

The Manuscript That We Finished: Structural Separation Reduces the Cost of Complement Coercion

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Two eye-tracking experiments examined the effects of sentence structure on the processing of complement coercion, in which an event-selecting verb combines with a complement that represents an entity (e.g., *began the memo*). Previous work has demonstrated that these expressions impose a processing cost, which has been attributed to the need to type-shift the entity into an event in order for the sentence to be interpretable (e.g., *began writing the memo*). Both experiments showed that the magnitude of the coercion cost was reduced when the verb and complement appeared in separate clauses (e.g., *The memo that was begun by the secretary; What the secretary began was the memo*) compared with when the constituents appeared together in the same clause. The moderating effect of sentence structure on coercion is similar to effects that have been reported for the processing of 2 other types of semantically complex expressions (inanimate subject–verb integration and metonymy). We propose that sentence structure influences the depth at which complex semantic relationships are computed. When the constituents that create the need for a complex semantic interpretation appear in a single clause, readers experience processing difficulty stemming from the need to detect or resolve the semantic mismatch. In contrast, the need to engage in additional processing is reduced when the expression is established across a clause boundary or other structure that deemphasizes the complex relationship.

Keywords: coercion, relative clauses, clefts, eye movements, sentence complexity

Sometimes the intended meaning of a sentence cannot be composed from the meanings of its words and the syntactic relations between them but instead must be attained in a less-well-specified manner such as adopting a figurative interpretation. Psycholinguists have extensively debated how the processing of such *semantically complex expressions* is related to the processing of more literal language. An early account of figurative-language processing was the *standard pragmatic model* (Grice, 1975; Searle, 1979), which was characterized by psycholinguists as an *indirect-access model* (e.g., Clark & Lucy, 1975; Janus & Bever, 1985; for reviews, see Glucksberg, 1991, 2001, 2003). According to the indirect-access model, the processing of semantically complex expressions involves the following steps: (a) the comprehender computes the literal meaning of an expression using the stored meanings of lexical entries; (b) the comprehender determines whether the literal meaning of the expression seems appropriate in the broader sentence context or whether it instead seems

“defective” (Searle, 1979); and (c) if the literal meaning is defective, the comprehender searches for an alternative meaning. The indirect access model thus predicts longer processing times for nonliteral or noncanonical expressions, compared with literal expressions.

Although the indirect-access model received some early empirical support, later studies found that semantically complex meanings can be computed rapidly given a sufficiently supportive context (Frisson & Pickering, 1999; Gerrig & Healy, 1983; Inhoff, Lima, & Carroll, 1984; Ortony, Schallert, Reynolds, & Antos, 1978; Shinjo & Myers, 1987) and in some cases may be activated before a literal interpretation (Gildea & Glucksberg, 1983; Glucksberg, Gildea, & Bookin, 1982; Keysar, 1989). Given these findings, the indirect-access model was challenged by a *direct-access model* (Gibbs, 1994; Gibbs & Gerrig, 1989; Glucksberg, 1991, 2003), according to which comprehenders use contextual information to immediately select the intended meaning of a word or expression, so that priority in processing is not necessarily given to either the literal or semantically complex interpretation. While these findings led many psycholinguists to see the indirect-access model as discredited, a number of studies investigating a variety of figurative language forms have continued to produce patterns of results that are consistent with its prediction that semantically complex expressions should take more time to process than literal expressions (e.g., Coulson & Van Petten, 2002, 2007; De Grauwe, Swain, Holcomb, Ditman, & Kuperberg, 2010; Dews & Winner, 1999; Filik & Moxey, 2010; Giora, Fein, & Schwartz, 1998; Honeck, Welge, & Temple, 1998; Lai, Curran, & Menn, 2009; Lowder & Gordon, 2012, 2013; Schwoebel, Dews, Winner, & Srinivas, 2000; Tarter, Gomes, Dubrovsky, Molholm, & Stewart, 2002; Temple & Honeck, 1999). These findings indicate that

This article was published Online First July 7, 2014.

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This research was supported by R01 HD060440-06A2 from National Institute of Child Health and Human Development. We thank Mariah Moore and Mike Deigan who served as coders in our predictability study. We also thank Rachael Jones and Kristine Chen for assistance in conducting the experiments.

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evidence about processing time does not necessarily lead to a rejection of the indirect-access model (cf. Glusckberg, 1991, 2003), though they do leave open the possibility that other mechanisms might account for the effects. Further, the key features of the indirect-access model have been incorporated into explanations of a different type of semantic complexity—complement coercion.

Complement Coercion

Complement coercion occurs when a verb that requires an event-denoting complement (e.g., *began*, *finish*, *start*) is paired with a noun phrase (NP) that refers to an object or other entity rather than an event (Jackendoff, 1997; Pustejovsky, 1995). For example, the complement NP *the hike* in (1a) represents an event, and so it matches the semantic requirements of the verb *began*. In contrast, the complement NP *the book* in (1b) represents an entity, and thus constitutes a semantic mismatch. Complement coercion is the process in which this entity comes to be interpreted as an event so as to satisfy the semantic constraints of the verb. Note that the meaning of (1b) could plausibly correspond to any of the meanings depicted in (1c).

- 1a. Mary began the hike.
- 1b. Mary began the book.
- 1c. Mary began [reading, writing, reviewing, publishing, translating, editing] the book.

In an early experiment on the processing of complement coercion, Traxler, Pickering, and McElree (2002) recorded participants' eye movements as they read sentences like those in (2). In this design, (2a) contains the expression that must undergo coercion, whereas (2b) and (2c) are control sentences representing both a preferred and nonpreferred interpretation. Traxler et al. showed that there was substantial processing difficulty associated with the coercion condition (2a) compared with the other conditions (2b and 2c) as shown by longer regression-path durations on the region immediately following the complement NP, as well as in later measures reflecting more rereading of the verb, the complement NP, and the postnoun region.

- 2a. The secretary began the memo about the new office policy. (coercion)
- 2b. The secretary wrote the memo about the new office policy. (preferred)
- 2c. The secretary typed the memo about the new office policy. (nonpreferred)

Traxler et al. further showed that the cost of complement coercion did not result simply from pairing an event-selecting verb with an NP regardless of the semantic relationship between the two constituents; that is, greater processing difficulty was observed when an event-selecting verb took an entity NP as its complement (e.g., *The boy started the puzzle*) compared with a neutral-verb condition (e.g., *The boy saw the puzzle*), but there was no evidence of processing difficulty when the event-selecting verb combined with an NP that represented an event (e.g., *The boy started the fight*) compared with the control condition (e.g., *The boy saw the fight*).

Additional experimental research has consistently demonstrated that complement coercion imposes an online processing cost in comparison to a variety of control conditions (for reviews, see Pykkänen, 2008; Pykkänen & McElree, 2006), with coercion costs seen using a broad range of methods: self-paced reading (McElree, Traxler, Pickering, Seely, & Jackendoff, 2001), eye-tracking during reading (Frisson & McElree, 2008; McElree, Frisson, & Pickering, 2006; Pickering, McElree, & Traxler, 2005; Traxler, McElree, Williams, & Pickering, 2005; Traxler et al., 2002), eye-tracking in the visual-world paradigm (Scheepers, Keller, & Lapata, 2008), speed-accuracy trade-off (McElree, Pykkänen, Pickering, & Traxler, 2006), electrophysiology (Baggio, Choma, van Lambalgen, & Hagoort, 2010; Kuperberg, Choi, Cohn, Paczynski, & Jackendoff, 2010), magnetoencephalography (Pykkänen, Martin, McElree, & Smart, 2009; Pykkänen & McElree, 2007), and functional MRI (Husband, Kelly, & Zhu, 2011).

Accounts of the difficulty in processing complement coercion build on the linguistic proposal that the combination of an event-selecting verb and an entity-denoting NP (e.g., *began the memo*) constitutes a semantic mismatch that requires that the entity-denoting NP be interpreted instead as an event (*type-shifted*) to satisfy the semantic constraints of the verb (Jackendoff, 1997; Pustejovsky, 1995). Traxler et al. (2005, p. 4) propose that this occurs through the following sequence of processing operations: (a) access of the stored lexical entry for the complement noun (e.g., *memo*) and an initial attempt to integrate its meaning with the unfolding meaning of the sentence; (b) detection of a mismatch between the stored semantic characteristics of the noun and the thematic properties of the verb, which triggers the coercion process; (c) an attempt to resolve the semantic mismatch by using the context of the sentence to infer an action that could plausibly be performed on the noun; and (d) reconfiguration of the semantic properties of the complement to allow for an event interpretation. Although not explicitly characterized as such, Traxler et al.'s account of the processing of coercion closely resembles the indirect-access model of figurative-language processing, which likewise involves an initial attempt to establish meaningful relations based on stored senses of a word, detection of a semantic mismatch (a "defect" in Searle's, 1979, terminology) when this initial interpretation fails, and a process of using contextual information to resolve the mismatch and ultimately arrive at the intended meaning.

A slightly different account put forth by Pykkänen and McElree (2006; see also Pykkänen, 2008) proposes that the type mismatch between the properties of the noun and verb effectively blocks the application of basic compositional operations, thereby triggering the costly type-shifting process of coercion. Further, Pykkänen and McElree argued that this account helps explain why processing costs are observed for expressions requiring complement coercion but not for other types of complex semantic expressions such as metonymy, which are proposed to involve a mismatch of "sorts" rather than a mismatch of "types" (see Pykkänen, 2008; Pykkänen & McElree, 2006, for a discussion). However, as we discuss later, the claim that familiar metonymic expressions are no more difficult to process than literal expressions has been disputed on the grounds that previous studies on the processing of metonymy (e.g., Frisson & Pickering, 1999, 2007; Humphrey, Kemper, & Radel, 2004) have failed to adequately control for sentence structure, which can have a strong moderating effect on the difficulty associated with processing complex semantic expressions.

Sentence Structure and Interpretation of Semantic Relationships

Our recent work (Lowder & Gordon, 2012, 2013) has shown that the difficulty of complex semantic interpretation is moderated by the structural relation between the expressions that together create the need for complex semantic interpretation; processing difficulty is observed when those expressions appear in a within-clause predicate-argument relationship, but this difficulty is reduced when they are related by a prepositional phrase or by modification with a relative clause. This effect was demonstrated first in studies on subject-verb integration that compared reading times for an action verb paired with an animate subject (e.g., *The sheriff injured the cowboy*) compared with an inanimate subject (e.g., *The pistol injured the cowboy*; Lowder & Gordon, 2012). Readers experienced greater difficulty processing the verb when the sentence subject was inanimate versus animate, with this effect emerging both when the subject-verb pair appeared together in the main clause of the sentence as well as when the two constituents appeared together inside a relative clause (e.g., *The sheriff that the pistol injured* vs. *The sheriff that the cowboy injured*). However, this processing difficulty was reduced or eliminated when the action verb was embedded in a relative clause that modified the inanimate subject (e.g., *The pistol that injured the cowboy* vs. *The sheriff that injured the cowboy*).

Lowder and Gordon (2013) found a comparable effect for the processing of *metonymy*, a figurative form where reference to an entity is made through the name of some other entity that is intimately associated with it. When a familiar place-for-institution metonym appeared as the object of a verb in a figurative context (e.g., *The journalist offended the college*), readers experienced greater processing difficulty than when the metonym appeared in a literal context (e.g., *The journalist photographed the college*) or when the object of the verb was animate (e.g., *The journalist offended the leader*). However, this processing difficulty was reduced when the metonym appeared as part of an adjunct phrase (e.g., *The journalist offended the honor of the college*). Previous work suggesting that familiar metonyms are no more difficult to process than literal expressions (Frisson & Pickering, 1999, 2007; Humphrey et al., 2004) had evaluated sets of stimuli that included cases where the metonym was the object of the verb, as well as cases where the metonym was in a locative or other adjunct phrase, with this mix of sentence types possibly reducing the sensitivity of the experiments in detecting the processing difficulty associated with familiar metonyms.

The pattern of results in these two studies (Lowder & Gordon, 2012, 2013) shows that complex semantic expressions are difficult to process when there is a within-clause predicate-argument relationship between the relevant constituents. These results are consistent with the basic predictions of the indirect-access model, according to which an initial attempt is made to integrate stored lexical entries with the unfolding meaning of the sentence, which leads to detection of a semantic mismatch and a search for an alternative meaning. A “semantic mismatch” under this account could be due to a mismatch that occurs when an inanimate subject is paired with an action verb that requires an animate subject (e.g., *The pistol injured the cowboy*; Lowder & Gordon, 2012), a mismatch that occurs when a psychological verb that requires an experiencer object is paired with an object that refers to a nonhu-

man place (e.g., *The journalist offended the college*; Lowder & Gordon, 2013), or a mismatch that occurs when a verb that requires an event NP is paired with an NP that refers to an entity (e.g., *The secretary began the memo*; McElree et al., 2001; Traxler et al., 2002). When a complex semantic expression is established across a clause boundary or with a prepositional phrase, processing difficulty is reduced (Lowder & Gordon, 2012, 2013)—an effect that may be related to the likelihood of detecting the mismatch, the process of searching for an alternative meaning, or both. These possibilities are consistent with a range of findings showing that sentence structure influences the depth at which language is processed (e.g., Baker & Wagner, 1987; Ferreira, Bailey, & Ferraro, 2002; Gordon & Hendrick, 1998; Sanford & Sturt, 2002).

Current Experiments

The indirect-access model outlines a process where an initial literal interpretation is evaluated and altered if necessary. This general process can be applied to different types of complex semantic relationships even though the precise mechanisms that allow for detection and resolution of different types of semantic mismatches are likely to vary. Like inanimate subject-verb integration and metonymy, complement coercion involves a mismatch in the meanings of expressions that should be related in order for a sentence to be understood. Indeed, some combinations of inanimate entities with action verbs of the sort studied by Lowder and Gordon (2012) (e.g., *The pistol injured the cowboy*) have been analyzed as requiring a process of *subject-type coercion* (Pustejovsky, 1995; Pustejovsky, Anick, & Bergler, 1993), in which the inanimate subject is type-shifted from an entity (e.g., *The pistol*) to an event (e.g., *Someone's shooting of the pistol*). Further, the stimuli used in psycholinguistic research on complement coercion have exclusively involved sentences in which the entity-denoting NP whose meaning must be coerced is the direct object of the verb that requires an event as its complement (Baggio et al., 2009; Frisson & McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; McElree et al., 2001; McElree, Frisson, & Pickering, 2006; McElree, Pylkkänen, et al., 2006; Pickering et al., 2005; Pylkkänen et al., 2009; Pylkkänen & McElree, 2007; Scheepers et al., 2008; Traxler et al., 2002, 2005). The current experiments investigate whether sentence structure moderates the magnitude of the coercion cost in the same way that it moderates the processing difficulty associated with other types of complex semantic expressions (Lowder & Gordon, 2012, 2013). Obtaining this pattern would be consistent with our prediction that sentence structure moderates the basic process of detecting and/or resolving a semantic mismatch for a range of semantic complexities that includes inanimate subject-verb integration, metonymy, and coercion.

Experiment 1

Experiment 1 tested whether placing the event-selecting verb and complement NP in separate clauses would reduce the coercion cost. This was done using passive constructions as shown in (3). In all conditions, the complement NP was positioned as the sentence subject, and the target verb appeared either in the main clause of the sentence (e.g., 3a and 3b) or in a relative clause (RC; e.g., 3c and 3d).

- 3a. The memo was begun by the secretary this morning so that it can be mailed this afternoon. (Simple Sentence, Coercion)
- 3b. The memo was written by the secretary this morning so that it can be mailed this afternoon. (Simple Sentence, Control)
- 3c. The memo that was begun by the secretary this morning needs to be mailed this afternoon. (RC, Coercion)
- 3d. The memo that was written by the secretary this morning needs to be mailed this afternoon. (RC, Control)

In Lowder and Gordon (2012; Experiment 2), we demonstrated that the processing cost of integrating an inanimate sentence subject with an action verb (e.g., *The pistol injured the cowboy*) is reduced when the critical constituents appear in separate clauses (e.g., *The pistol that injured the cowboy*). If sentence structure influences the processing of complement coercion in a similar way, then we would expect that the coercion cost in the RC condition (e.g., 3c vs. 3d) should be smaller than the coercion cost in the Simple Sentence condition (e.g., 3a vs. 3b).

In addition, this is the first experiment we are aware of that has examined complement coercion in a sentence context that presents the critical words in an order other than agent NP, verb, complement NP (e.g., *The secretary began the memo*). The passive structures employed here allow us to examine how the processing of complement coercion in this new configuration of words is similar or different to patterns that have been obtained in previous experiments.

Method

Participants. Thirty-six students at the University of North Carolina at Chapel Hill participated in this experiment in exchange for course credit. They were all native English speakers and had normal or corrected-to-normal vision. One participant was excluded due to poor comprehension-question accuracy and was replaced with a new participant.

Materials. Each participant was presented with 36 experimental sentences and 88 filler sentences. The experimental sentences (see Example 3) were adapted from Traxler et al. (2002, Experiment 1). In constructing the simple-sentence versions of each item, we used the same agent NP (e.g., *the secretary*) and complement NP (e.g., *the memo*) that Traxler et al. had used. The complement NP was positioned as sentence subject, followed by a past participle verb with the auxiliary *was* or *were*, and the agent NP was included in a *by*-phrase (e.g., *The memo was written/begun by the secretary . . .*). Whereas Traxler et al. had included verbs that represented the coercion, preferred, and nonpreferred interpretation of each item (see Example 2), we only included the coercion and preferred verbs. The verbs used in the Coercion and Control conditions did not differ in length, $t(70) = 1.45, p > .15$, or log frequency (SUBTLEXus database; Brysbaert & New, 2009), $t(70) = 1.27, p > .20$. The RC versions of each item were created by inserting the complementizer *that* between the subject NP and auxiliary verb and then rewriting the remainder of the sentence. See Appendix A for the full set of experimental stimuli.

The experimental sentences were counterbalanced across four lists so that each participant saw only one version of each item and so that each participant saw the same number of sentences from each of the four conditions.

Procedure. Participants' eye movements were recorded with an EyeLink 1000 system (SR Research, Mississauga, ON, Canada) at a sampling rate of 1,000 Hz, which was calibrated at the beginning of each session and was recalibrated throughout the session as needed. A chinrest was used to minimize head movement. Participants were instructed to read at a natural pace. At the start of each trial, a fixation point was presented near the left edge of the monitor, marking the location where the first word of the sentence would appear. When the participant's gaze was steady on this point, the experimenter initiated presentation of the sentence. After reading the sentence, the participant pressed a button, which caused the sentence to disappear and a true–false comprehension question to appear in its place. Participants pressed one button to answer “true,” and another button to answer “false.” After the participant answered the comprehension question, the fixation point for the next trial appeared.

Participants were first presented with four of the filler sentences. After this warm-up block, the remaining 120 sentences were presented in a different random order for each participant.

Analysis. Data analysis focused on four standard eye-movement measures (see Clifton, Staub, & Rayner, 2007; Rayner, 1998). *Gaze duration* is the sum of all initial fixations on a region; it begins when the region is first fixated and ends when gaze is directed away from the region, either to the left or right (for multiword regions, this measure is commonly referred to as *first-pass reading time*). *Regression-path duration* (also called *go-past time*) is the sum of all fixations beginning with the initial fixation on a region and ending when the gaze is directed away from the region to the right. Thus, regression-path duration includes time spent rereading earlier parts of the sentence before the reader is ready to proceed with the rest of the sentence. *Second-pass duration* is the time spent rereading a region after the eyes have exited the right boundary of this region. Unlike the other measures, second-pass duration includes zeroes (i.e., trials when the reader did not reread this region). *Total time* is the sum of all fixations on a word or region.

We report reading times for three regions of interest. The *subject NP* consisted of the first two words of the sentence, which were always a determiner and noun (e.g., *The memo*). The *verb region* included the event-selecting or control verb (e.g., *begun, written*), as well as the word immediately following it, which was always the preposition *by*. The preposition was included in the verb region because the verb alone was skipped on 19% of trials, which therefore did not contribute data to the gaze duration or regression-path duration measures. Creating a combined region reduced the skipping rate and associated data loss to 8% of trials. The *agent NP* consisted of the determiner and noun that followed the preposition *by* (e.g., *the secretary*).

An automatic procedure in the EyeLink software combined fixations that were shorter than 80 ms and within one character of another fixation into one fixation. Additional fixations shorter than 80 ms and longer than 800 ms were removed. In addition, means and standard deviations were computed separately for each condition, region of interest, and dependent measure. Reading times

that were greater than 3 standard deviations from the condition mean were eliminated.

Results

Comprehension-question accuracy. Mean comprehension-question accuracies for each condition were as follows: Simple-Coercion (92%), Simple-Control (95%), RC-Coercion (92%), RC-Control (96%). Because these values are very close to the upper limit of the distribution, the data were arcsine-transformed before inferential statistics were calculated (Cohen, Cohen, West, & Aiken, 2003; for a similar approach, see Johnson, Lowder, & Gordon, 2011). The analysis revealed a main effect of verb type, $F_1(1, 35) = 17.85$, mean-square error (MSE) = 0.07, $p < .001$; $F_2(1, 35) = 6.01$, $MSE = 0.11$, $p < .02$, such that responses to questions following Control sentences were more accurate than to questions following Coercion sentences. This difference was unexpected, especially considering that the comprehension questions never probed readers' interpretation of the coercion expression. For example, the question following Example 3 was "True or False: The memo is going to be mailed." It is possible that the longer reading times on the target words in the Coercion condition (discussed later) distracted readers' attention from the information contained in the rest of the sentence, resulting in lower accuracy. However, because accuracy was very high across all conditions, we do not place much weight on this finding. The main effect of sentence structure and the interaction between sentence structure and verb type were not significant.

Subject NP. Mean reading times for the three regions of interest are presented in Table 1. No statistically significant effects were observed in gaze duration or total time on the subject NP.

Analysis of second-pass duration revealed a significant main effect of sentence structure, $F_1(1, 35) = 7.16$, $MSE = 4,935$, $p < .02$; $F_2(1, 35) = 8.96$, $MSE = 4,194$, $p < .01$, such that reading times were longer in the Simple-Sentence condition than the RC condition.

Verb region. Analysis of all four reading-time measures on the verb region revealed main effects of verb type such that the Coercion condition was more difficult to process than the Control condition. The effect was significant in gaze duration, $F_1(1, 35) = 23.11$, $MSE = 2,398$, $p < .001$; $F_2(1, 35) = 17.30$, $MSE = 3,045$, $p < .001$, regression-path duration, $F_1(1, 35) = 23.68$, $MSE = 5,581$, $p < .001$; $F_2(1, 35) = 15.40$, $MSE = 8,165$, $p < .001$, second-pass duration, $F_1(1, 35) = 18.71$, $MSE = 8,426$, $p < .001$; $F_2(1, 35) = 13.44$, $MSE = 11,813$, $p < .005$, and total time, $F_1(1, 35) = 38.31$, $MSE = 10,666$, $p < .001$; $F_2(1, 35) = 21.69$, $MSE = 17,181$, $p < .001$. In addition, all four reading-time measures showed main effects of sentence structure such that the Simple-Sentence condition was more difficult to process than the RC condition. The effect was marginally significant in regression-path duration, $F_1(1, 35) = 4.04$, $MSE = 5,541$, $p < .06$; $F_2(1, 35) = 3.84$, $MSE = 9,127$, $p < .06$, but fully significant in gaze duration, $F_1(1, 35) = 18.30$, $MSE = 1,661$, $p < .001$; $F_2(1, 35) = 15.47$, $MSE = 2,000$, $p < .001$, second-pass duration, $F_1(1, 35) = 33.34$, $MSE = 6,412$, $p < .001$; $F_2(1, 35) = 34.67$, $MSE = 5,690$, $p < .001$, and total time, $F_1(1, 35) = 40.24$, $MSE = 9,858$, $p < .001$; $F_2(1, 35) = 37.16$, $MSE = 9,878$, $p < .001$.

Critically, these main effects were qualified by significant interactions between verb type and sentence structure. The interaction was significant in gaze duration (marginal in the item analysis), $F_1(1, 35) = 4.60$, $MSE = 2,073$, $p < .05$; $F_2(1, 35) = 4.04$,

Table 1
Results of Experiment 1: Mean Reading Times (and Standard Errors) in Milliseconds

Measure	Subject NP	Verb region	Agent NP
Simple-Coercion	<i>The memo</i>	(was)	<i>begun by</i>
Simple-Control	<i>The memo</i>	(was)	<i>written by</i>
RC-Coercion	<i>The memo</i>	(that was)	<i>begun by</i>
RC-Control	<i>The memo</i>	(that was)	<i>written by</i>
Gaze duration			
Simple-Coercion	360 (16)	310 (14)	290 (14)
Simple-Control	361 (16)	254 (11)	286 (13)
RC-Coercion	363 (19)	264 (13)	282 (14)
RC-Control	389 (21)	241 (11)	270 (11)
Regression-path duration			
Simple-Coercion	—	387 (22)	439 (27)
Simple-Control	—	283 (12)	358 (20)
RC-Coercion	—	319 (18)	395 (19)
RC-Control	—	301 (15)	316 (16)
Second-pass duration			
Simple-Coercion	207 (21)	277 (21)	136 (15)
Simple-Control	180 (19)	193 (18)	115 (13)
RC-Coercion	162 (15)	182 (19)	77 (8)
RC-Control	163 (20)	134 (14)	93 (12)
Total time			
Simple-Coercion	580 (29)	613 (31)	476 (28)
Simple-Control	551 (29)	464 (25)	441 (25)
RC-Coercion	546 (29)	465 (26)	402 (18)
RC-Control	556 (34)	401 (20)	389 (23)

Note. NP = noun phrase; RC = relative clause.

$MSE = 1,987$, $p = .052$, such that the coercion cost for the Simple-Sentence condition (56 ms), $t_1(35) = 5.11$, $p < .001$; $t_2(35) = 4.02$, $p < .001$, was over twice as large as the coercion cost in the RC condition (23 ms), $t_1(35) = 2.01$, $p < .06$; $t_2(35) = 2.28$, $p < .05$. The interaction was also significant in regression-path duration, $F_1(1, 35) = 24.14$, $MSE = 2,722$, $p < .001$; $F_2(1, 35) = 13.40$, $MSE = 5,386$, $p < .005$, such that there was a robust coercion cost in the Simple-Sentence condition, $t_1(35) = 6.68$, $p < .001$; $t_2(35) = 5.15$, $p < .001$, and no evidence of a coercion cost in the RC condition, $t_1(35) = 1.20$, $p > .20$; $t_2(35) < 1$. The interaction was marginally significant in second-pass duration (only in the subject analysis), $F_1(1, 35) = 2.93$, $MSE = 3,940$, $p < .10$; $F_2(1, 35) = 1.69$, $MSE = 6,305$, $p > .20$, but fully significant in total time, $F_1(1, 35) = 9.28$, $MSE = 7,031$, $p < .005$; $F_2(1, 35) = 5.08$, $MSE = 12,560$, $p < .05$, such that the coercion cost for the Simple Sentence condition (149 ms), $t_1(35) = 7.67$, $p < .001$; $t_2(35) = 4.97$, $p < .001$, was over twice as large as the coercion cost in the RC condition (64 ms), $t_1(35) = 2.60$, $p < .02$; $t_2(35) = 2.09$, $p < .05$.

Agent NP. Analysis of all four reading-time measures on the agent NP revealed main effects of sentence structure such that the Simple-Sentence condition was more difficult to process than the RC condition. The effect was significant in gaze duration (marginal in the item analysis), $F_1(1, 35) = 5.55$, $MSE = 929$, $p < .05$; $F_2(1, 35) = 3.14$, $MSE = 2,091$, $p < .09$, regression-path duration, $F_1(1, 35) = 9.68$, $MSE = 6,865$, $p < .005$; $F_2(1, 35) = 12.97$, $MSE = 6,332$, $p < .002$, second-pass duration, $F_1(1, 35) = 19.74$, $MSE = 2,971$, $p < .001$; $F_2(1, 35) = 15.81$, $MSE = 3,549$, $p < .001$, and total time, $F_1(1, 35) = 26.54$, $MSE = 5,446$, $p < .001$; $F_2(1, 35) = 15.21$, $MSE = 9,659$, $p < .001$. In addition, there was a main effect of verb type that was significant in regression-path duration, $F_1(1, 35) = 25.09$, $MSE = 9,235$, $p < .001$; $F_2(1, 35) = 40.48$, $MSE = 6,031$, $p < .001$, and marginally significant in total time, $F_1(1, 35) = 3.61$, $MSE = 5,822$, $p < .07$; $F_2(1, 35) = 2.97$, $MSE = 6,432$, $p < .10$. The interaction between sentence structure and verb type was not significant in any measure.

Discussion

The results of Experiment 1 replicated previous reading-time studies in demonstrating the online costs associated with processing complement coercion (Frisson & McElree, 2008; McElree et al., 2001; McElree, Frisson, & Pickering, 2006; Pickering et al., 2005; Traxler et al., 2002, 2005). Whereas these previous experiments all presented the critical words in the configuration agent NP, verb, complement NP (e.g., *The secretary began the memo*), the current experiment employed passive structures to present the critical words in the reverse configuration (e.g., *The memo was begun by the secretary*). Coercion costs emerged in gaze duration, regression-path duration, second-pass duration, and total time on the verb region, as well as in regression-path duration on the agent NP. Interestingly, there was no evidence of a coercion cost on the complement NP (e.g., *The memo*) in any measure when it was presented as sentence subject. In contrast, robust coercion effects are typically observed on the complement NP when it is presented as the object of the verb (see, e.g., Traxler et al., 2002; Frisson & McElree, 2008; Pickering et al., 2005).

Crucially, the magnitude of the coercion cost was significantly reduced when the verb and complement NP were separated by a

clause boundary compared to when they appeared together in the same clause. There was evidence for this interaction effect in gaze duration and total time on the verb region; however, the effect was most striking in regression-path duration on the verb region, where a robust coercion cost was observed in the Simple-Sentence condition, with no hint of this cost in the RC condition.

This pattern of effects is consistent with our previous work, which has shown that sentence structure moderates the processing of other complex semantic expressions such as inanimate subject-verb integration (Lowder & Gordon, 2012) and metonymy (Lowder & Gordon, 2013). We have proposed that when the constituents that together require complex semantic interpretation are separated so that one appears in the main clause of the sentence and another is embedded in a relative clause or some other adjunct phrase, readers are less likely to detect the semantic mismatch or are less likely to engage in a deep process of searching for an alternative meaning. However, there is an alternative explanation that has not yet been ruled out. In all of our demonstrations of interactions between sentence structure and complex semantic interpretation, the constituent that first signals the semantic mismatch (i.e., the need to derive a complex meaning) has been positioned in a defocused sentence position (e.g., *The pistol that injured the cowboy*; *The journalist offended the honor of the college*; *The memo that was begun by the secretary*). Thus, Experiment 2 was conducted to determine whether structural separation of the critical constituents would reduce the magnitude of the coercion cost, even when the constituent that signals the semantic mismatch is in linguistic focus.

Experiment 2

Experiment 2 further tested the hypothesis that the coercion cost would be reduced when the verb and complement NP appeared in separate clauses. Whereas Experiment 1 did this by comparing simple sentences and relative clauses, Experiment 2 uses different types of cleft constructions (see Example 4). The clause structure of the clefts in (4a) and (4b) resembles that of the Simple Sentences used in Experiment 1. That is, integration of the critical verb-NP pair occurs within the same clause. In contrast, the clause structure of the pseudoclefts in (4c) and (4d) imposes a boundary between the verb and complement NP, as was the case with the RCs in Experiment 1.

- 4a. It was the secretary that began the memo about the new office policy shortly after being hired. (Cleft, Coercion)
- 4b. It was the secretary that wrote the memo about the new office policy shortly after being hired. (Cleft, Control)
- 4c. What the secretary began was the memo about the new office policy shortly after being hired. (Pseudocleft, Coercion)
- 4d. What the secretary wrote was the memo about the new office policy shortly after being hired. (Pseudocleft, Control)

Cleft structures such as those in Example 4 have been used previously to examine the processing of linguistic information that is focused versus that which is nonfocused. The clefts in (4a) and

(4b) place linguistic focus on *the secretary*, as they seem to answer the implied question, *Who wrote the memo?* In contrast, the pseudoclefts in (4c) and (4d) place linguistic focus on *the memo*, as they seem to answer the implied question, *What did the secretary write?* As such, the structure of these sentences signals to the reader that some new piece of information is being asserted in contrast to information that is presented as presupposed. Previous work using structures like these as focus cues has shown that focused linguistic information enjoys a variety of processing benefits. For example, compared with nonfocused information, focused information attracts attention more quickly and more effectively (Carpenter & Just, 1977; Hornby, 1974; Langford & Holmes, 1979; Sturt, Sanford, Stewart, & Dawydiak, 2004; Zimmer & Engelkamp, 1981), is remembered better (Birch, Albrecht, & Myers, 2000; Birch & Garnsey, 1995; Singer, 1976), better facilitates anaphor resolution (Almor, 1999; Foraker & McElree, 2007), and leads to enhanced detection of false information (Bredart & Modolo, 1988). In addition, readers tend to spend more time processing focused than nonfocused information (Benatar & Clifton, 2014; Birch & Rayner, 1997; Price & Sanford, 2012; cf. Birch & Rayner, 2010). Thus, the complement NP should attract more attention and show longer processing times when it appears in a pseudocleft compared with a cleft. However, pseudoclefts also impose a structural separation between the complement NP and the critical verb, thereby dissociating the effects of focus on the complement and the effects of structural separation on the complex semantic processing that occurs with coercion. On the one hand, if the strong linguistic focus placed on the complement NP by the pseudocleft leads to enhanced relational processing, such that the reader engages in deep interpretation of the verb–complement relationship, then a larger coercion effect should occur for pseudoclefts compared with clefts. On the other hand, if the separation of the verb and complement NP into different clauses serves to deemphasize their relationship, then a smaller coercion effect should occur for pseudoclefts compared with clefts.

Method

Participants. Forty-eight students at the University of North Carolina at Chapel Hill participated in this experiment in exchange for course credit. They were all native English speakers and had normal or corrected-to-normal vision. No participants had taken part in Experiment 1.

Materials. Each participant was presented with 36 experimental sentences and 110 filler sentences. As in Experiment 1, the experimental sentences (see Example 4) were adapted from the materials used by Traxler et al. (2002). The same agent NPs (e.g.,

the secretary), verbs (e.g., *wrote* versus *began*), and target NPs (e.g., *the memo*) that had been used by Traxler et al. were also used here. These words were inserted into cleft and pseudocleft structures, and the posttarget material was rewritten to form a coherent sentence. See Appendix B for the full set of experimental stimuli.

Predictability. Twenty-four participants, none of whom participated in any other aspect of the study, were presented with fragments of the stimuli used in Experiment 2 and instructed to continue each fragment to make a complete sentence. Fragments for all four conditions were presented up to and including the determiner before the critical noun (e.g., *It was the secretary that wrote/began the . . .*; *What the secretary wrote/began was the . . .*). Participants' responses were then compared with the actual experimental stimuli to assess the predictability of the critical words. Cloze proportions (i.e., proportions of responses that were completed with the target words) are presented in Table 2. There was a significant main effect of verb type, $F(1, 23) = 39.09, p < .001$, such that cloze proportions in the Control condition were higher than in the Coercion condition. This finding is consistent with several previous coercion studies that have reported lower cloze probabilities for coercion sentences than control sentences (e.g., Kuperberg et al., 2010; Pykkänen & McElree, 2007; Traxler et al., 2002), which highlights the difficulty of equating these types of sentences on predictability. However, of primary importance to the current experiment, neither the main effect of sentence structure nor the interaction between verb type and sentence structure was significant ($F_s < 1.05, p_s > .30$).

In addition, two independent raters, who were naïve to the purposes of the study, were presented with the NPs that had been supplied in the completions. Raters assigned a code of 0 to NPs that referred to entities and 1 to NPs that referred to events. Agreement between raters was 90%. Table 2 shows mean event ratings for the four conditions. There was a significant main effect of verb type, $F(1, 23) = 118.05, p < .001$, indicating participants' greater tendency to provide entity NPs for the Control fragments and event NPs for the Coercion fragments. Neither the main effect of sentence structure nor the interaction between verb type and sentence structure was significant ($F_s < 1.22, p_s > .28$) indicating that any effects of sentence structure on the magnitude of the coercion cost are unlikely to be due to readers' expectations about the stimulus sentences.

Procedure. The sentences were counterbalanced across four lists, as in Experiment 1. All aspects of the eye-tracking procedure were identical to the procedure described in Experiment 1.

Analysis. One of the items contained an animate target NP (i.e., *The lawyer defended/endured the defendant*) that could not be

Table 2
Predictability Results From Experiment 2 Completion Study

Condition	Example	Cloze probability	Event rating
Cleft–Coercion	<i>It was the secretary that began the . . .</i>	.05	.43
Cleft–Control	<i>It was the secretary that wrote the . . .</i>	.25	.05
Pseudocleft–Coercion	<i>What the secretary began was the . . .</i>	.05	.36
Pseudocleft–Control	<i>What the secretary wrote was the . . .</i>	.22	.05

Note. For the event ratings, a score of 0 was assigned to entity noun phrases (NPs), whereas a score of 1 was assigned to event NPs.

readily adapted to the pseudocleft structure used for the rest of the items. This was addressed by constructing a different type of pseudocleft (i.e., *The one who the lawyer defended/endured was the defendant*). However, this item elicited extreme processing difficulty relative to the other pseudoclefts and was excluded from all analyses. We report reading times for three regions of interest. The *verb region* included the event-selecting or control verb (e.g., *began, wrote*). The *target NP* consisted of the determiner and noun that followed the verb (e.g., *the memo*). The postnoun region consisted of the three words following the target NP in most cases (e.g., *about the new*). For four of our items, there were only two words that remained constant following the target NP between the Cleft and Pseudocleft conditions. For these four items, the postnoun region consisted of only those two words. For each of these regions, we analyzed gaze duration, regression-path duration, second-pass duration, and total time. The same data-exclusion criteria used in Experiment 1 were also employed here.

Results

Comprehension-question accuracy. Mean comprehension-question accuracies for each condition were as follows: Cleft-Coercion (95%), Cleft-Control (95%), Pseudocleft-Coercion (96%), and Pseudocleft-Control (95%). As in Experiment 1, data were arcsine-transformed before calculating inferential statistics. There were no significant main effects or interactions.

Verb region. Mean reading times for the three regions of interest are presented in Table 3. Analysis of regression-path duration showed a significant main effect of sentence structure, such that times were longer for the Pseudocleft compared with the

Cleft conditions, $F_1(1, 47) = 20.81$, $MSE = 6,988$, $p < .001$; $F_2(1, 34) = 18.03$, $MSE = 5,555$, $p < .001$. The verb in the Cleft condition immediately follows the complementizer *that*, which serves as a cue to the reader that the following information is less important relative to the focused information at the beginning of the sentence. Later processing measures also showed significant main effects of sentence structure in second-pass duration, $F_1(1, 47) = 24.30$, $MSE = 6,185$, $p < .001$; $F_2(1, 34) = 19.64$, $MSE = 6,502$, $p < .001$, and total time, $F_1(1, 47) = 26.29$, $MSE = 13,012$, $p < .001$; $F_2(1, 34) = 24.98$, $MSE = 9,196$, $p < .001$, such that times were longer in the Pseudocleft compared with the Cleft conditions. However, this effect is likely due to more rereading of the verb after hitting the target NP in the Pseudocleft condition (see below). In addition, there were robust coercion costs on this region, with main effects of verb type emerging in second-pass duration, $F_1(1, 47) = 70.71$, $MSE = 6,486$, $p < .001$; $F_2(1, 34) = 31.92$, $MSE = 10,109$, $p < .001$, and total time, $F_1(1, 47) = 59.09$, $MSE = 10,515$, $p < .001$; $F_2(1, 34) = 25.06$, $MSE = 17,977$, $p < .001$. The interaction between sentence structure and verb type was not significant in any measure.

Target NP. Readers spent more time processing the target NP when it was focused by virtue of being in a pseudocleft compared with when it was in a cleft. This main effect of sentence structure was observed in regression-path duration, $F_1(1, 47) = 49.20$, $MSE = 10,358$, $p < .001$; $F_2(1, 34) = 72.44$, $MSE = 5,199$, $p < .001$, and total time, $F_1(1, 47) = 8.31$, $MSE = 14,253$, $p < .01$; $F_2(1, 34) = 10.83$, $MSE = 9,447$, $p < .005$. In addition, there was a significant main effect of verb type in regression-path duration, $F_1(1, 47) = 7.63$, $MSE = 12,096$, $p < .01$; $F_2(1, 34) = 5.96$,

Table 3
Results of Experiment 2: Mean Reading Times (and Standard Errors) in Milliseconds

Measure	Verb	Target NP	Postnoun region
Cleft–Coercion	<i>began</i>	<i>the memo</i>	<i>about the new</i>
Cleft–Control	<i>wrote</i>	<i>the memo</i>	<i>about the new</i>
Pseudocleft–Coercion	<i>began</i> (was)	<i>the memo</i>	<i>about the new</i>
Pseudocleft–Control	<i>wrote</i> (was)	<i>the memo</i>	<i>about the new</i>
Gaze duration			
Cleft–Coercion	245 (8)	314 (10)	422 (18)
Cleft–Control	234 (7)	306 (9)	420 (14)
Pseudocleft–Coercion	236 (7)	303 (11)	414 (16)
Pseudocleft–Control	241 (7)	306 (11)	423 (14)
Regression-path duration			
Cleft–Coercion	298 (12)	391 (16)	626 (30)
Cleft–Control	284 (9)	342 (12)	466 (19)
Pseudocleft–Coercion	356 (16)	489 (26)	584 (23)
Pseudocleft–Control	336 (17)	451 (19)	534 (20)
Second-pass duration			
Cleft–Coercion	218 (20)	220 (19)	164 (20)
Cleft–Control	132 (14)	124 (14)	147 (16)
Pseudocleft–Coercion	285 (21)	207 (19)	160 (19)
Pseudocleft–Control	176 (12)	166 (18)	143 (15)
Total time			
Cleft–Coercion	484 (23)	569 (26)	676 (34)
Cleft–Control	376 (17)	458 (23)	601 (23)
Pseudocleft–Coercion	574 (26)	584 (30)	662 (32)
Pseudocleft–Control	455 (18)	543 (26)	638 (26)

Note. NP = noun phrase.

$MSE = 12,228.13$, $p < .05$, second-pass duration, $F_1(1, 47) = 50.39$, $MSE = 4,378$, $p < .001$; $F_2(1, 34) = 13.38$, $MSE = 12,139$, $p < .005$, and total time, $F_1(1, 47) = 22.87$, $MSE = 12,142$, $p < .001$; $F_2(1, 34) = 6.62$, $MSE = 29,489$, $p < .02$, such that the Coercion condition was more difficult than the Control condition.

Critically, there was a significant interaction between sentence structure and verb type in second-pass duration, $F_1(1, 47) = 4.95$, $MSE = 7,347$, $p < .05$; $F_2(1, 34) = 4.64$, $MSE = 5,682$, $p < .05$. The coercion cost for the Cleft condition (96 ms), $t_1(47) = 5.91$, $p < .001$; $t_2(34) = 4.39$, $p < .001$, was over twice as large as the coercion cost for the Pseudocleft condition (41 ms), $t_1(47) = 2.66$, $p < .02$; $t_2(34) = 1.74$, $p < .10$. The interaction between sentence structure and verb type was also significant in total time, $F_1(1, 47) = 6.43$, $MSE = 9,113$, $p < .02$; $F_2(1, 34) = 4.33$, $MSE = 10,674$, $p < .05$. Whereas there was a robust coercion effect for the Cleft condition, $t_1(47) = 5.34$, $p < .001$; $t_2(34) = 3.41$, $p < .005$, the effect did not reach significance in the Pseudocleft condition, $t_1(47) = 1.93$, $p > .05$; $t_2(34) = 1.09$, $p > .28$.

Postnoun region. There were no significant main effects of sentence structure in the postnoun region. In contrast, main effects of verb type emerged in analysis of regression-path duration, $F_1(1, 47) = 32.98$, $MSE = 16,083$, $p < .001$; $F_2(1, 34) = 11.76$, $MSE = 30,653$, $p < .005$, and total time (significant in the subject analysis), $F_1(1, 47) = 5.88$, $MSE = 19,401$, $p < .02$; $F_2(1, 34) = 2.42$, $MSE = 29,625$, $p > .12$. For regression-path duration, the interaction between sentence structure and verb type was significant, $F_1(1, 47) = 12.01$, $MSE = 12,033$, $p < .002$; $F_2(1, 34) = 11.39$, $MSE = 8,214$, $p < .005$, with the coercion effect for the Cleft condition (160 ms), $t_1(47) = 6.05$, $p < .001$; $t_2(34) = 4.24$, $p < .001$ being over three times as large as the coercion effect for the Pseudocleft condition (50 ms), $t_1(47) = 2.31$, $p < .03$; $t_2(34) = 1.65$, $p > .10$. For total time, the interaction between sentence structure and verb type was marginally significant only in the subject analysis, $F_1(1, 47) = 3.02$, $MSE = 10,253$, $p < .09$; $F_2(1, 34) = 2.11$, $MSE = 11,829$, $p > .15$. The coercion cost was significant for the Cleft condition, $t_1(47) = 3.41$, $p < .002$; $t_2(34) = 2.15$, $p < .05$, but there was no difference between the Pseudocleft-Coercion and Pseudocleft-Control conditions, $ts < 1$.

Discussion

In line with the results of Experiment 1, Experiment 2 demonstrated that the processing cost associated with complement coercion is reduced when the verb and complement NP appear in separate clauses. Evidence for this reduction in difficulty was seen in regression-path duration on the postnoun region, as well as in later measures of second-pass duration and total time on the complement NP and in total time on the postnoun region. Whereas the constituent that signaled the semantic mismatch was presented in a defocused sentence position in the RC condition in Experiment 1, the constituent that signaled the semantic mismatch in the Pseudocleft condition in Experiment 2 was the most prominent word in the sentence.

The results of this experiment demonstrate that while the amount of processing on the complement NP is increased by linguistic focus, linguistic focus does not increase the cost of coercion. This finding shows that the difficulty of understanding complex semantic expressions is due to noncanonical relationships among multiple elements in the sentence, with sentence structure

guiding the reader's limited attention to some relationships but not others. We propose that when a complex semantic relationship is particularly salient, by virtue of all its components appearing together in a single clause, readers are more likely to focus on the relationship among these words and engage in a process of deep interpretation. When instead the various elements that constitute a complex expression appear in separate clauses, the relationship is seen as being less important to the overall interpretation of the sentence, leading to shallower processing that does not fully address the semantic mismatch that is the source of the complexity.

General Discussion

The two experiments reported in this article demonstrated that the processing cost associated with complement coercion was reduced when the event-selecting verb and entity NP appeared in different clauses. Experiment 1 demonstrated that the magnitude of the coercion cost was reduced when the complement NP was the sentence subject, and the verb was embedded in a relative clause (e.g., *The memo that was begun by the secretary*) compared with when the constituents appeared together in the same clause (e.g., *The memo was begun by the secretary*). Experiment 2 employed cleft and pseudocleft structures, which allowed for a direct test of whether placing linguistic focus on the complement NP (i.e., the element that needs to be type-shifted) leads to enhanced processing difficulty or whether structural separation of the verb and complement leads to reduced difficulty. Readers spent more time processing the complement NP when it was focused by the pseudocleft (e.g., *What the secretary wrote/began was the memo*) compared with when the cleft focused a different NP (e.g., *It was the secretary that wrote/began the memo*), suggesting that the structural properties of the pseudocleft did draw readers' attention to the complement. However, the magnitude of the coercion cost was reduced when the verb and complement appeared in separate clauses in the pseudoclefts compared with when they appeared in the same clause in the clefts. This pattern of effects may seem counterintuitive. That is, given that the pseudocleft highlights the complement as the most important element of the sentence, one might expect that this would also cause the reader to relate it to the other elements of the sentence in a deep and meaningful way, which would result in a larger coercion cost for the pseudoclefts than the clefts. The fact that the opposite pattern of effects was obtained underscores the importance of considering how sentence structure influences the *relationships* between various constituents in the sentence and how emphasis or deemphasis of a single element may change its relation to other elements in the sentence.

The processing cost of coercion has been explained as arising from detection of a mismatch between the semantic characteristics of the verb and complement that then triggers an effortful process of reconfiguring the entity interpretation into an event interpretation (Traxler et al., 2005). In other words, a straightforward combination of the literal meanings of the verb and complement results in a defective interpretation, which requires the comprehender to derive a more appropriate meaning of the expression (Searle, 1979). Accounts of the coercion cost have not typically been considered alongside accounts of figurative language processing and other types of complex semantic expressions; however, we propose that they are similar in the sense that they involve a semantic mismatch and require greater processing compared to

more literal control expressions. The findings reported here and in our previous work (Lowder & Gordon, 2012, 2013) support a basic prediction of the indirect access model for determining the meaning of complex semantic relations in sentences where there is a close structural relationship between the overt expressions that convey the mismatched meanings. In particular, processing time on the critical expressions was longer for complex semantic relations than for a variety of control conditions. Differences in time to comprehend complex versus control meanings have been commonly used in tests of the indirect access model (e.g., Clark & Lucy, 1975; Gerrig & Healy, 1983; Gildea & Glucksberg, 1983; Glucksberg et al., 1982; Frisson & Pickering, 1999; Inhoff et al., 1984; Janus & Bever, 1985; Keysar, 1989; Ortony et al., 1978; Shinjo & Myers, 1987; for reviews, see Glucksberg, 2001, 2003). According to the indirect access model, the difference in reading times is due to the time necessary to detect the semantic mismatch and to undertake the additional processing required for meaningful interpretation. We propose that the need to detect and resolve the semantic mismatch is common across different types of complex semantic relations but that the mechanisms for detection and resolution of the semantic mismatch are likely to differ depending on the type of expression. For example, it has been argued that the cost of complement coercion reflects the time needed to mentally construct semantic representations that are not explicitly licensed by the syntax of the sentence (e.g., Frisson & McElree, 2008; Traxler et al., 2002, 2005). In contrast, it could be argued that for familiar metonyms resolution of the mismatch reflects operations involved in selecting the figurative sense of the word after initial consideration of its nonmetonymic sense—a process that would be similar to finding the contextually appropriate meaning of a homonym (e.g., Duffy, Morris, & Rayner, 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Sereno, Pacht, & Rayner, 1992). The greater magnitude and broader distribution of the coercion cost compared with the metonymy cost (see Lowder & Gordon, 2013) support the idea of a difference in the interpretation of complement coercion and metonymy. This view is consistent with the interpretation offered by McElree, Frisson, and Pickering (2006) that “there is a straightforward process of accessing a familiar metonym, but . . . a more complex process of enriched composition is involved in the resolution of [coercion]” (p. 189) in conceptualizing interpretation of complement coercion as more complex than interpretation of familiar metonyms. However, our characterization differs from that of McElree et al. in that interpreting a familiar metonym is not regarded as completely straightforward (see Lowder & Gordon, 2013, for a discussion).

Our findings further show that the difference in time spent processing complex semantic relations compared with control conditions is eliminated or reduced when there is a distant structural relationship between the overt expressions that convey the mismatched meanings. The indirect access model does not predict this moderating effect of sentence structure, but it identifies two stages of processing where it might occur. When the overt expressions that convey the mismatched meanings are structurally separated, readers might be less likely to detect a semantic mismatch, or they might interpret semantic relationships at a shallow level which does not lead to the extra processing required for full understanding. This perspective highlights the importance of sentence structure as a powerful cue to language comprehension—one that indicates not only that particular constituents should be processed

more deeply than others but also that particular relationships should be processed more deeply than others. We propose that there are several underlying mechanisms that may further explain the moderating effect of sentence structure.

One possibility is that when an expression (e.g., a verb and complement) must be integrated across a clause boundary, readers compute the syntactic relationship between these two constituents but leave the semantic relationship underspecified. Traditional notions of sentence processing propose that the meaning of a sentence is composed through a straightforward process that involves computing syntactic relationships among the words in the sentence and then using corresponding semantic operations to methodically assemble individual word meanings into an overall sentence meaning. Complement coercion, as an example of enriched composition, challenges standard views of sentence processing by showing that language conveys meanings derived from the relation between expressions that are not explicitly licensed by syntax (see Pyllkkänen & McElree, 2006, for a discussion). When expressions requiring complement coercion are embedded in a syntactically complex sentence, readers may be particularly concerned with gaining a basic understanding of how the various nouns and verbs combine structurally and may not be as concerned with deriving a complete interpretation of the meaning of the relation between expressions. For example, given a sentence like *The memo that was begun by the secretary needs to be mailed*, readers may process the relations between the main clause and relative clause at a level where they understand that the secretary had something to do with the memo, but they do not fully distinguish the relationship until a later processing stage or perhaps not at all (for further discussion of underspecification, see Frisson, 2009; Frisson & Pickering, 1999, 2001; Lowder & Gordon, 2013).

A second, potentially related possibility is that structural cues in the sentence may indicate to the reader that the relation conveyed should be interpreted as presupposed or given and is thus not as important as relations that are asserted within a clause. For example, in *The memo that was begun by the secretary needs to be mailed*, the implication is that the secretary’s relation to the memo is background knowledge and is less important than understanding the information about the memo that is asserted in the main clause. Similarly, the phrase *What the secretary began* presupposes that some event has already occurred. When the entity NP is asserted as that event (e.g., *the memo*), the strong presupposition due to sentence structure that an appropriate event has already taken place reduces the likelihood that the semantic mismatch between the entity NP and needed event will be detected and therefore reduces the processing cost of coercion. In this way, structural manipulations that indicate to the reader which relationships should be focused on as opposed to those that are simply background knowledge may cue the reader to adopt an underspecified representation of a noncanonical relationship and instead focus deeply on the more prominent relations in the sentence.

The idea that structural manipulations mark a semantic relationship as presupposed might also explain the moderating effects of sentence structure on inanimate subject–verb integration (Lowder & Gordon, 2012) and metonymy (Lowder & Gordon, 2013). For example, in the sentence *The pistol that injured the cowboy remained in the saloon*, the relationship between the sentence subject and the embedded verb seems to serve as background information relative to the information being asserted in the main clause of the

sentence. Indeed, this analysis highlights the role of the relative clause as a modifier, or adjunct phrase, as it serves to restrict the identity of the head noun or further modify its meaning. In a similar way, embedding a metonym in an adjunct phrase (e.g., *The journalist offended the honor of the college*) seems to mark it as presupposed, as though *the college* had already been brought into the discourse and is now being presented as background knowledge so that the more important relationships between the verb and its arguments can occupy the focus of the sentence. Previous work has suggested that presupposed sentential information is less likely to attract attention and be evaluated deeply compared with information that is newly asserted (e.g., Baker & Wagner, 1987; Bredart & Modolo, 1988; Engelkamp & Zimmer, 1982; Hornby, 1974); however, this work has tended to focus on the presupposition or assertion of particular words in the sentence rather than the relationship between multiple constituents.

Conclusion

The psycholinguistic literature on complement coercion, inanimate subject–verb integration, metonymy, and other types of figurative language has tended to characterize these phenomena as distinct. Although the precise mechanisms that lead to successful interpretation of these forms may vary, we believe that they are all similar in that they involve a semantic mismatch at the level of literal meaning. Critically, the structure of the sentence influences the likelihood that the mismatch will be detected and the degree to which additional processing that establishes meaningful relations is performed.

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Appendix A

Experiment 1 Stimuli

The stimuli from Experiment 1 are shown below. Within each set, the first sentence displays the Simple-Sentence condition, whereas the second sentence displays the RC condition. Within the brackets, the first verb was used in the Control condition, whereas the second verb was used in the Coercion condition.

- The memo was {read/started} by the engineer yesterday morning before anyone else had gotten to work.
The memo that was {read/started} by the engineer yesterday morning outlined the details of the fundraiser.
- The soup was {eaten/tried} by the girl at the restaurant even though it smelled bad.
The soup that was {eaten/tried} by the girl at the restaurant smelled bad.
- The memo was {written/begun} by the secretary this morning so that it can be mailed this afternoon.
The memo that was {written/begun} by the secretary this morning needs to be mailed this afternoon.
- The article was {read/finished} by the editor late last night just in time for the publisher.
The article that was {read/finished} by the editor late last night has gone to the publisher.
- The house was {designed/finished} by the architect last week before we hired a landscaper.

- The house that was {designed/finished} by the architect last week still needs a landscaper.
- The braid was {braided/started} by the stylist at the salon even though it should have been trimmed first.
The braid that was {braided/started} by the stylist at the salon really should have been trimmed first.
- The kitchen was {designed/begun} by the designer while we were away so that we would be surprised.
The kitchen that was {designed/begun} by the designer while we were away was a big surprise.
- The newspaper was {edited/finished} by the editor with such skill that it received a Pulitzer Prize.
The newspaper that was {edited/finished} by the editor with such skill received a Pulitzer Prize.
- The novel was {read/begun} by the publisher two months before it went on sale to the general public.
The novel that was {read/begun} by the publisher two months ago just went on sale to the general public.
- The papers were {written/tried} by the student late last night even though they are due today.
The papers that were {written/tried} by the student late last night are due today.
- The portrait was {criticized/started} by the critic at the gallery after everyone else had left for the day.

(Appendices continue)

The portrait that was {criticized/started} by the critic at the gallery demonstrated many artistic techniques.

12. The gates were {closed/finished} by the guard every evening to keep troublemakers off the property.

The gates that were {closed/finished} by the guard every evening kept troublemakers off the property.

13. The garden was {planted/begun} by the woman last spring in the big open space behind her house.

The garden that was {planted/begun} by the woman last spring grew beautiful tulips and daffodils.

14. The fields were {plowed/started} by the farmer last March with plans to grow corn, beans, and cucumbers.

The fields that were {plowed/started} by the farmer last March produced corn, beans, and cucumbers.

15. The coffee was {prepared/started} by the waitress first thing in the morning before any customers arrived.

The coffee that was {prepared/started} by the waitress first thing in the morning greeted the customers as they arrived.

16. The script was {analyzed/begun} by the director very carefully so he could make changes along the way.

The script that was {analyzed/begun} by the director very carefully needed several changes along the way.

17. The coffee was {consumed/started} by the banker in the break room before the bank opened for business.

The coffee that was {consumed/started} by the banker in the break room was available all day long.

18. The grades were {recorded/started} by the teacher after school so progress reports could be sent home the next day.

The grades that were {recorded/started} by the teacher after school were sent home in progress reports the next day.

19. The syllabus was {written/finished} by the professor very quickly so that it would be ready for the first day of class.

The syllabus that was {written/finished} by the professor very quickly contained several errors on the first day of class.

20. The convertible was {driven/preferred} by the lawyer from the firm even though it attracted a lot of attention.

The convertible that was {driven/preferred} by the lawyer from the firm attracted a lot of attention.

21. The manuscript was {read/begun} by the publisher during lunch because the deadline was quickly approaching.

The manuscript that was {read/begun} by the publisher during lunch was already past its deadline.

22. The defendant was {defended/endured} by the lawyer during the trial even though everyone knew he was guilty.

The defendant that was {defended/endured} by the lawyer during the trial made one final plea to the jury.

23. The prescription was {written/begun} by the doctor at the hospital with hopes that it would treat this rare infection.

The prescription that was {written/begun} by the doctor at the hospital is supposed to treat this rare infection.

24. The taxes were {audited/begun} by the auditor last September while most of the executives were on vacation.

The taxes that were {audited/begun} by the auditor last September turned out to be full of serious mistakes.

25. The tuxedo was {worn/endured} by the surfer at the wedding despite his attempts to wear shorts instead.

The tuxedo that was {worn/endured} by the surfer at the wedding looked much better than we anticipated.

26. The velvet was {worn/preferred} by the nurse at the hospital even though it was extremely expensive.

The velvet that was {worn/preferred} by the nurse at the hospital was extremely expensive.

27. The letter was {written/begun} by the child in November so that it would certainly make it to Santa by Christmas.

The letter that was {written/begun} by the child in November would certainly make it to Santa by Christmas.

28. The biplane was {flown/preferred} by the pilot from California because of its classic design.

The biplane that was {flown/preferred} by the pilot from California had a classic design.

29. The article was {written/begun} by the journalist over the weekend so that it would be published today.

The article that was {written/begun} by the journalist over the weekend needs to be published today.

30. The house was {built/started} by the builder one year ago with plans for the family to move in this month.

The house that was {built/started} by the builder one year ago is ready for the family to move in this month.

31. The truck was {repaired/finished} by the mechanic ahead of schedule without encountering any problems at all.

The truck that was {repaired/finished} by the mechanic ahead of schedule encountered no additional problems.

32. The cake was {eaten/resisted} by the dieter at the party while everyone else was digging in.

The cake that was {eaten/resisted} by the dieter at the party was extremely unhealthy.

33. The novel was {read/begun} by the teenager two nights before the book report was due.

The novel that was {read/begun} by the teenager two nights ago was actually very scary.

34. The book was {read/finished} by the student three months after she saw the movie.

The book that was {read/finished} by the student three months ago was made into a movie.

35. The necklace was {stolen/attempted} by the robber in the empty museum, but the event was recorded on camera.

The necklace that was {stolen/attempted} by the robber in the empty museum was worth half a million dollars.

36. The plane was {flown/mastered} by the pilot four months before he received his full license.

The plane that was {flown/mastered} by the pilot four months ago was the last aircraft of its kind.

(Appendices continue)

Appendix B

Experiment 2 Stimuli

The stimuli from Experiment 2 are shown in their pseudocleft form. Each sentence was also presented as a cleft, as described in the text. Within the brackets, the first verb was used in the Control condition, whereas the second verb was used in the Coercion condition.

1. What the engineer {read/started} was the memo for the new employee orientation today.
2. What the girl {ate/tried} was the soup while chatting with friends at the new restaurant.
3. What the secretary {wrote/began} was the memo about the new office policy shortly after being hired.
4. What the editor {read/finished} was the article about tax increases before going home for dinner.
5. What the architect {designed/finished} was the house for the family down the block.
6. What the stylist {braided/started} was the braid in the girl's hair yesterday afternoon.
7. What the designer {designed/began} was the kitchen in the house next door, but she was worried that she wouldn't finish.
8. What the editor {edited/finished} was the newspaper that had to go out early the next morning.
9. What the publisher {read/began} was the novel written by Mark Twain's son.
10. What the student {wrote/tried} was the papers assigned for class, but he did not receive a good grade.
11. What the critic {criticized/started} was the portrait in the gallery, saying that it reminded him of Picasso.
12. What the guard {closed/finished} was the gates on the property before going home for the night.
13. What the woman {planted/started} was the garden as soon as the last winter frost melted away.
14. What the farmer {plowed/started} was the fields on the south side of the property where he hoped to grow corn.
15. What the waitress {made/started} was the coffee as soon as she saw all the customers lined up outside the diner.
16. What the director {read/started} was the script for the action movie that would begin filming next summer.
17. What the banker {drank/started} was the coffee in the break room since he was getting sleepy.
18. What the teacher {recorded/started} was the grades for her class since report cards are going out next week.

19. What the professor {wrote/finished} was the syllabus for his class, but he also needed to write all his lectures.
20. What the lawyer {drove/preferred} was the convertible with the fine leather seats, even though it was expensive.
21. What the publisher {read/started} was the manuscript two days after receiving it from the editor.
22. The one who the lawyer {defended/endured} was the defendant who everyone thought was guilty.
23. What the doctor {wrote/began} was the prescription for the new cold medicine that the child needed.
24. What the auditor {audited/began} was the taxes for the company that had gotten into trouble with the IRS.
25. What the surfer {wore/endured} was the tuxedo even though it made him feel uncomfortable all night long.
26. What the nurse {wore/preferred} was the velvet made in India, but she agreed that it was too expensive.
27. What the child {wrote/began} was the letter for Santa Claus, hoping it would get to him before Christmas.
28. What the pilot {flew/preferred} was the biplane whenever he went on long trips.
29. What the journalist {wrote/began} was the article about the hurricane that had devastated the town.
30. What the builder {built/started} was the house for his family, but he still needed a landscaper to do the yard.
31. What the mechanic {repaired/finished} was the truck several days before he started to work on the car.
32. What the dieter {ate/resisted} was the cake at the birthday party, even though she had eaten carrots all week.
33. What the teenager {read/began} was the novel about vampires, even though he knew it would give him nightmares.
34. What the student {read/finished} was the book about sailing, and she was eager to try out her new skills.
35. What the robber {stole/attempted} was the necklace at the museum, but he was spotted on the security camera.
36. What the pilot {flew/mastered} was the plane after just six lessons, but he nearly crashed at takeoff.

Received January 20, 2014
Revision received May 21, 2014
Accepted May 22, 2014 ■