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RESEARCH REPORT

To Err Is Human; To Structurally Prime From Errors Is Also Human

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Natural language contains disfluencies and errors. Do listeners simply discard information that was clearly produced in error, or can erroneous material persist to affect subsequent processing? Two experiments explored this question using a structural priming paradigm. Speakers described dative-eliciting pictures after hearing prime sentences that either were disfluent but with a consistent dative structure or were sentences that began as datives but were corrected to transitives (e.g., *The mechanic is giving the new part . . . uh . . . is recognizing the new part*). If an erroneous and corrected sentence fragment is discarded, then the original form of an ultimately transitive utterance should not influence future production. However, if the syntactic parse of an error is not discarded, then it should influence speakers' subsequent choice of syntactic structure. In both experiments, structural priming was significantly reduced when primes were corrected to a non-dative structure (relative to disfluent but ultimately dative primes). However, target descriptions did show an influence from corrected errors when the prime and target shared the same verb. Thus, a parse mapping a verb to a specific argument structure can persist despite being explicitly marked as an error, reflecting the incremental and predictive nature of comprehension.

Keywords: syntactic priming, parsing, errors, repairs

Speakers are generally quite accurate in their speech, only producing speech errors on about eight of every 10,000 words (Garnham, Shillcock, Brown, Mill, & Cutler, 1981). Nevertheless, speakers do make errors when something goes wrong in planning or production or simply when they change their minds about what to say. These errors could pose difficulty for listeners, who not only must attempt to understand what a speaker says, but also must recognize that some of what the speaker said was not part of the intended utterance. As an example, consider listening to this quote from a former U.S. president:

> A parent can send the school—a child to a different public school. In other words, when—there has to be accountability in order for a—I mean, there has to be a consequence in order for an accountability system to work. (George W. Bush on the No Child Left Behind Act, May 11, 2004)

Because parsing is incremental and predictive (e.g., Altmann & Kamide, 1999), someone listening to this speech could take the first sentence to be a double-object dative (*A parent can send the school a child*) but when the listener then hears a prepositional phrase, he or she must somehow eliminate *the school* from the original parse to reach a final analysis of the sentence as a prepositional dative (*A parent can send a child to a different school*).

One way that the parser could deal with errors such as these is to simply discard the erroneous parse. This fits with the idea that errors and disfluencies lie outside the linguistic system (Chomsky, 1965) and so have nothing to do with the speaker's intended message. A considerable amount of psycholinguistic research makes this assumption, at least implicitly, by focusing on "ideal delivery" utterances. By this account, when the parser recognizes an error, that information is dropped (or perhaps actively suppressed) from the listener's incremental parse of the speaker's utterance. Some evidence for this comes from findings that listeners are actually quite poor at detecting errors in others' speech (Ferber, 1991; Tent & Clark, 1980), suggesting that these departures from ideal production were not robustly encoded.

On the other hand, listeners might not completely discard parsed errors. One reason to maintain corrected information is that speakers sometimes refer back to that material. For example, a sentence like "*Pass me the latest issue of JEP:LMC . . . um, I mean, the previous one*," would be difficult to interpret if the corrected material "*latest issue of JEP:LMC*" had been completely discarded. In addition, erroneously produced material might provide listeners with useful information. This is because speech errors are not random events, but occur as a function of the difficulty of material being produced (Beattie & Butterworth, 1979), speakers' beliefs (cf. McKenzie & Nelson, 2003), and speakers' communicative goals (e.g., Ekman, 1985). Because of this, the errors that speakers make might provide some collateral information about their cognitive states and beliefs.

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Indirect evidence that comprehended errors might persist comes from investigations of garden-path sentences such as "*While Anna dressed the baby spit up on the bed*." These sentences contain a temporarily syntactic ambiguity such that readers tend to initially interpret "the baby" as the direct object of "dressed" rather than as the subject of the embedded clause. This leads readers to an incorrect transitive parse (a so-called *garden path*), which is typically reflected in longer reading times compared to an unambiguous sentence where the correct intransitive structure is indicated by a comma (i.e., *While Anna dressed, the baby spit up on the bed*). After reading sentences like these, participants are more likely to respond "yes" to questions like "Did Anna dress the baby?" following ambiguous sentences than following unambiguous sentences (Christianson, Hollingworth, Halliwell, & Ferreira, 2001), suggesting that something of the incorrect/discarded parse lingers to influence listeners' interpretations. Participants also tend to paraphrase these garden-path sentences in a way that suggests the persistence of the garden-path interpretation (e.g., by rephrasing the example above as "*Anna dressed the baby and it spit up on the bed*"; Patson, Darowski, Moon, & Ferreira, 2009).

A more implicit demonstration of the persistence of incorrect garden-path parses comes from van Gompel, Pickering, Pearson, and Jacob (2006), who relied on *structural priming*, that is, speakers' tendency to repeat recently processed syntactic structures (Bock, 1986; Pickering & Ferreira, 2008). Their participants completed sentence fragments after reading the same type of garden-path sentences as used by Christianson et al. (2001), and they more often produced transitive completions after reading ambiguous garden-path sentences, and intransitives following unambiguously intransitive sentences. These results again suggest that aspects of the inappropriate interpretation of garden-path sentences persist. However, it is important to realize that these findings may or may not reflect persistence of the syntactic parse. Although the persistence of a transitive structure is syntactic, transitives and intransitives ultimately express two very different messages; thus, these findings could instead reflect persistence at a semantic or prosodic level (as van Gompel et al., 2006, have acknowledged). Nevertheless, these data show that at least some aspects of a garden-path analysis can persist to affect listeners' interpretations.

This persistence of garden-path interpretations shows that listeners do not entirely eliminate material that is unintended by the speaker. This might, however, be a different situation from what happens when speakers (implicitly or explicitly) signal that they have changed their minds or said something that they did not intend to say. Nevertheless, it seems that even information that is explicitly corrected can persist. Listeners give higher acceptability ratings to sentences like "*The girl chosen, uh, selected for the role celebrated with her parents and friends*" than to sentences like "*The girl picked, uh, selected for the role celebrated with her parents and friends*" (Lau & Ferreira, 2005). Presumably, this is because the verb "chosen" activates a passive reduced relative clause structure, which persists long enough to make the local ambiguity at "selected" easier to understand (whereas "picked" is just as structurally ambiguous as "selected"). Similarly, people rate sentences like "*Mary will throw, uh, put the ball*" as more acceptable than "*Mary will put the ball*," presumably because the initial structure of "throw" makes the lack of a prepositional phrase seem more acceptable (F. Ferreira, Lau, & Bailey, 2004).

Although these findings show that erroneous and corrected material influences off-line grammaticality judgments, evidence for an effect of corrected errors on *on-line* processing remains elusive. Corley (2010) monitored listeners' eye movements around a display of objects while they listened to sentences with corrected errors like "*The boy will eat, uh, move the cake*." If the corrected verb (*eat*) persists, then listeners should show anticipatory fixations on edible things (here, by looking at a picture of a cake in a display where *cake* is the only edible object; cf. Altmann & Kamide, 1999). However, listeners did not preferentially focus on any particular object in this condition, suggesting that the error (*eat*) was successfully overwritten by the repair (*move*).[1] In a similar task, Shuval, Konieczny, and Hemforth (2011) not only found no evidence for persistence of corrected errors in terms of predictive eye movements, but they actually found that listeners looked *less* at pictures corresponding to erroneous and corrected material, suggesting that corrected errors may even have been suppressed.

In sum, listeners show persistent activation of eventually incorrect analyses of garden-path sentences where there is no explicit marker of an incorrect parse, as evidenced by post-sentence comprehension questions (Christianson et al., 2001), paraphrases (Patson et al., 2009), and priming from the initial parse (van Gompel et al., 2006). Evidence for persistence of corrected errors, on the other hand, is mixed: When listeners hear a corrected error, they show effects of the structural analyses of that error on "off-line" measures (F. Ferreira et al., 2004; Lau & Ferreira, 2005) but show little effect of such errors on patterns of anticipatory eye movements (Corley, 2010; Shuval et al., 2011). Thus, it is not yet clear if listeners maintain the parse of a corrected error or if such material is eliminated in favor of the corrected utterance.

The goal of the experiments described below was to determine if the syntactic parse of a discarded analysis persists even when the to-be-discarded information was clearly corrected. As in van Gompel et al. (2006), we relied on structural priming as an implicit measure of the persistence of a syntactic parse; however, we employed the English dative alternation (where the alternating forms are propositionally equal) to minimize the contribution of semantic information to priming. Specifically, these experiments presented participants with sentences that appeared to be of dative syntax but were then corrected to a non-dative (transitive) structure (e.g., *The architect is handing the plans . . . um . . . is admiring the plans*) and then looked to see if the erroneously produced sentence-fragment influenced participants' subsequent syntactic production.

The evidence discussed above from sentence acceptability ratings, question answering, and priming from garden-path sentences (whether it be structural or otherwise) is consistent with the claim that syntactic information lingers; thus, these corrected sentence fragments might lead to structural priming. However, the error in sentences like these is not even a complete sentence, and it is not clear that a disfluent and only partially produced sentence can lead to structural priming. And even if such fragments can lead to

[1] Note, however, that Corley (2010) did find an effect of corrected errors later in the sentence, suggesting that while listeners were able to quickly override errors, they nonetheless exerted some influence on later processing.

priming, explicit error signals and corrections might cue the parser to simply discard the erroneous parse, which would therefore not influence future production. Furthermore, while some evidence suggests that aspects of comprehended errors can persist, there is still no evidence that unambiguously shows persistence of an erroneous *syntactic* parse, as previous findings could be due to semantic or thematic persistence.

Experiment 1

In Experiment 1, participants listened to prime sentences that contained several disfluencies and corrected errors, then they described dative eliciting pictures. These prime sentences were either standard (though disfluent) datives or were sentences that started with a fragment of a dative structure, but were then corrected to a transitive structure. The influence of the standard datives and of the corrected dative fragments was assessed by examining the extent of structural priming—that is, the extent to which participants repeated the specific dative structure of a prime (or erroneous and corrected prime fragment) when describing a target picture.

Method

Participants. Forty-eight University of California, San Diego (UCSD) undergraduates participated in Experiment 1 in exchange for course credit. One participant who responded "false" on every comprehension question was excluded from analysis. All participants reported learning English as their native language.

Materials. Prime stimuli consisted of 24 sentences adapted from Pickering and Branigan (1998) that were digitally recorded by a native English speaker and contained a number of deliberate disfluencies and corrections. Each sentence item occurred in a prepositional-dative (PD) form (e.g., *The mechanic is giving the new part . . . to the driver*), a double-object-dative (DO) form (e.g., *The mechanic is giving the driver . . . the new part*), or as a sentence beginning as a dative but corrected to a transitive structure. These corrected sentences were created by cross-splicing the recorded PD and DO stimuli with recorded transitive utterances in which the transitive verb was preceded by a disfluency marker (e.g., *The mechanic is, uh . . . is recognizing the new part/the driver*), resulting in two additional conditions: PD corrected to transitive (e.g., *The mechanic is giving the new part . . . uh . . . is recognizing the new part*) and DO corrected to transitive (e.g., *The mechanic is giving the driver . . . uh . . . is recognizing the driver*). Thus, these corrected stimuli were identical to the non-corrected versions until the disfluency marker (*uh*) and transitive correction. These four prime conditions were counterbalanced across four lists such that each item appeared an equal number of times in each condition across the experiment, and such that each participant was presented with each item only once. A simple true/false comprehension question was created for each sentence (half true and half false) to encourage participants to attend to the sentences. A line-drawn picture of a dative action was paired with each item in order to elicit target utterances.

Procedure. The experiment was administered with PsyScope 1.2.5 (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants were told that they were participating in an experiment investigating how disfluencies affect language processing, so they should expect many of the sentences that they heard to contain disfluencies. Each trial began with an auditorily-presented sentence (the *prime*), followed 500 ms later by a dative-eliciting picture (the *target*). After participants finished producing a sentence describing the picture, they pressed a button to read and answer a true/false comprehension question about the prime sentence.

Analysis. Participants' target picture descriptions were digitally recorded and later coded as PDs or DOs. Trials in which participants did not describe pictures with an alternating dative structure or incorrectly answered post-trial comprehension questions were excluded from the analysis, leading to the exclusion of 28.6% of all utterances. In this and all experiments reported here, data were analyzed with logistic mixed-effects models using orthogonal contrast coding (see Jaeger, 2008) as implemented in the lme4 package (Bates, Maechler, & Bolker, 2011) in R Version 2.14.1 (R Development Core Team, 2011). *Prime structure* (PD or DO) and *corrected prime structure* (ultimately dative or ultimately transitive) were treated as fixed effects, and participants and items were treated as crossed random effects with maximal random effects structure. Parameter estimates were calculated with maximum likelihood modeling, and the statistical significance of individual fixed-effect estimates was determined with the Wald z statistic. For readability and for purposes of graphical presentation, values are described as proportions rather than as log-odds ratios.

Results and Discussion

Figure 1 shows the proportion of prepositional datives produced as a function of prime structure (PD or DO) and corrected prime structure (ultimately dative or ultimately transitive). Overall, speakers produced 16.7% more PDs after PD primes than after DO primes (a significant main effect of prime structure; see Table 1 for statistical results). This effect interacted with corrected prime structure, showing that while ultimately-dative primes strongly influenced speakers' subsequent syntactic choices (leading to a 27.3% priming effect), primes that were only partially produced as datives and ultimately corrected to transitives did not lead to significant priming.

Participants correctly answered 88% of the comprehension questions overall. Although accuracy did not vary significantly by condition, there was a marginally significant main effect of corrected prime structure (see Table 1), reflecting participants' somewhat lower accuracy on questions about primes corrected to transitives than on questions about primes that were consistently datives.

These results show that speakers do not show priming from non-completed dative sentences that were corrected to transitives, which implies that the parser successfully discards comprehended material that was clearly produced erroneously. This conclusion is surprising, however, based on other evidence that comprehension and production can be influenced by material that is contrary to the final parse (e.g., Lau & Ferreira, 2005; van Gompel et al., 2006). Furthermore, the corrected conditions did show a small numeric (albeit non-significant) priming effect. In addition, the verbs that participants used in their target descriptions repeated the verb from the corresponding prime utterance significantly more often in the ultimately-dative than in the ultimately-transitive conditions (55% vs. 40% repeated verbs, respectively). Given evidence that verb repetition increases the size of priming effects overall (the "lexical

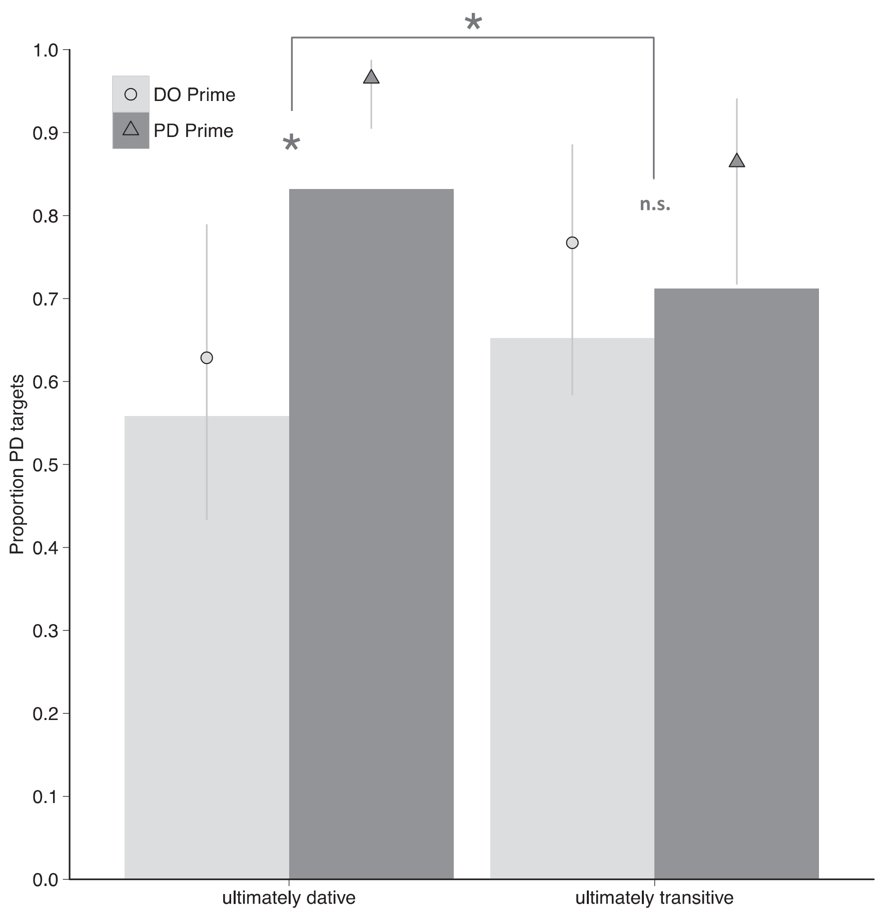

Figure 1. Proportion of prepositional-dative picture descriptions produced in Experiment 1 as a function of prime condition (prepositional-dative [PD] or double-object-dative [DO]) and corrected prime condition (ultimately dative or ultimately transitive). The bar graph represents raw proportions (averaged over subject means), and the superimposed dot plot represents model estimates (transformed to proportions), with confidence intervals for these estimates indicated via error bars. An asterisk indicates significant differences ($p < .05$) for the prime structure by corrected prime structure interaction and for the simple main effect in the ultimately dative condition; "n.s." indicates the non-significant simple main effect in the ultimately transitive condition.

boost"; Pickering & Branigan, 1998), it may be that verb repetition accounts for part of the difference in priming between these two conditions.

This possibility gains some support from a post hoc analysis that includes verb repetition as a factor. Specifically, a significant interaction between verb repetition and prime structure reflects a difference in the size of the priming effects for both types of primes as a function of verb repetition. Most relevant here are the ultimately-transitive conditions, in which target trials that included the dative verb from the prime fragment showed a 7.4% priming effect, whereas trials where prime and target verb differed showed only a 3.9% effect. This suggests that we might only observe significant priming from corrected sentence fragments when prime fragments and target sentences use the same verb. This conclusion is tentative, however, as verb repetition was not an experimentally manipulated factor, and so other causes for this pattern are possible (e.g., participants might have been more likely to repeat verbs when they better remembered the prime sentence, and this better memory, rather than the repeated verb, might have led to greater priming effects).

There is another potentially relevant difference between the ultimately-dative and ultimately-transitive conditions in Experiment 1: All ultimately-transitive primes included a disfluency (followed by a repair) immediately following the first post-verbal noun phrase (NP; e.g., *The mechanic is giving the driver . . . uh . . .*). In contrast, though the ultimately-dative sentences did include disfluencies and pauses, they did not systematically occur after the first post-verbal NP. Given that disfluencies can lead to significant effects on parsing (e.g., Bailey & Ferreira, 2003; Corley, MacGregor, & Donaldson, 2007), it is possible that the "standard" priming effects in the ultimately-dative conditions could be significantly reduced were disfluences to occur in that same location.

Experiment 2

Experiment 1 found no significant priming effect from the parse of erroneous, partially-produced structures; however, the numeric pattern in these conditions makes it difficult to dismiss the possibility that partial parses of erroneous material are not completely

Table 1
Fixed-Effect Model Coefficients and Statistical Tests From Experiment 1

Statistical test	Coefficient	*SE*	*z*	*p*
Syntactic priming				
(Intercept)	1.72	0.41	4.23	<.001
Prime structure	1.72	0.30	5.82	<.001
Corrected prime structure	0.41	0.24	1.75	<.10
Structure × Corrected Structure	2.17	0.54	4.04	<.001
Simple main effects, where prime condition = ultimately dative				
(Intercept)	1.94	0.44	4.38	<.001
Prime structure	2.91	0.45	6.44	<.001
Simple main effects, where prime condition = ultimately transitive				
(Intercept)	1.48	0.39	3.83	<.001
Prime structure	0.49	0.32	1.51	*ns*
Comprehension question accuracy				
(Intercept)	−3.31	0.37	−8.88	<.001
Prime structure	−0.09	0.40	−0.23	*ns*
Corrected prime structure	−0.93	0.49	−1.87	<.10
Structure × Corrected Structure	−0.85	0.61	−1.41	*ns*
Post hoc analysis of prime-target verb repetition				
(Intercept)	−0.18	0.29	−0.64	*ns*
Corrected prime structure	0.90	0.19	4.79	<.001
Post hoc analysis including verb repetition				
(Intercept)	2.01	0.56	3.60	<.001
Prime structure	0.69	0.46	1.51	*ns*
Corrected prime structure	0.34	0.40	0.84	*ns*
Verb repetition	−0.04	0.38	−0.10	*ns*
Structure × Corrected Structure	1.84	0.94	1.96	<.10
Structure × Verb Repetition	2.11	0.60	3.54	<.001
Corrected Structure × Verb Repetition	0.17	0.56	0.30	*ns*
Structure × Corrected Structure × Verb Repetition	1.45	1.16	1.26	*ns*

Note. The maximal random effects structure (i.e., all random intercepts and slopes) was included in all analyses with the exception of the post hoc analysis including verb repetition, in which the random slope for the three-way interaction term by items had to be removed for the model to converge.

discarded and can persist to affect future processing. Experiment 2 aimed to determine if this numeric effect is reliable by replicating Experiment 1 with two modifications: First, participants in Experiment 2 were constrained to use the verb from the prime fragment in their target descriptions. This was expected to increase the size of priming effects overall (Pickering & Branigan, 1998), thus allowing for the detection of relatively subtle effects that might result from the corrected-to-transitive primes. Second, the prime sentences in the ultimately-dative conditions were edited to include a filled pause (*uh* or *um*) following the first post-verbal NP, making these conditions identical to the corrected-to-transitive primes until the onset of the repair itself. Based on evidence that fillers like *um* and *uh* have rapid effects on comprehension (e.g., Corley et al., 2007), prime sentences with such filled pauses might lead to relatively smaller priming effects than would fluent utterances.

Method

Participants. Forty-eight University of Maryland undergraduates participated in Experiment 2 in exchange for course credit. Data were unavailable from two participants because of equipment problems and from one participant who did not produce any analyzable target descriptions. All participants reported learning English as their native language.

Materials and procedure. The sentence priming stimuli were identical to those used in Experiment 1, with two exceptions: First, the ultimately-dative prime sentences were edited to include a disfluency marker (*uh* or *um*) in the same location as the disfluency marker in the ultimately-transitive primes—that is, following the first post-verbal NP (e.g., *The mechanic is giving the new part . . . uh . . . to the driver*). Second, target pictures now included the dative verb used in the corresponding prime sentence printed at the bottom of each picture, and participants were instructed to use that verb in their description. The procedure was also identical to Experiment 1, except the task was administered using PsyScope X (Build 57; Bonatti, n.d.). As in Experiment 1, the design of Experiment 2 crossed the within-participants manipulations of prime structure (PD or DO) with corrected prime structure (ultimately dative or ultimately transitive).

Results and Discussion

As in Experiment 1, target utterances were coded as prepositional datives or double object datives. Trials in which participants did not correctly answer the comprehension question were excluded from analysis, as were trials in which participants did not produce an alternating dative structure, leading to the exclusion of 23.1% of all trials.

Figure 2 shows the proportion of prepositional datives produced as a function of prime structure (PD or DO) and corrected prime structure (ultimately dative or ultimately transitive). Participants in Experiment 2 produced 15.8% more PDs after PD than DO primes (a significant main effect of prime structure; see Table 2 for statistical results) and showed greater structural priming effects from ultimately-dative primes than from ultimately-transitive primes (an interaction between prime structure and corrected prime structure). Ultimately-dative primes led to a significant 25.1% priming effect, even with disfluency markers following the first post-verbal NP. Dative primes that were ultimately corrected to transitives led to a smaller, but still significant, 6.2% priming effect. Participants correctly answered 86.9% of the comprehension questions in Experiment 2, and accuracies did not differ significantly by condition.

It is worth noting that the priming effect in the ultimately transitive conditions was approximately 13% when calculated from the statistical model, which is notably larger than the 6.2% estimate obtained by calculating mean proportions over participants. This discrepancy results from substantial variability across participants *and* items in overall dative structure preference (reflected in random intercepts) and in the extent to which participants and items showed priming effects (reflected in random slopes). Averaging over items obscures this item-based variability, which in this case leads to a smaller estimated effect. Model estimates and raw data averages gave relatively similar estimates in Experiment 1, reflecting greater consistency across items (i.e., smaller item random effects) than in Experiment 2. It is unclear exactly why responses across items were more variable in Experiment 2; however, the consistent numerical pattern of data across experiments suggests that the priming effect from corrected errors exists, but is relatively small. In light of these differences, we report both model estimates and aggregated raw data in the figures.

Experiment 2 shows that partially produced material that is discarded from the eventual parse of a sentence can still linger to affect future processing, at least when that future processing involves the same verb as in the prime. In addition, the substantial priming effect in the ultimately-dative conditions suggest that

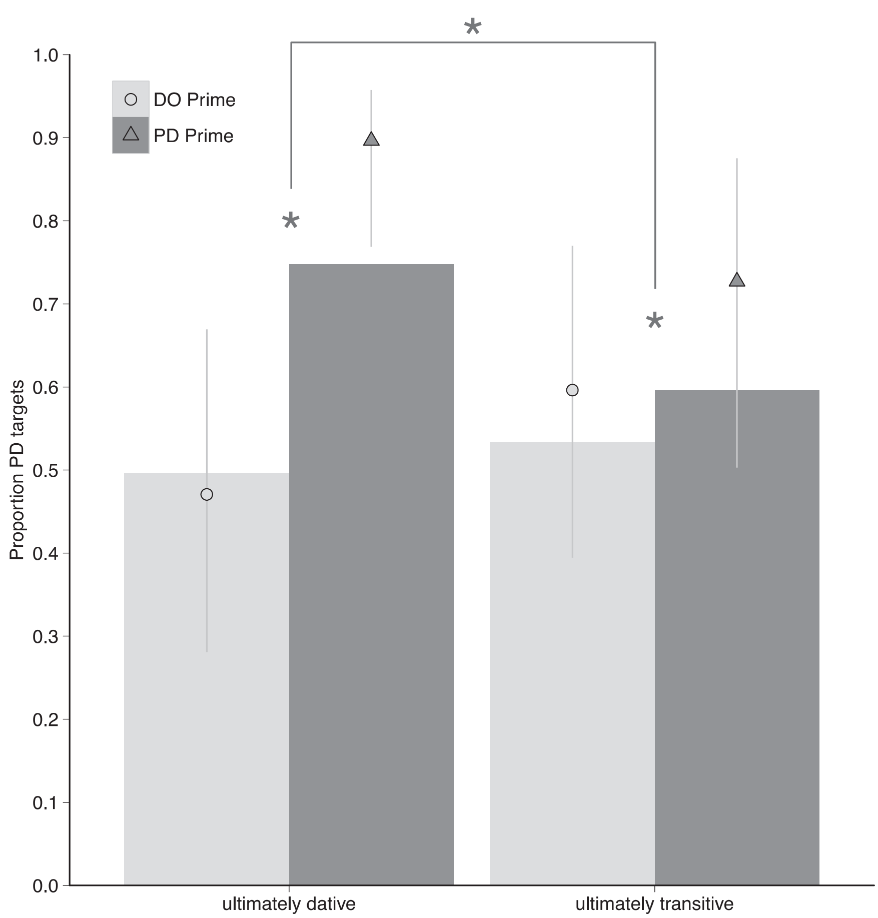

Figure 2. Proportion of prepositional-dative picture descriptions produced in Experiment 2 as a function of prime condition (prepositional-dative [PD] or double-object-dative [DO]) and corrected prime condition (ultimately dative or ultimately transitive). The bar graph represents raw proportions (averaged over subject means), and the superimposed dot plot represents model estimates (transformed to proportions), with confidence intervals for these estimates indicated via error bars. An asterisk indicates significant differences ($p < .05$) for the prime structure by corrected prime structure interaction and for the simple main effects in the ultimately transitive and in the ultimately dative conditions.

Table 2
Fixed-Effect Model Coefficients and Statistical Tests From Experiment 2

Statistical test	Coefficient	*SE*	*z*	*p*
Syntactic priming				
(Intercept)	0.87	0.41	2.13	<.05
Prime structure	1.46	0.25	5.88	<.001
Corrected prime structure	0.35	0.25	1.39	*ns*
Structure × Corrected Structure	1.73	0.49	3.53	<.001
Simple main effects, where prime condition = ultimately dative				
(Intercept)	1.02	0.40	2.58	<.01
Prime structure	2.16	0.35	6.15	<.001
Simple main effects, where prime condition = ultimately transitive				
(Intercept)	0.66	0.40	1.65	<.10
Prime structure	0.59	0.29	2.02	<.05
Comprehension question accuracy				
(Intercept)	2.70	0.31	8.66	<.001
Prime structure	−0.29	0.26	−1.14	*ns*
Corrected prime structure	−0.37	0.38	−0.97	*ns*
Structure × Corrected structure	0.95	0.49	1.93	<.10

Note. The maximal random effects structure (i.e., all random intercepts and slopes) was included in all analyses.

syntactic priming is robust to the occurrence of filled pauses (although note that it is not possible to directly compare the size of the priming effects in Experiments 1 and 2 because of other differences between the experiments).

General Discussion

These experiments showed that comprehended errors are not always fully discarded, even when marked with disfluencies and corrections. This complements and extends work that has used meta-linguistic judgments to show the persistence of comprehended errors (F. Ferreira et al., 2004; Lau & Ferreira, 2005) and of initial analyses of garden-path sentences (Christianson et al., 2001) by using structural priming as an implicit measure of persistence. These data also extend previous demonstrations of priming from initial analyses of garden-path sentences (van Gompel et al., 2006), as the priming effects found in the current experiments are unambiguously syntactic in nature and occurred following a prime that was only partially produced before being corrected.

Importantly, the influence that comprehended errors exert on future syntactic production appears to be relatively weak, suggesting that listeners are quite good at discarding the syntactic parse of comprehended material that turns out to have been produced in error. This fits with findings that listeners' anticipatory eye movements appear to be unaffected by corrected errors (Corley, 2010; Shuval et al., 2011), at least when those corrections are prefaced by filled pauses like *um*. Hearing an error and correction appears to signal listeners to stop predicting upcoming semantic information (cf. Corley et al., 2007), and these data show that listeners less robustly predict upcoming *syntactic* information after corrections as well.

Still, it is not the case that listeners are entirely uninfluenced by errors. Instead, the structure of target utterances was influenced by the only partially realized syntax of comprehended errors, at least when target utterances included the verb used in the prime fragments. This suggests that structural priming from corrected sentence fragments may reflect persistence of lexically dependent aspects of the parse (i.e., persistence of the transient mapping of a specific verb with a specific argument structure; e.g., Melinger & Dobel, 2005; Pickering & Branigan, 1998) rather than persistence of abstract syntax (e.g., Chang, Dell, & Bock, 2006). Under this account, hearing a filled pause and correction causes listeners to stop predicting upcoming syntactic structure, thus leaving them with an incomplete structural analysis of the error material that is insufficient to produce lexically independent structural priming. However, the error material also pairs specific verbs with specific dative structures, and this pairing appears to be sufficient to produce verb-specific structural priming. This fits with recent conceptions of structural priming arising from both lexically dependent and lexically independent mechanisms (V. S. Ferreira & Bock, 2006). This also suggests that incomplete sentences *not* explicitly halted and corrected might yet produce lexically-independent priming effects based on listeners' predictive activation of complete abstract structures (see Melinger & Dobel, 2005, for evidence that complete sentences are not necessary to produce structural priming).

It is important to acknowledge that the errors and disfluencies used in these experiments were not naturally produced. This was a necessary limitation in order to preserve experimental control and to generate a sufficient number of appropriate errors. However, the artificial errors and disfluencies used here might differ in important ways from natural errorful and disfluent speech. In particular, the type of error used in these experiments is uncommon: In an analysis of the Switchboard corpus, Lau and Ferreira (2005) found that only 4.2% of tagged disfluencies were word replacements, and only 16.5% of those replacements were verb replacements. It is possible that the unusually high incidence of verb replacement errors in these stimuli (or any other unintended difference between these stimuli and naturally produced errors) could have changed participants' parsing strategies, and so it would thus be useful for future research to investigate these same questions using naturally produced speech errors. Nevertheless, these data show that the syntactic parse of errors can persist, at least under these conditions, and add to growing body of work investigating how listeners deal with disfluency and errors.

The persistence of errors shown here and elsewhere is likely an inevitable effect of an incremental and predictive system. It may even be advantageous for listeners to be influenced by speakers' errors if, for example, errors "leak" information about their knowledge that might be useful for the listener to know (cf. Wardlow Lane, Groisman, & Ferreira, 2006). However, while perceived errors and temporary mis-parses like garden paths can persist, this persistence is relatively weak: Listeners are sensitive to error signals and corrections, and they appear to effectively avoid making predictions based on errors. Overall, these data suggest that our parsing system is optimized to be both predictive and sensitive to error.

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