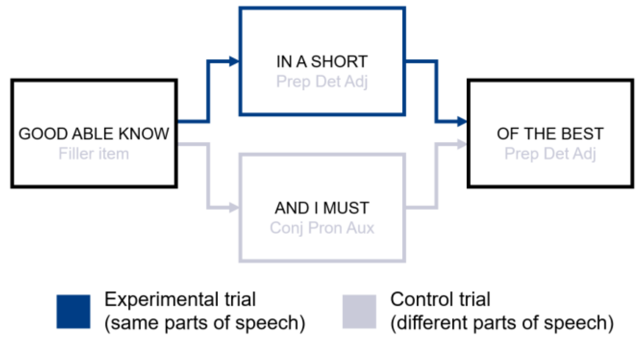

Figure 2: Three consecutive trials of the phrasal decision task. Each trial is separated by a fixation cross (not shown). In this example, *in a short* is expected to prime *of the best*, in contrast to *and I must*.

Results and Discussion

Only the target trials were used for analysis. Following Jolsvai et al. (2020), we excluded incorrect responses (n = 252), responses quicker than 200 milliseconds (n = 1), and responses slower than the upper quartile plus three times the IQR (n = 133). These criteria had to be met for both the prime and the target response. Thus, the final sample comprised 2174 trials (85% data retention).

Participants responded faster in experimental trials (M = 0.849, Mdn = 0.769, SD = 0.314 seconds) than in control trials (M = 0.881, Mdn = 0.800, SD = 0.323 seconds), yielding an overall priming effect of 32 milliseconds. The Bayesian mixed-effects model showed very strong evidence in favor of a priming effect, B = -0.067, 95% CI [-0.118; -0.018], ER = 71.29, pd = 98.62% (Figure 3, Panel A).

Our results provide preliminary evidence that structural priming can occur even with multiword chunks and in the absence of syntactic constituents. However, a possible alternative explanation is that the effect may arise simply from priming the individual parts of speech in isolation. In other words, the effect may occur at the word-level and be independent of the order of the words (see Pickering et al., 2002, for a similar inquiry in the context of phrase structure rules). If so, the effect is arguably not due to the multiword structure of the stimuli. In the second study, we sought to address this confound and to replicate our initial findings using new set of stimuli and participants. Specifically, we added an additional priming condition in which a prime stimulus (e.g., *me again and*, corresponding to *pronoun adverb conjunction*) was followed by a sequence of words with the same set of parts of speech but in the reverse order (reverse trials, e.g., *or how you*, corresponding to *conjunction adverb pronouns*).

[2] For Study 1, we preregistered a model with treatment coding, but eventually switched to the more parsimonious alternative of cell-mean coding. The preregistered model yields the same conclusion as the final model (ER = 180.82, pd = 99.45%).

Study 2: Parts-of-Speech Order Matters

Methods

Participants We used the same Bayesian sampling approach as in Study 1. Seventy-one University of Florida undergraduates participated in exchange for course credit. Fourteen participants were excluded due to being non-native speakers or inattentiveness. The final sample comprised 57 (6 male, 51 female; 46 monolingual; age: M = 19.77, SD = 2.53) All participants completed the experiment online.

Materials As in Study 1, the primes used in the experimental, control, and reverse trials were matched individually on their semantic similarity to the target, their length in letters, as well as their trigram, bigram, and unigram frequencies, $\chi^2(2) \leq 3.51$, $|d|$s ≤ 0.24, rs $\geq .72$. The targets spanned 29 different parts-of-speech sequences.

Procedure and Analytic strategy The same as in Study 1.

Results and Discussion

As before, we excluded incorrect responses (n = 729), responses quicker than 200 milliseconds (n = 1), and responses slower than the upper quartile plus three times the IQR (n = 179), yielding a final sample of 2739 trials (75% data retention).

Replicating the result of Study 1, participants responded faster in experimental trials (M = 1.058, Mdn = 0.918, SD = 0.454 seconds) than in control trials (M = 1.089, Mdn = 0.986, SD = 0.427 seconds), yielding an overall priming effect of 31 milliseconds with strong evidence, B = -0.056, 95% CI [-0.115; 0.002], ER = 16.00, pd = 94.12% (Figure 1, Panel B). In addition, participants responded slower in reverse trials (M = 1.116, Mdn = 0.996, SD = 0.454 seconds) than in the experimental trials, yielding an overall priming effect of 58 milliseconds. There was also strong evidence for this difference, B = -0.089, 95% CI [-0.154; -0.025], ER = 75.92, pd = 98.70% (Figure 3, Panel B).

The results replicate the findings of the first study. Importantly, the contrast between the experimental and reverse trials indicates that the effect is due to the multiword sequential structure rather than word-level effects, addressing the possible limitation of Study 1. Together, the first two studies provide an initial existence proof of structural priming with non-constituent parts-of-speech sequences.

There are, however, many aspects of structural priming that our two studies do not address. First, both studies lack in ecological validity. Being experimental studies, it is unclear whether their results generalize beyond the experimental context (Yarkoni, 2020). Second, the studies only address structural priming in language comprehension, whereas most previous research has focused on production (Pickering & Ferreira, 2008). Finally, one could argue that the participants are still processing the stimuli in terms of constituent structures they build up "around" the chunks. In Study 3, we sought to address these shortcomings. Previous work into structural priming has demonstrated that structural priming can be observed in actual conversations by way of corpus analysis (Gries, 2005; Gries & Kootstra, 2017). Thus, Study 3 sought to replicate this approach by analyzing structural priming of non-constituent fragments of parts of speech in a corpus of natural dialogue.

Study 3: Non-Constituent Priming in Dialogue

Methods

Data The Switchboard corpus (Godfrey et al., 1992) consists of telephone conversations spoken in different varieties of American English. We used a subset of the corpus that has been transcribed and annotated with phrase structure trees for the Penn Treebank project (Taylor et al., 2003).

Analytic Strategy To estimate the extent of structural priming between speech turns, we calculated the local linguistic alignment (LLA; Fusaroli et al., 2012; Xu & Reitter, 2015; for the conceptual relationship between priming and alignment, see Pickering & Garrod, 2004; Ferreira & Bock, 2006). The LLA quantifies the number of repetitions across speech turns standardized by the length of

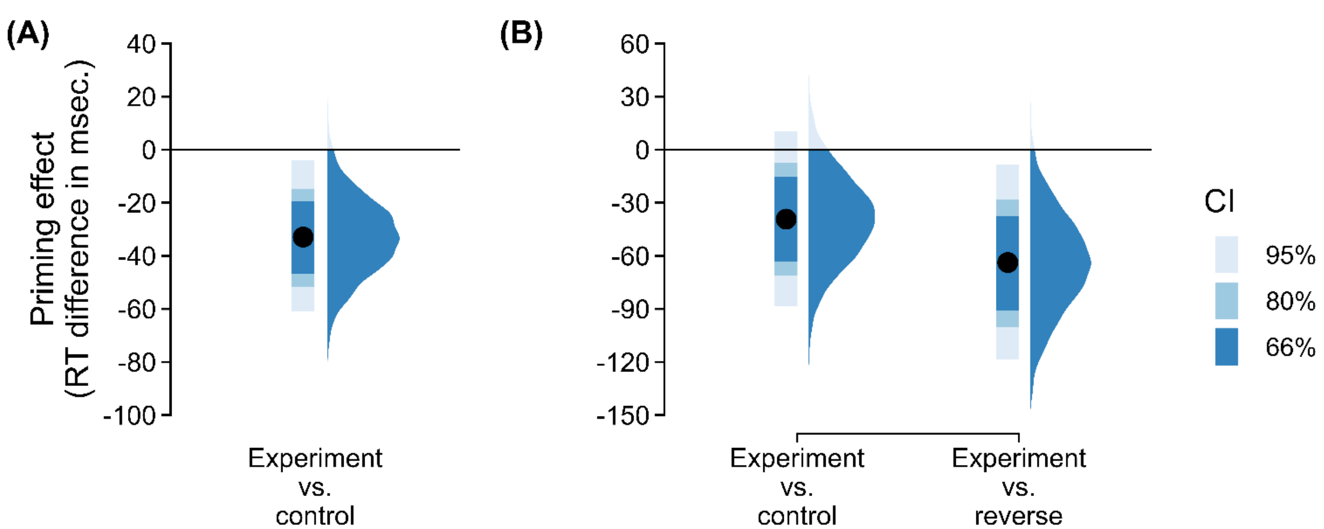

Figure 3: Predicted differences between conditions in Study 1 (Panel A) and Study 2 (Panel B).

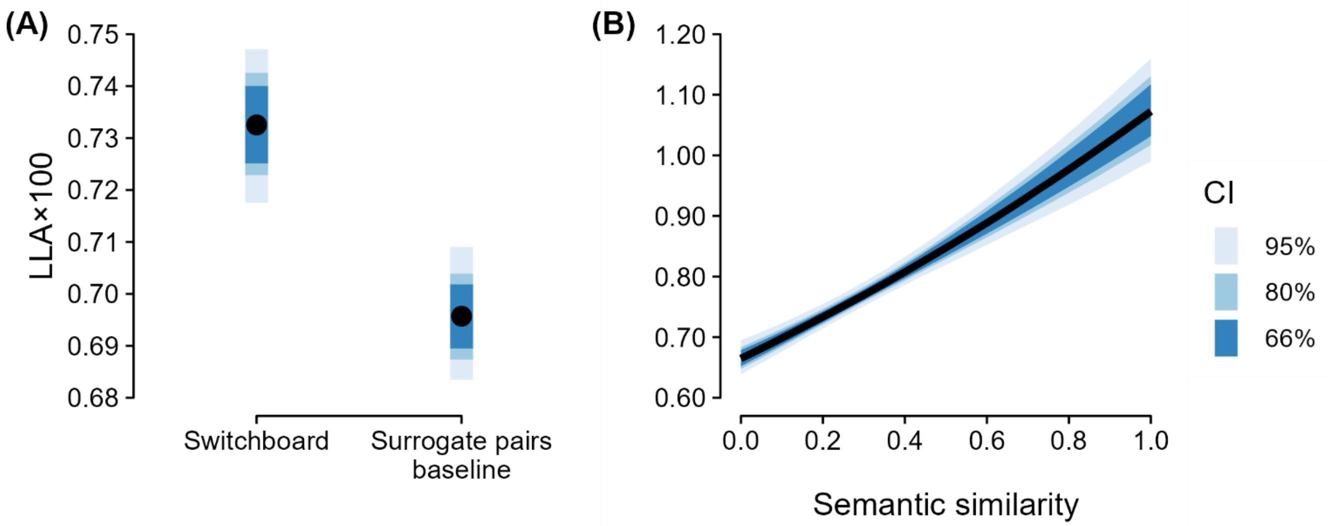

Figure 4: Predicted values of structural priming (i.e., LLA) in comparison with a surrogate pairs baseline (Panel A) and conditioned on the semantic similarity between speech turns (Panel B).

the turns. Specifically, if P and T are the parts-of-speech trigrams in the prime and target speech turns, respectively, the LLA is defined as

$$\text{LLA} = \frac{\text{Number of elements in } T \text{ also in } P}{\text{Length of } P \cdot \text{Length of } T}$$

To ensure that the estimate reflected structural priming of non-constituent chunks, we conservatively only counted repetitions that could not otherwise be explained as verbatim repetition or as priming between consecutive constituents belonging to the same larger constituent (i.e., *combinatorial nodes*; Pickering & Ferreira, 2008). Take for example the following two turns (from sw2107).

A: You said you have four cats.
pronoun verb pronoun verb numeral noun
B: I have four cats.
pronoun verb numeral noun

In total, two parts-of-speech trigrams occurs in both turns: *pronoun verb numeral* and *verb numeral noun*. However, the latter coincides with lexical repetition ("have four cats"). Moreover, the first reoccurring trigram could be explained as priming of the entire subordinate clause $[\textit{pronoun}]_{NP}[\textit{verb}\ [\textit{numeral noun}]_{NP}]_{VP}$. Thus, the non-constituent structural priming between these turns is estimated as zero. This procedure was repeated for each consecutive turns. The first turn of each conversation was discarded.

We first tested if the structural priming of non-constituent chunks occurred above chance-level. As a baseline, we constructed surrogate pairs (Dideriksen et al., 2022; Duran et al., 2019): for each speaker, we interleave their speech turns with turns from a randomly chosen speaker in a different conversation. We then fit a Bayesian mixed effects model, regressing the extent of priming on a binary variable encoding whether the data come from the original corpus or the surrogate pairs. We used an ordered beta likelihood function (Kubinec, 2022), which matches the distribution of the outcome (i.e., bound between zero and one with an excess of zeros).

As a secondary analyses, we tested if structural priming was more likely to occur across turns with semantic overlap (*the semantic boost*; Cleland & Pickering, 2003; Griffin & Weinstein-Tull, 2003; Pickering & Ferreira, 2008). To do so, we regressed the extent of structural priming on the semantic similarity between the current and previous speech turn, obtained via sentence-BERT (Reimers & Gurevych, 2019).

Results and Discussion

The results of the regression analyses are presented in Figure 4. The average level of structural priming was 0.007, which was larger than in the surrogate pairs baseline, B = -0.037, 95% CI [-0.051; -0.023], ER = ∞, pd = 100% (Figure 4, Panel A). This result indicates that speakers tend to reuse non-constituent parts-of-speech trigrams that they have just heard. The extent of priming was related to the semantic similarity between the speech turns; higher semantic predicted more structural priming, B = 0.339, 95% CI [0.270; 0.404], ER = ∞, pd = 100% (Figure 4, Panel B). This result is consistent with the semantic boost effect.

General Discussion

The nature of the mental representations subserving human language ability has been the focus of longstanding debate in cognitive science. In the present investigation, we found that three-word multiword sequences with identical parts of speech (e.g., *in a short* and *of the best*, corresponding to the structure *preposition determiner adjective*) elicited structural priming in a phrasal decision task. This effect occurred even though the sequences were non-constituents, that is, they either crossed syntactic boundaries or were an incomplete fragment of a larger phrasal constituent. We then demonstrated that structural priming of non-constituent parts-of-speech sequences can also be observed in dialogue from a naturalistic corpus. Altogether, our results encompass both comprehension and production, experimental and corpus data, and include a wide variety of structures as well as a previously documented moderation effect (i.e., the semantic boost), pointing to the psychological reality of non-constituent multiword parts-of-speech sequences.

Theoretical Implications

Structural priming has been taken as evidence for the psychological reality of phrase structure rules and constituents (e.g., Pickering & Ferreira, 2008). However, our results demonstrate that structural priming can occur with incomplete sentences and in the absence of syntactic constituents. This challenges the idea that syntactic representation revolves around phrase structure rules and constituents (Branigan & Pickering, 2017). Consider Pickering and Ferreira's (2008) proposal that phrase structure rules are encoded by combinatorial nodes that are activated whenever the corresponding phrase structure rule is encountered. For example, once the VP → V NP PP rule is applied (i.e., primed), the residual activation in the (NP, PP) node increases the likelihood of the rule being reapplied later, thereby leading to structural priming. By this hypothesis, no combinatorial nodes would be associated with non-constituent word sequences like the ones tested here, and thus no priming would be expected. It could perhaps be suggested that partial activation of one or more nodes relating to the parts-of-speech sequence explains the observed priming. However, this explanation would likely result in a kind of one-to-many structural priming, where a prime would partially activate many potential structures simultaneously, flooding the language system with pre-activation. The system would thus be less sensitive to the subtle differences in syntax that are typically used to study structural priming, and as a result, structural priming would no longer be specific to a particular construction (e.g., passives).

Our results align better with the view that structural priming is a kind of implicit learning that can be modelled in a neural network (e.g., the dual-path model; Chang et al., 2000, 2006). This type of model contains no hardwired rules regarding constituency structure, but rather discovers syntactic regularities from distributional properties of the language it perceives. As such, the model may exhibit structural priming with multiword sequences. However, it is not clear whether the model would show the kind of non-constituent parts-of-speech priming observed in our results.

Construction-based approaches to language (e.g., Culicover et al., 2017; Goldberg, 2006) provide a more natural way of capturing the prevalence of multiword chunks in language, while also accommodating previous evidence on structural priming (e.g., Hare & Goldberg, 1999). Constructions are typically understood as conventionalized mappings between form and meaning, from individual words (e.g., *aardvark, zebra*) to multiword sequences (e.g., *kick the bucket, nice of* you) to phrasal patterns (such as *the X-er, the Y-er*, e.g., *the bigger, the better*). Nonetheless, work within construction grammar tends to focus on multiword combinations that form constituents because these are the ones that have conventionalized meanings and therefore are likely to be represented. Our finding of non-constituent structural priming may thus also pose a challenge for traditional construction-based approaches to language.

Our results thus call for a more flexible framework for linguistic representations that can accommodate both constituent and non-constituent patterns. Recent exemplar-based proposals may provide part of the answer (e.g., Ambridge, 2020) but the priming of parts-of-speech patterns as shown here would seem to require some representational sensitivity to abstractions beyond the storage of individual multiword sequences. Another possibility is Goldberg's (2019) proposal where constructions are viewed as graded generalization over encountered exemplar sequences—if such constructions incorporate both constituent and non-constituent multiword chunks. However, more work is needed to integrate these results more gracefully with the theoretical proposals in the broader usage-based camp.

Limitations and Outlook

The present research has some limitations, one of which is particularly prominent: there is more to structural priming than just parts of speech. For instance, Scheepers (2003) demonstrated priming of high versus low relative clause attachment, while keeping the surface structure constant. This finding cannot be easily explained in terms of parts-of-speech sequences (nor in terms of phrase structure rules; see Loncke et al., 2011). Rather, structural priming likely exists at multiple levels (Pickering and Ferreira, 2008), and some of the structural properties of language are not apparent at the level of three-word sequences (e.g., the order of thematic roles; Bock and Loebell, 1990; Hare & Goldberg, 1999). It remains for future research to uncover the relation between structures existing at multiple levels of representation (e.g., words, multiword sequences, sentences, and beyond).

Conclusion

The notion of constituent structure has deep roots in (psycho)linguistics, appearing in multiple contemporary approaches to grammar. In particular, constituent structure has been thought to underlie the structural priming effect. We demonstrate that structural priming can occur between multiword chunks that cross constituent boundaries. These results call for us to look beyond constituents if we wish to uncover the building blocks of language.

Acknowledgments

We thank Pablo Contreras Kallens for insightful discussions and his assistance in corpus mining, Kelly Chan and April Chen for their help in generating stimuli, Felicity Frinsel for her help in setting up the experiment in-lab, Erin Westgate for access to the University of Florida student participant pool, and Riccardo Fusaroli for his guidance in conducting the statistical analyses.

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