Context effects in coercion: Evidence from eye movements

Matthew J. Traxler a,*, Brian McElree b, Rihana S. Williams c, Martin J. Pickering d

a Department of Psychology, University of California at Davis, One Shields Avenue, Davis, CA 95616, USA
b New York University, 6 Washington Place, Rm. 860, NY 10003, USA
c The Florida State University, PO Box 1270, Tallahassee, FL 32306, USA
d University of Edinburgh, 7 George Square, Edinburgh, EH8 9LW, Scotland

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Abstract

Four eye-movement monitoring studies examined the processing of expressions argued to require enriched semantic composition (Pustejovsky, 1995). Previous research found that noun phrases denoting entities (e.g., the book) were difficult to process following verbs that require event complements (e.g., begin). Expressions like began the book may be difficult to process because they require complex operations to construct an event sense (e.g., began writing the book), they engender competition between alternative interpretations (cf. began reading the book), or they require a costly retrieval operation to recover a suitable activity (e.g., reading). Introducing the activity before a target expression did not eliminate the processing cost (Experiments 1 and 2), but introducing the entire event sense did (Experiments 3 and 4). These findings are incompatible with accounts that would attribute the observed cost to the retrieval or selection of an implicit activity in the event sense of the expression. They suggest that interpretation is costly when composition requires the online construction of a sense not lexically stored or available in the immediate discourse.

Keywords: Semantics; Coercion; Enriched composition; Sentence processing

Introduction

For some phrases and clauses, the products of lexical and syntactic analysis might be sufficient for deriving a suitable interpretation (e.g., Jackendoff, 1997, 2002). Comprehenders may be able to assemble an interpretation for an expression by selecting relevant semantic properties associated with the words in the expression and by combining them in a manner that is guided by the grammatical constraints implicit in the expression. In such circumstances, the compositional mechanism might be rather minimal, consisting merely of rules or principles for recursively combining semantic properties.

However, other common and seemingly simple expressions appear to require a richer form of composition (Jackendoff, 1997, 2002; Pustejovsky, 1991, 1995). The boy began the book is an example of such an expression. Verbs like begin, finish, and enjoy require...
post-verbal arguments that semantically represent events (e.g., *The boy began the fight; The boy finished the assignment; The boy enjoyed the movie*). When the complement of these verbs is a noun phrase (NP) with a default interpretation as an entity, like *the book*, it cannot be combined straightforwardly with the verb to form an interpretable verb phrase (VP); rather, it must be construed as an event to satisfy the semantic requirements of the verb. Typically, comprehenders construct an event sense of the complement by implicitly generating an activity that is commonly associated with the complement noun and compatible with the agent of the clause. Thus, the sentence *the boy began the book* is typically interpreted as *the boy began reading the book*, whereas *the author began the book* is interpreted as *the author began writing the book* (McElree, Traxler, Pickering, Seely, & Jackendoff, 2001; Traxler, Pickering, & McElree, 2002).

Pustejovsky (1991, 1995) termed this type of enriched composition *complement coercion*, a process by which a context-sensitive interpretation for a complement expression emerges from the interaction of semantic properties in the sentence and discourse. In cases like *began the book*, comprehenders use elements in the sentence and discourse to *coerce* the default interpretation of the NP into a different sense by shifting its interpretation from one semantic type (e.g., ENTITY) to a different one (e.g., EVENT). Coercion could be circumvented if speakers or writers produced expressions with fully specified event structures, such as *began reading the book* or *began to read the book* instead of *began the book*. However, corpus analyses demonstrate that such expressions are very rare when the event is commonly associated with the noun (e.g., *reading* or *writing a book*), being used less than 5% of the time. Full event structures tend to occur only with less predictable activities like *translate the book* (Briscoe, Copestake, & Boguraev, 1990; Lapata & Lascarides, 2003; Lapata, Keller, & Scheepers, 2003).

Recent on-line studies indicate that readers find expressions requiring coercion harder to process than expressions that do not (McElree et al., 2001; Pickering, McElree, & Traxler, in press; Traxler et al., 2002; see also Piñango, Zurif, & Jackendoff, 1999). For example, McElree et al. (2001) contrasted sentences such as (1a) with sentences like (1b) and (1c). Apart from the coercion verb, (1b) and (1c) correspond to the preferred and non-preferred interpretations of (1a), but neither requires coercion, as the verbs select for an ENTITY complement.

(1a) The author began the book at the house on the island (coerced).
(1b) The author wrote the book at the house on the island (preferred).
(1c) The author read the book at the house on the island (non-preferred).

In a self-paced reading experiment, readers had more difficulty with coercing expressions (e.g., 1a) than with non-coercing expressions (e.g., 1b and 1c) after encountering *book*. In an eye-movement monitoring experiment, Traxler et al. (2002) also found that readers had more difficulty with coercing than non-coercing expressions, with coercing expressions showing most regressions from *the book* and greatest total reading time on the verb and the two words immediately following *the book*. Further experiments using both eye-movement monitoring and self-paced reading showed that readers had no difficulty with *The boy started the fight* as compared to *The boy saw the fight*, but they did have difficulty with *The boy started the puzzle* as compared to *The boy saw the puzzle*. The crucial difference is that, unlike *the book*, an NP like *the fight* can be interpreted as an event directly. These results indicate that the observed coercion cost is specific to the type of NP complement and *not* because verbs like *begin* engender processing difficulty regardless of the semantic type of its complement. Finally, a coercion cost is observed even when the aspectual properties of the coercion and control stimuli and the NPs are entirely controlled for (e.g., *the author began the book... vs. the author began writing the book...*) (Pickering et al., in press).

Collectively, these findings provide behavioral evidence for the psychological reality of an enriched form of composition. However, current evidence does not identify what specific cognitive operations distinguish enriched composition from simpler forms of composition. Towards this goal, we report four experiments that examine how contextual information affects the processing difficulty associated with complement coercion. Appropriate contextual information often reduces processing difficulty at both lexical (Duffy, Morris, & Rayner, 1988) and syntactic levels (Altmann, Garnham, & Dennis, 1992; Liversedge, Pickering, Branigan, & van Gompel, 1998). For example, Liversedge et al. (1998) found that a locative by-phrase following a passive verb form (*The shrubs were planted by the greenhouse*) was more difficult to process than an agentive by-phrase (*The shrubs were planted by the apprentice*) when these sentences occurred in isolation. However, the difficulty with the locative disappeared when context provided an expectation of a location (*The man was wondering where to plant the shrubs*). We might therefore expect that contextual information could reduce the processing difficulty associated with coercion. More importantly, examining what types of contextual information affect the difficulty of coercion should help explicate the computations involved in enriched composition.
We now outline different hypotheses for what operations are costly for readers to perform in complement coercion. We then discuss how context may influence those operations, and how it may generally affect the attendant cost of processing coerced expressions.

Why is enriched composition costly?

Text comprehension often requires inferring information not explicitly represented in the text or utterance. For example, an expression like *The beer was warm* is more difficult to process following a context sentence like *Dave took the picnic supplies out of the trunk* (Clark & Haviland, 1977). The standard explanation of this difference is that comprehenders take time to perform a “bridging inference,” which relates *beer* to *picnic supplies* in order to situate the expression *The beer was warm* in a coherent discourse representation. One might, therefore, wonder whether complement coercion is costly simply because it involves the same type of bridging inference.

However, a crucial difference between these cases is that complement coercion requires generating unexpressed semantic content to establish a sensible interpretation of the expression itself, not merely to link the expression to a discourse model. Bridging inferences may improve inter-sentential coherence, but they are not necessary to recover the standard interpretation of an expression. For example, comprehenders can interpret *The beer was warm* by simply attributing the property of being warm to *the beer* without inferring that *beer* is a subset of the picnic supplies, but they cannot interpret *the man began the beer* without generating an activity to construe the complement as an event. That process creates an event sense of the complement that satisfies the semantic restrictions of the verb. Hence, the processing cost observed in our past studies appears to reflect the intrinsic complexity of the compositional operations, not the difficulty of integrating the expression into the discourse.

Other sentence forms also appear to trigger the generation of unexpressed semantic content but, interestingly, are not costly to process. Certain verb forms can activate implicit arguments (Tanenhaus & Carlson, 1989; Mauner & Koenig, 2000; Mauner, Melinger, Koenig, & Bienvenue, 2002; Mauner, Tanenhaus, & Carlson, 1995). For example, when processing a truncated passive like *The ship was sunk*, readers appear to open an agent role in their discourse representation, which they can link to an established discourse entity or subsequently bind to an new entity (e.g., Mauner & Koenig, 2000; Mauner et al., 2002). Research on implicit arguments has focused on whether readers do indeed compute implicit arguments, not on whether the computation of these arguments is itself costly. Nevertheless, inspection of the reading times reported in Mauner et al. (2002) indicates that expressions like *The ship was sunk*, which trigger an implicit argument, are not measurably more difficult to process than expressions like *The ship had sunk*, which do not trigger an implicit argument.\(^1\)

A notable difference between these constructions and those involving coercion is that implicit argument roles are thought to be specified in the lexical representation of the verb form and hence may be retrieved automatically with the verb (e.g., Mauner & Koenig, 2000; Mauner et al., 2002). In contrast, coercion requires the computation of an extended sense for the complement, one that we believe is unlikely to be directly encoded in the lexical representation of either the verb or noun. That is, although nouns like *book* are polysemous (e.g., *book* can denote a physical object, as in *Pick up the book*, or the contents of a published work, *the book was dense*), it is rather unlikely that fully specified event senses (e.g., *read the book*) are stored in the noun’s lexical representation as this would require the storage of numerous event senses corresponding to particular pairings of verbs (begin, finish, enjoy, etc.) with various agents (*the author, the printer, the student*, etc.). Although storage of a fully articulated event sense might be feasible for some very frequent and specialized pairings, it would be uneconomical as a general rule.

In most circumstances, we assume that readers cannot simply select a suitable event sense from the noun’s lexical representation when they encounter an expression like *began the book*; rather, they must deploy on-line operations to compute a contextually suitable event sense. We attribute the observed processing costs to these on-line operations (McElree et al., 2001; Pickering et al., in press; Traxler et al., 2002). Our approach is inspired by Pustejovsky’s (1995) generative treatment of coercion. Formally, complement coercion is an operation that converts an expression, \(\alpha\), to the semantic type expected by a governing function, \(\beta\). In *began the book*, \(\beta\), the verb *begin*, selects for an eventual function, and a coercion operation is applied to convert the expression *the book, \(\alpha\)*, from its default semantic type ENTITY to the type EVENT. This is accomplished by first selecting an activity compatible with the agent and commonly associated with the noun, assumed to be stored in the noun’s *Qualia* structure (Pustejovsky, 1995), and then incorporating it into the interpretation of the expression by building an event structure, such as \([\_began[\_reading the book]]\).

We do not fully endorse the types of lexical representations in Pustejovsky’s framework because we assume

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\(^1\) The relevant comparison is found in the control conditions of Experiment 1 of Mauner et al. (2002) contrasting truncated passive clauses (*The ship was sunk*) and intransitive clauses (*The ship had sunk*) following adverbial control clauses, which provide a neutral context for both types of clauses.
that coerced senses are computed from a broader range of properties than the Qualia structure of the complement noun proposed by Pustejovsky (see also Jackendoff, 2002). Moreover, comprehenders appear capable of using properties that do not appear to be exclusively derived from the complement noun but instead appear to be associated with the agent of the sentence or other discourse elements. (For example, authors typically write but goats do not; hence, interpreting the goat began the book will rely more on what goats can do to books than the typical properties of books). Nonetheless, we attribute the increased processing costs in coercion to operations similar to those that Pustejovsky proposes are used to build a representation for the event sense of the complement.

Specifically, we propose people process the expression began the book by using the following operations:

(A) When encountering the noun book, comprehenders access the word’s lexical entry and attempt to integrate various stored senses of this word into the evolving semantic representation of the sentence.

(B) The mismatch between the verb’s selectional restrictions and the stored senses of the noun triggers a coercion process.

(C) Comprehenders use salient properties associated with the complement noun and other relevant discourse elements (including but not necessarily limited to the agent phrase) to infer a plausible action that could be performed on the noun.

(D) Comprehenders incorporate the event sense into their semantic interpretation of the VP by reconfiguring the semantic representation of the complement, converting [began[The book]] into [began[reading the book]]. (Conceivably, this could also require reconfiguration of an associated syntactic representation.)

We have hypothesized that the coercion cost is associated with the operations in (D), specifically with the time required to build an eventive representation of the complement (McElree et al., 2001; Traxler et al., 2002). A priori, however, the cost could originate from other components outlined in (B) and (C) above. (Any cost associated with A is not specific to coercion.)

One might propose that the observed processing costs simply reflect the detection of a mismatch in early phases of processing (B above) between the semantics of the verb and complement. However, we first note this type of account leaves unanswered how readers recover a viable interpretation of expressions like began the book. Second, although disruption in processing does occur when an interpretation does not make sense (e.g., Clifton, 1993; Pickering & Traxler, 1998; Traxler & Pickering, 1996), it is not entirely clear whether this account is fully compatible with the delayed and sustained effects found in prior work. For example, reading differences often do not emerge on the noun but rather in later regions and on measures typically considered to reflect integrative processing in eye-movement data (Pickering, Frisson, McElree, & Traxler, 2004). Finally, a recent magnetoencephalographic (MEG) study (Pylkkänen, Liinas, & McElree, 2004; Pylkkänen, Liinas, & McElree, submitted) found that complement coercion (The author began the book) does not modulate the same brain activity found in clear cases of mismatching semantic relations between a verb and its complement. Relative to control expressions like The author wrote the book, anomalous expressions like The author amused the book increased the activity in a left temporal source at 300–400 ms (M350)—the MEG analogue of an event-related potential (ERP) N400 component. However, The author began the book generates the same activity levels in this source as the control expression. Complement coercion modulates a frontal source, an anterior midline field in a later 350–500 ms time-window, generating more activity in this source than either the anomalous or simpler control sentences. These findings suggest that the increased activity associated with complement coercion involve more than simple detection of mismatching semantic properties.

More plausible alternative explanations attribute the coercion cost to operations outlined in (C) above. One possibility is that the cost reflects the time needed to access the knowledge of what type of activity is appropriate for the event sense. For example, in the student began the book, this knowledge might be that a book is a type of artifact on which one can perform the action of reading. In essence, this account attributes the cost to the time need to infer or retrieve an appropriate activity for the coerced sense.

A related alternative also attributes the cost to operations in (C), although not to those involved in retrieving an activity but rather to those involved with selecting an appropriate activity from among a plausible set of actions. Expressions like began the book are underspecified, and so it is often possible to interpret them in several ways. In this sense, underspecified expressions may be viewed as being ambiguous; not in the more restricted sense of being ambiguous between two or more fixed alternatives, but in the common sense that they can be understood in more than one way.

Normative data show that an appropriate agent (e.g., author) can strongly constrain the interpretation (e.g., Lapata et al., 2003; McElree et al., 2001), and we have selected our materials in past studies so that only one interpretation was strongly preferred. This makes our materials functionally similar to other types of ambiguities that are not costly to process. For example, lexical ambiguity is costly only for balanced words with two meanings of roughly comparable frequency or biased words where context supports the non-preferred
meaning (Duffy et al., 1988; Rayner & Duffy, 1986). Nevertheless, it is at least possible that expressions like began the book are temporarily ambiguous, and that there is uncertainty and competition in selecting an activity, which could introduce some delays in processing, particularly when contextual constraints are weak.

Contrary to both these alternative explanations, we do not attribute the observed costs to competition engendered by ambiguity, and we assume that the knowledge needed to enrich a complement is activated in an automatic and cost-free manner. On our account, the costs are due to the additional operations needed to construct the appropriate event sense for the complement, as in (D) above.

The role of context

The reported experiments manipulate contextual information to assess the general question of how context affects coercion operations, and to evaluate specific hypotheses for the source of the difficulty with complement coercion.

It is uncontroversial that contextual information plays a crucial role in coercion operations. Minimally, the context in which the VP occurs affects the type of activity comprehenders will assume is implicit in the eventive interpretation of the complement. For example, The author began the book suggests the interpretation “writing the book,” The student began the book the interpretation “reading the book” and The goat began the book the interpretation “eating the book.” Hence, context information constrains the interpretation of the complement and may even supply the action implicit in the event sense. In terms of the framework outlined above, contextual information influences the operations in (C), namely retrieving and selecting an appropriate action for the coerced sense.

However, contextual information could conceivably affect any or all of the component processes outlined above, and it could modulate the cost accordingly. At the extreme, it could eliminate the cost if it provided an appropriate event sense for the complement, enabling comprehenders to bypass stored senses of nouns like book in favor of an event-related meaning supplied by the context, thereby circumventing all of the operations outlined in (B–D) above. In these circumstances, readers may be able interpret the expression by referring back to an appropriate sense in the discourse representation. We evaluate this hypothesis in Experiments 3 and 4.

Experiments 1 and 2 were designed to assess whether the locus of the cost of coercion exclusively resides in inferring or selecting the action that is implicit in the event sense, the two hypotheses associated with (C) above. These experiments examined the cost of processing an expression like the student began the book following a neutral context sentence or a context sentence that explicitly describes the agent performing the action (e.g., reading) that is implicit in the dominant coerced sense. If the cost solely reflects the time to infer or access the action implicit in the event sense—e.g., to infer that a book is a type of artifact on which one can perform the action of reading, either through accessing properties of the complement noun or properties of other elements in the discourse—then the cost should be eliminated if the immediate context explicitly introduces the relevant action. This follows from standard assumptions that processing the verb reading in the context sentence should activate the concept of reading, thereby making it readily accessible when the coercing expression is encountered. If the time to infer a plausible action only partially contributes to the coercion cost, then an appropriate context should attenuate rather than eliminate the cost.

Placing the required activity in an explicit context also tests the second alternative hypothesis that the cost reflects the time to select one of several actions that could be performed on the noun. Because the complement expression is underspecified, multiple interpretations may be possible, and the cost might reflect the time it takes comprehenders to settle on one interpretation.

As contextual information is typically thought to constrain interpretation very rapidly (e.g., Morris, 1994; Pickering & Traxler, 1998), an explicit context should eliminate or attenuate any processing cost that is due to this type of underspecification. Minimally, the context sentences should strongly bias the interpretation of the target sentence toward the mentioned activity. Generally, ambiguity costs are greatly reduced when one interpretation is heavily favored (e.g., Rayner & Duffy, 1986).

Contrary to both these alternative explanations, we hypothesize that the observed cost is not due to competition among different interpretations, and we assume that the knowledge needed to enrich the interpretation of began the book can be accessed from the complement noun or other discourse element in a relatively automatic and cost-free manner even if it is not explicitly represented in the context. On our account, the costs are due to the additional operations needed to construct the appropriate event sense for the complement given a relevant action, and, as a consequence, we predict that placing the activity in the immediate context will not eliminate processing costs.

If our hypothesis is correct, it may still be possible to circumvent these costly structure-building operations by drawing upon the previous use of such operations. For example, it may be possible to reduce the difficulty with began the book if readers have just computed the interpretation. In these circumstances, readers may be able to interpret the expression by referring back to an appropriate sense in the discourse representation. This prediction was tested in Experiments 3 and 4.
Experiment 1

The first experiment used an eye-movement monitoring procedure to examine readers’ processing of coercing expressions following contexts like (2a) that explicitly introduced the action implicit in the event interpretation of the VP (e.g., building), or following more neutral contexts like (2b) where the mentioned activity (e.g., looking) was not directly related to the activity implicit in the event interpretation of the target VP:

(2a) The contractor had been building in the suburbs. That spring, he began a condominium next to the shopping center (event context, coercing target).

(2b) The contractor had been looking for new jobs. That spring, he began a condominium next to the shopping center (neutral context, coercing target).

The same context sentences were paired with target sentences that explicitly expressed the preferred activity associated with the coercing expression, as in (2c) and (2d), which served as controls for the experimental passages:

(2c) The contractor had been building in the suburbs. That spring, he built a condominium next to the shopping center (event context, control target).

(2d) The contractor had been looking for new jobs. That spring, he built a condominium next to the shopping center (neutral context, control target).

With neutral context sentences, coercing target expressions [e.g., began a condominium in (2b)] should be more difficult to process than the control expressions [e.g., built a condominium in (2d)], replicating prior findings (McElree et al., 2001; Traxler et al., 2002). However, the context sentences in (2a) and (2c) should activate the concept of “building,” and hence they should eliminate or substantially reduce the corresponding differences in the target sentences in (2a) and (2c) if inferring or retrieving the implicit activity in the coercing expression is the source of the difficulty. The context sentence in (2a) should also reduce or eliminate the uncertainty about the implicit activity described in the target expression began the condominium. Hence, the context sentence in (2a) should eliminate or reduce the difference between the target sentences in (2a) and (2c) if coercion costs reflects uncertainty about the interpretation or competition among different interpretations.

In contrast, if building a representation that instantiates an event interpretation of the complement is the locus of the observed processing cost, then relevant context sentences like (2a) should not eliminate the observed cost in interpreting coercing expressions such as began the condominium. Unlike the other two explanations, this hypothesis predicts a main effect of coercion across the two types of context.

Method

Participants

Forty undergraduates at the University of South Carolina participated in return for course credit. All of the participants were native speakers of English with normal vision and hearing.

Stimuli

We constructed 28 sets of passages like (2a)–(2d). Half of the target sentences contained coercing expressions selected from stimuli used in previous studies (McElree et al., 2001; Traxler et al., 2002). The other half of the target sentences contained non-coercing expressions, and hence served as controls. The context sentences were designed to introduce an activity that represented the preferred relationship between the agent introduced in the context sentence and the object represented the preferred relationship between the agent introduced in the context sentence and the object. The verbs in the coercing and control conditions occurred at an average frequency of 246 and 214 times respectively in the Brown Corpus (Francis & Kucera, 1982). This difference was not significant, \( F(1, 27) = 51.6, \ p < .0001, \ MSe = 1.55 \). The verbs occurred at an average frequency of 246 and 214 times respectively in the Brown Corpus (Francis & Kucera, 1982). This difference was not significant, \( F(1, 27) < 1 \).

We report and analyze raw scores in the results sections below. To rule out length effects, we also analyzed residual reading times. Residual reading times were calculated by using length in characters to predict reading time in a correlational analysis, then subtracting the predicted reading times from the observed times. When these residual reading times were analyzed in the same way as the raw data, the results were nearly identical to the raw score results.

One version of each item was randomly assigned to one of four lists such that an equal number of each type appeared on each list and so that no participant saw more than one version of each item. The experimental passages were presented along with 42 passages from an unrelated experiment.
Eye-movement-monitoring procedure

A Fourward Technologies Dual-Purkinje Image eye-tracker monitored participants’ eye movements while they read passages like (2a)–(2d). The tracker has angular resolution of 10°/arc. The tracker monitored only the right eye’s gaze location, but viewing was binocular. A PC displayed materials on a VDU 70 cm from participants’ eyes. The display consisted of Borland C default font with approximately four characters per degree of visual angle. The location of participants’ gaze location was sampled every millisecond and the PC software recorded the tracker’s output to establish the sequence of eye fixations and their start and finish times. At the beginning of the experiment, the experimenter seated the participant at the eye tracker and used a bite-plate and head rests to minimize head movements. The tracker was then aligned and calibrated before the experiment began. After reading each passage, the participant pressed a key. After 10 of the filler passages, the participant responded to a comprehension question. Participants received feedback on their responses. All of the participants in the analyses reported below scored at 90% accuracy or above on the comprehension questions. Between each trial, a pattern of boxes appeared on the computer screen along with a cursor that indicated the participant’s current gaze location. If the tracker was mis-aligned, the experimenter recalibrated it before proceeding with the next trial.

Results and discussion

We report four standard measures of eye-movement data: first-pass time, first-pass regressions, regression-path time, and total time. First-pass time is the sum of all the fixations beginning with the reader’s first fixation in a region until the reader’s gaze leaves the region (on one-word scoring regions, first-pass time is equivalent to gaze duration; e.g., Rayner & Duffy, 1986). A first-pass regression occurs when the reader’s gaze crosses the left edge of the scoring region following a first-pass fixation. Regression-path time (sometimes referred to as go-past time) includes all of the time from when a reader first fixates within a target region until the reader fixates anything to the right of the region (Brysbaert & Mitchell, 1996; Traxler, Bybee, & Pickering, 1997). This measure includes time spent re-reading previous regions and the target region prior to the reader moving on to subsequent text. It may reflect the time necessary for a reader to process the text to a sufficient degree that the reader is then prepared to input new information. Total time is the sum of all of the fixations within a region. Three scoring regions were examined. The verb region included the matrix verb of the sentence plus the auxiliary (e.g., was) in items that had one. The noun region included the direct object of the coercing expression and the preceding determiner. The determiner was included in the noun region because the reader’s perceptual span while fixating the determiner probably extends to the target word, and hence fixation times on the determiner may be affected by characteristics of the noun (Rayner & Pollatsek, 1989). In previous research, we have often observed effects emerging just downstream from the critical noun (e.g., Traxler et al., 2002). Hence, we defined a post-noun region consisting of the two words following noun region. Table 1 presents mean scores on the four dependent measures by condition and region for Experiment 1.

<table>
<thead>
<tr>
<th>Condition</th>
<th>First-pass time</th>
<th>First-pass regressions (%)</th>
<th>Regression-path duration</th>
<th>Total time</th>
</tr>
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<tbody>
<tr>
<td><strong>Verb region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event context, coercing target</td>
<td>350</td>
<td>6.8</td>
<td>393</td>
<td>420</td>
</tr>
<tr>
<td>Neutral context, coercing target</td>
<td>369</td>
<td>3.2</td>
<td>386</td>
<td>426</td>
</tr>
<tr>
<td>Event context, control target</td>
<td>329</td>
<td>3.6</td>
<td>343</td>
<td>365</td>
</tr>
<tr>
<td>Neutral context, control target</td>
<td>362</td>
<td>5.0</td>
<td>393</td>
<td>388</td>
</tr>
<tr>
<td><strong>Noun region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event context, coercing target</td>
<td>425</td>
<td>8.9</td>
<td>496</td>
<td>533</td>
</tr>
<tr>
<td>Neutral context, coercing target</td>
<td>430</td>
<td>6.1</td>
<td>454</td>
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<td>6.4</td>
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<td>487</td>
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<td><strong>Post-noun region</strong></td>
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<tr>
<td>Event context, coercing target</td>
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<td>11.4</td>
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<tr>
<td>Neutral context, control target</td>
<td>446</td>
<td>8.9</td>
<td>497</td>
<td>513</td>
</tr>
</tbody>
</table>

Note. Fixation times are reported in milliseconds.
Prior to analyzing the data, we removed any fixation times less than 120 ms or greater than 2000 ms. This procedure eliminated 10.4% of the data in Experiment 1. Next, the data were subjected to 2 (context: event vs. neutral) × 2 (verb: coercing vs. control) repeated-measures ANOVAs with participants (F1) and items (F2) treated as random factors. Both factors were considered within participants and items.

**Verb region**

First-pass times on the verb region when the contexts contained the event were 26 ms shorter than when the context was neutral. This led to a significant effect of context in the by-participants analysis, \( F(1,39) = 5.85, p < .05, MSe = 4615 \), and a trend in the by-items analysis, \( F(2,127) = 2.90, p = .10, MSe = 4537 \). This marginal effect might indicate that the target verb was easier to process when the context mentioned a related action than when the verb introduced a new action. However, there was no effect of the verb type, and this replicates findings from previous studies showing that coercing verbs by themselves are no more difficult as a class than other types of verbs (McElree et al., 2001; Traxler et al., 2002). It also indicates that any difference between the coercing and control conditions in subsequent measures in this experiment cannot be attributed to spillover effects originating at the verb itself.

No main effects or interactions occurred in the first-pass regressions or regression-path duration data from the verb region, but there was a main effect of verb type (coercing versus control) in the total time data. Coercing verbs had mean total time of 423 ms versus 377 ms for the control verbs, \( F(1,39) = 10.6, p < .01, MSe = 8332; \ F(2,127) = 10.8, p < .01, MSe = 6888 \). This total time difference indicated that, overall, readers had greater difficulty processing coercing expressions, regardless of context. No other main effects or interactions occurred in the total time data from the verb region.

**Noun region**

There were only two effects of note in the noun region. First, as in the verb region, there was some indication of an effect of verb type in the total time data, as sentences with coercing verbs had mean total times of 520 ms versus 493 ms for sentences with control verbs. However, although this effect was significant by items, \( F(2,127) = 4.36, p < .05, MSe = 4874 \), it was marginal by subjects, \( F(1,39) = 3.44, p = .07 \). This marginal effect parallels the significant effect seen in the verb region, and it suggests that readers had difficulty processing coercing expressions, regardless of context. The regression-path time data produced a trend toward an effect of context in the by-participants analysis, \( F(1,39) = 3.34, p = .08, MSe = 8297 \), but not in the by-items analysis, \( F(2,127) = 2.19, NS, MSe = 9177 \). This marginal effect resulted from longer regression-path times in the event contexts (486 ms) than in the neutral contexts (459 ms). The direction of this difference is antithetical to the marginal first-pass effect of context on the verb region, and hence it may reflect some tradeoff in processing the respective regions.

**Post-noun region**

Only one marginal effect occurred in the data from the post-noun region. In the regression-path analyses, the by-items analysis produced a trend toward an effect of verb type, \( F(1,39) = 2.76, p = .10, MSe = 12,112; \ F(2,127) = 3.56, p < .07, MSe = 11,898 \). If real, this finding suggests that the difficulty of coercion may begin shortly after the coercing expression is encountered. This would accord with earlier findings (Traxler et al., 2002).

**Summary and implications**

Expressions thought to require coercion were measurably more costly to process than those in which the default interpretation of the NP matched the semantic requirements of the verb, a result that replicates previous findings with both self-paced and eye-movement monitoring procedures (McElree et al., 2001; Pickering et al., in press; Traxler et al., 2002). Crucially, however, there was no evidence to indicate that providing a context that directly specified the action implicit in the dominant interpretation of the coerced expressions attenuated the attendant processing costs.

These results are difficult to reconcile with accounts that would attribute the cost to the time or effort needed to retrieve a possible activity associated with the NP complement. Prior processing of a specific, appropriate action should have made the coercing expression as easy to process as the control expression, or, minimally, easier to process than a coercing expression in a neutral context. The results are also inconsistent with accounts that would attribute the costs to the inherent underspecification of expressions requiring coercion. Again, providing the action should have eliminated or at least attenuated the underspecification inherent in these expressions, reducing the difficulty accordingly. However, the pattern is what is predicted by our hypothesis that coercion costs result from the additional operations needed to build an event structure for the VP.

**Alternative explanations**

A context that introduces the activity in an event coercion may have the potential to reduce or eliminate the coercion cost, but the cost we observed in this experiment may instead reflect a mismatch between the target text and the reader’s expectation about what objects might be upcoming. For example, when reading The contractor was building in the suburbs..., readers may have inferred that the builder was building houses. When they subsequently encountered the builder began a condominium, they would have to update their discourse representation, deleting the inferred object (houses) and replacing it with the actual object (condominium).
To test this account, we collected fill-in-the-blank responses for the stimuli used in this experiment. In the first completion task, 50 participants read the context and target sentences together, with the critical noun (e.g., condominium) replaced by a blank space. Participants were instructed to fill in the blank with the first sensible noun that came to mind. From the participants’ responses, we calculated three percentages: (1) The percentage of the most frequent response given (e.g., house). (2) The percentage of the most frequent response given plus any words that were synonyms or near synonyms (e.g., house and building). (3) The percentage of completions given that contained the critical target noun (e.g., condominium). In a second completion task, 45 participants were presented with the context sentences alone, e.g., The contractor had been building the_____ in the suburbs, with determiner (the) and a blank following the verb, and they were likewise instructed to fill in the blank with a plausible noun. The same three percentages as in the first norming task were calculated based on the participants’ responses.

Simple correlation analyses were used to assess whether the likelihood of a particular noun affected readers’ eye movements. We used the three fill-in-the-blank measures (most frequent response percentage, most frequent response plus synonyms, percentage of time that the target word was used in the completion task) from each completion task as predictors of the differences in reading times between the coercing and control target sentences. Separate correlations were computed for each of the differences in the four dependent variables (first pass time, total time, regressions, and regression-path duration). We analyzed the event context conditions separately from the neutral context conditions before conducting a further set of correlation analyses in which the neutral and event context conditions were analyzed together. [Hence, we had six predictor variables, three from the first set of norms, three from the second, and three criterion variables (neutral context coercion minus control, event context coercion minus control, combined coercion minus control), for each of four different dependent variables.]

If the difference between the coercing and control conditions reflects a kind of semantic reanalysis, then, assuming that the completion percentages adequately reflect how often the eye-tracking participants made the putative object inference, the magnitude of the difference between the coercing and control conditions at the target noun phrase should increase with increasing proportions of responses other than the actual one used in the target expression, and the magnitude of the difference should decrease with increasing proportion of responses used in the target expression. However, to the contrary, none of the correlation analyses found a significant \( p < .05 \) relationship between the completion proportions and the measures of the processing difficulty between the control and coercion expressions. For example, the 18 separate analyses of the total time data from the NP region yielded \( r \)-values between \(-.28 (p = .15) \) to \(+.31 (p = .11) \), with an average \( r \)-value of \(-.03 \). Our analysis technique maximizes the possibility of a statistically significant result, even a spurious one, which would run counter to the coercion hypothesis.

Given the lack of significant correlations between several measures of processing difficulty and several measures of what readers might expect at different points in the materials, there is little grounds to attribute the observed differences to a type of misanalysis based on expectations.

**Experiment 2**

Experiment 2 tests further the idea that the observed costs in Experiment 1 resulted from readers inferring one object (e.g., house) after processing the context sentence and subsequently revising this interpretation. We did so by eliminating the putative need to revise the projected semantic interpretation. Using the first norming data described in the previous section, we selected the most frequently occurring noun for each test sentence. This noun represented the most likely object that reader would infer from all of the context material prior to the critical region. These nouns minimize the need for readers to revise any initial semantic commitment they might make based on the processing of the context sentence. Thus, any processing cost observed in the coercing conditions in this experiment can be less plausibly attributed to the revision of a prior semantic commitment.

**Method**

**Participants**

Forty-eight undergraduates from the University of California at Davis participated in exchange for course credit. All participants were native English speakers with normal vision and hearing. One participant was removed from the analyses reported below because of missing data on more than half of the trials.

**Stimuli and procedure**

The stimuli were adapted from the previous experiment by replacing the critical nouns with the nouns that occurred most frequently in the fill-in-the-blank norming described in the preceding results section. The experimental and analysis procedures were identical to Experiment 1.

**Results and discussion**

As in the Experiment 1, we analyzed data from three scoring regions—verb, noun, and post-noun. Prior to
analyzing the data, we removed any fixation times less than 120 ms or greater than 2000 ms. This procedure eliminated 11.4% of the data in Experiment 2. The data were initially subjected to 2 (context: event vs. neutral) × 2 (verb type: coercing vs. control) repeated measures ANOVAs with both factors treated as within-participants and -items. Table 2 presents mean values for the four dependent measures by condition for each of the three scoring regions.

**Verb region**

Data from the verb region produced main effects of verb type in the first pass \[ F(1, 46) = 4.90, p < .05, MSe = 3017; F(2, 127) = 7.73, (p < .05), \] and total time \[ F(1, 46) = 25.5, p < .001, MSe = 6539; F(2, 127) = 8.43, p < .01, MSe = 10,289, \] as sentences with coercing verbs had longer fixation times than sentences with control verbs. No other main effects or interactions attained statistical significance.

The 18 ms first-pass effect could reflect length differences between the two conditions, even though we did not find comparable first pass effects in Experiment 1. Attributing the 60 ms main effect in total time to the cost of coercion is somewhat complicated by this 18 ms first-pass effect, as it is possible that at least a part of the 60 ms total time effect may reflect length differences. Indeed, the 60 ms total time effect is higher than the comparable 46 ms difference seen in Experiment 1. The fact that it is higher by approximately the same amount as the first pass effect is at least suggestive of an additive combination of length and coercion effects.

**Noun region**

Data from the noun region produced an interaction of context and sentence types in the total time data \[ F(1, 47) = 4.80, p < .05, MSe = 12,970; F(2, 127) = 5.01, p < .05, MSe = 5004. \] Tests for simple effects showed that the coercing condition had longer total fixation time than the control condition when the target sentence followed a neutral context \[ F(1, 47) = 7.16, p < .01, MSe = 12,970; F(2, 127) = 8.35, p < .01, MSe = 5004, \] but not when the target sentence followed the event context (both \( F < 1 \)). Likewise, the coercing target sentences following neutral contexts had greater total fixation time than the coercing target sentences that followed event contexts \[ F(1, 47) = 4.17, p < .05, MSe = 12,970; F(2, 127) = 4.08, p < .05, MSe = 5004. \] No other main effects or interactions were significant in the noun region. The data from this region provide some evidence that the event context eliminated the coercion cost. However, analyses of the post-noun region, like the verb region, suggest otherwise.

**Post-noun region**

There was a trend toward a main effect of verb type (coercing slower than control) in the first-pass data in post-noun region \[ F(1, 47) = 3.19, p < .10, MSe = 5606; F(2, 127) = 3.47, p < .10, MSe = 2850. \] The main effect of verb type was significant in three measures, in the total time data \[ F(1, 47) = 9.37, p < .01, MSe = 9125; F(2, 127) = 8.32, p < .01, MSe = 6869, \] in the first-pass regressions data \[ F(1, 47) = 7.95, p < .01, MSe = 862; F(2, 127) = 4.82, p < .05, MSe = 88.0, \] and in regression-path time \[ F(1, 47) = 5.11, p < .05, MSe = 25,963; F(2, 127) = 5.04, p < .05, MSe = 16,101. \] No other main effects or interactions were significant.

**Summary and implications**

The interaction of context (event vs. neutral) and verb type (coercing vs. control) in the total time data
from the noun region provided some evidence that explicitly introducing the activity implicit in the coerced expression eases the difficulty of coercion. At the noun region, the event context eliminated the difference between the coerced and control condition. However, the main effects of verb type in first-pass regressions, regression-path time, and total time in the post-noun region indicate that expressions requiring complement coercion were subsequently more difficult to process than control expressions, even with an event context. Hence, the data indicate that, at best, this type of context facilitated the processing of a coerced expression but it did not eliminate the overall cost. In this respect, the results resemble those from Experiment 1, except that in Experiment 1 there was no indication that context moderated processing costs associated with coercing expressions.

One explanation of this pattern is that readers experienced generalized difficulty when processing coercing expressions (as in previous studies), but that information about specific activities or events in the context helped readers to home in on a plausible interpretation. Specifically, the presence of an appropriate activity in the immediate context may have facilitated the identification of an appropriate action for the coercing expression, and thereby momentarily reduced processing difficulty at the noun region. However, because readers may still need to build a fully integrated event sense of the coerced complement, a main effect of coercion emerged in the subsequent region.

Although plausible, we note that such an account presupposes a much stronger time-locking between eye movement and mental processes than may be empirically justified (Pickering et al., 2004). For example, it is not clear why, in Experiment 1, there was a main effect of coercion at the noun region, with longer total times for coerced than control expressions irrespective of context, and no comparable differences in the post-noun region, whereas, in Experiment 2, main effects emerged in the post-noun region. In general, the exact point at which coercion costs become evident in total-time and other second-pass measures appears to be somewhat variable. In some cases, coercion effects are seen at the NP and in the post-noun region (Experiment 1; Traxler et al., 2002, Experiment 2). In other cases, differences emerge at the NP and not the post-noun region (see Experiment 4), or, like here, in the post-noun but not the NP region (Traxler et al., 2002, Experiment 1). Given this variability, it does not appear prudent to draw strong conclusions based on the exact location of the difference.

What is clear from the present results is that the difficulty in coercion does not fully rest with either inferring the activity implicit in the coercion expression or in the inherent ambiguity of the coercion expression. The differences in the post-noun region are consistent with the hypothesis that part of the coercion costs results from the operations needed to build an event structure for the VP. Moreover, because the target nouns in this experiment were the objects most likely to be inferred from the context, the processing costs cannot be attributed to the mismatches between expectations based on the context and material in the target sentences.

**Experiment 3**

Coercion costs were observed in Experiments 1 and 2 even when the context provided the activity implicit in the coerced expression. The act of building an event structure to instantiate unexpressed but necessary semantic content may be the source of this processing cost. If so, then processing difficulty should be reduced if readers have just computed the required event sense. Prior processing may prime the required operations (procedural priming) or prime the content of the interpretation. In the limit, there may be no need to build an event interpretation for the expression if the discourse representation contains the required sense; a target coercing expression might be interpreted simply by referring back to the relevant part of an already established discourse structure.

To test this idea, the context sentences in this experiment included a full event structure, either one that had to be generated by a coercion operation, as in (3a) and (3c), or one that overtly expressed the event implicit in the expressions requiring coercion (according to earlier collected norms; McElree et al., 2001; Traxler et al., 2002), as in (3b) and (3d). Fully crossed with the context sentences were two target sentences, one that required coercion, as in (3a) and (3b), or one that was the simple analogue of the coerced form, as in (3c) and (3d):

(3a) The student started a book in his dorm room. Before he started the book about the opium trade, he checked his e-mail (coercing context, coercing target).

(3b) The student read a book in his dorm room. Before he started the book about the opium trade, he checked his e-mail (control context, coercing target).

(3c) The student started a book in his dorm room. Before he read the book about the opium trade, he checked his e-mail (coercing context, control target).

(3d) The student read a book in his dorm room. Before he read the book about the opium trade, he checked his e-mail (control context, control target).

Based on prior findings, we predicted that context sentences requiring coercion (3a and 3c) would be more difficult to process than the control sentences, which
readers can process with simple compositional operations (3b and 3d). At issue is whether the same difference would be evident in the target sentences.

Additionally, both the context sentences in (3a) and (3b) might eliminate or attenuate the difficulty of the coerced target expressions. Although only the context sentence in (3a) requires enrichment of the VP, they both place in the discourse the relevant event sense, and hence potentially eliminate the need to compute the extended sense of the VP in the target sentence. If attenuation requires exact repetition of the procedures used to compute the interpretation for the VP, then only the context sentence in (3a) should be effective. But if attenuation only requires repetition of the event sense (here, reading the book), then both (3a) and (3b) should lead to reduced difficulty processing coercing expressions in the target sentences. Both contexts contrast with the event context in Experiment 1 in that they specifically link the NP in the target expression to the action that is implicit in the coerced sense (e.g., reading a book) rather than simply introducing the action (e.g., reading) without linking that action to a specific NP. The context in (3a) and (3b) may enable readers to circumvent the hypothesized coercion operations by linking the expression in the target sentence to an already established discourse structure, not unlike the manner in which readers might interpret an elided VP (cf. The student started read a book in his dorm room. Before he did that, he checked his e-mail). In conjunction with the fact that context did not eliminate difficulty associated with coercing expressions in Experiment 1, such a finding would provide strong support for the hypothesis that what is costly in coercion is the building of an interpretive structure to instantiate unexpressed semantic content, but that such operations are only necessary when the relevant event sense is not already available.

Method

Subjects

Thirty participants from the same population as Experiment 1 took part in the experiment under the same terms.

Stimuli

We constructed 28 sets of items like (3a)–(3d) by modifying the items from Experiment 1. Some of the coercing and control verbs were changed to more closely match for length across conditions (see below). Half of the context sentences contained coercing expressions, and half contained comparable non-coercing expressions. Hence, the context was either coercing or control. This factor was crossed in the target sentences, half of which contained a coercing expression and half of which contained a non-coercing expression. One version of each item was randomly assigned to one of four lists such that an equal number of each type appeared on each list and so that no participant saw more than one version of each item. The experimental passages were presented to participants along with 36 passages from an unrelated study. The verbs in the coercing and control conditions were on average 7.9 and 6.2 characters long, respectively. This difference was statistically significant, $F(1, 27) = 12.1, p < .01, MSe = 3.3$. The verbs occurred at an average frequency of 230 and 197 times respectively in the Brown Corpus (Francis & Kucera, 1982). This difference was not significant, $F < 1$. As in the preceding experiments, we conducted residual reading time analyses which yielded the same pattern of effects.

Because some of the subordinate clauses in the target sentences violated temporal iconicity, and because such violations can produce elevated reading time, we performed a plausibility-post test to determine the general acceptability of the sentence-pairs. Eighteen naïve raters from the same pool as the eye-movement participants read randomized lists containing the prime-target pairs and assigned a number from 1 to 7 for each reflecting their assessment of how much sense each pair made as a whole. All four conditions produced mean ratings above 5.1, indicating that our participants found the stimuli to be fairly sensible. When the rating data were subjected to 2 (context: coercing vs. control) × 2 (target: coercing vs. control) ANOVAs with participants and items treated as random factors, there was a main effect of target by participants, $F(1, 17) = 6.91, p < .05, MSe = 0.29$, but not by items $F(2, 27) = 1.58$, with stimuli with coercing expressions in the target sentence being rated slightly higher than stimuli with control expressions in the target (5.5 vs. 5.1). No other effects approached significance.

Design and procedure

Crossing context sentence type (coercing vs. control context) and target sentence type (coercing vs. control target) produced a $2 \times 2$ design with both factors manipulated within-participants and -items. The eye-movement monitoring procedure was identical to Experiment 1.

Because both context and target sentences in Experiment 3 contained coercing and control expressions, we analyzed both sentences using scoring regions comparable to those in the first experiment. Hence, there was a verb region in the context sentence and in the target

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2 One might be concerned that coercion cost might be lower or minimal in the target sentences because many of the coercing expressions occur in subordinate clauses, perhaps because readers process these clauses less fully or deeply than main clauses. However, we have found significant coercion costs in expressions like Before beginning the book... in both self-paced reading and eye-tracking procedures (McElree, Pickering, Traxler, & Chen, in preparation).
sentence, a noun region in the context and target sentences, and so on.

Results and discussion

Table 3 presents mean values for the four dependent measures for each of the six scoring regions. Prior to analyzing the data, we removed any fixation times less than 120 ms or greater than 2000 ms. This procedure eliminated 13.3% of the data.

In the context sentence, the verb region produced a main effect of context sentence type in the total time measure, as context sentences with coercing expressions had mean total times 98 ms longer than control expressions, \( F(1,29) = 4.14, \ p = .05, \ MSe = 16,980; \ F(1,27) = 3.49, \ p = .07, \ MSe = 10,888 \). The same analysis produced a main effect of target sentence type (coercing greater than control) in the by items analysis, \( F(1,27) = 5.77, \ p < .05, \ MSe = 9152 \), but not in the by participants analysis, \( F(1,29) = 1.5, \ NS, \ MSe = 15,309 \).

In the context sentence, the noun region produced main effects of context sentence type (coercing greater than control) in regression-path time, \( F(1,29) = 8.05, \ p < .01, \ MSe = 16,862 \). The post-noun region produced a main effect of context sentence type (coercing greater than control) in the first-pass regressions, \( F(1,29) = 10.4, \ p < .01, \ MSe = 241 \); \( F(1,27) = 4.08, \ p < .05, \ MSe = 147, \) and in

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</table>

*Note.* Fixation times are reported in milliseconds.
regression-path times, \( F(1, 29) = 5.98, \ p < .05, \ MSe = 17,728; \) \( F(2, 27) = 3.95, \ p = .06, \ MSe = 12,279. \) Additionally, the post-noun region produced main effects of the target sentence type (coercing greater than control) in the total time data, \( F(1, 29) = 3.51, \ p = .07, \ MSe = 14,277; \) \( F(2, 27) = 6.75, \ p < .05, \ MSe = 8943. \)

These results indicate that coercing expressions were more difficult to process than control expressions beginning very soon after readers fixated the object noun. This replicates findings from Experiments 1 and 2 and from previous studies (McElree et al., 2001; Pickering et al., in press; Traxler et al., 2002). The lack of a first pass effect in the verb region indicates further that effects in subsequent measures are not due to differences in factors like the length or frequency of the verbs.

Main effects of target sentence type may also indicate that more re-reading of the context sentence occurred when the target sentence contained a coercing expression than when it contained a control expression. However, it is odd that this effect would be evident only in the by-items analysis of total time on the verb in the context sentence and on the post-noun region (which also had only a strong trend toward an effect in the by-participants analysis). Hence, we doubt this effect is meaningful.

**Target sentence**

No effects were significant in both the by-participants and by-items analyses in the target sentence. First-pass data from the verb region produced a main effect of target sentence type in the by-participants analysis, \( F(1, 29) = 4.11, \ p < .05, \ MSe = 5960, \) but not in the by-items analysis, \( F(2, 27) < 1. \) Regression path time data from the noun region produced a trend toward an interaction of context and target types, \( F(1, 29) = 3.03, \ p < .10, \ MSe = 13,418; \) \( F(2, 27) = 3.19, \ p < .10, \ MSe = 12,848. \) The post-noun region produced a trend toward a main effect of target sentence type (coercing greater than control) in the regression path time data, \( F(1, 29) = 3.08, \ p < .10, \ MSe = 13,216; \) \( F(2, 27) = 3.09, \ p < .10, \ MSe = 12,350. \) Hence, unlike in the context sentence, there is no clear evidence to support the claim that coercing expressions were more difficult than control expressions in the target sentence.

**Context versus target sentences**

To verify that the coercion cost was greater in the context than in the target sentences, and hence to further test the claim that context can attenuate the coercion costs, we conducted a set of analyses comparing corresponding regions in the context and target sentences. The tests consisted of 2 (region: context sentence versus target sentence) \( \times 2 \) (context verb type: coercing versus control) \( \times 2 \) (target verb type: coercing versus control) ANOVAs, with all factors within participants (F1) and items (F2). We conducted these ANOVAs on the four dependent measures for each of the three scoring regions. For our purposes, the critical statistic is the interaction of region and context verb type, which is based on comparing the coercing and control conditions in the context and target sentences, respectively. A positive result indicates a different-sized effect of verb type (coercing versus control) in the context sentence than in the target sentence.

The verb region produced an interaction in the total time data, \( F(1, 29) = 14.3, \ p < .001, \ MSe = 8339; \) \( F(2, 27) = 7.79, \ p < .01, \ MSe = 11,180, \) stemming from the fact that the coercion cost on the verb in the context sentence was 98 ms as compared to 18 ms in the target sentence. The noun region also produced interactions in the total time data, \( F(1, 29) = 5.84, \ p < .05, \ MSe = 8379; \) \( F(2, 27) = 3.85, \ p = .06, \ MSe = 10,640, \) with coercion costs of 63 ms in context sentence as compared to 1 ms in the target sentence. The post-noun region produced interactions in the first-pass regressions data, \( F(1, 29) = 6.67, \ p < .05, \ MSe = 163; \) \( F(2, 27) = 7.37, \ p < .01, \ MSe = 117, \) as the context sentence had roughly twice as many regressions in the coercing condition as the control (18.2% vs. 9.8%), while the target sentence had equal numbers of regressions across conditions (5.3% vs. 3.1%). The regression-path duration data produced an interaction that was reliable by participants, \( F(1, 29) = 6.05, \ p < .05, \ MSe = 12,845, \) but not by items, \( F(2, 27) = 1.32, \ NS, \ MSe = 15,645. \)

**Summary**

Collectively, the separate analyses of the context and target sentences and the comparative analyses of the two sentences indicate that the cost associated with processing a coercing expression was attenuated and virtually eliminated by processing a context sentence that either required the same coercion operation (started the book) or that explicitly mentioned the event structure (read the book) that is thought to underlie its interpretation. The correlational analysis procedure described in the Experiment 1 results section was applied to the data from Experiment 3, again without producing a significant result.

**Experiment 4**

One potential complication in Experiment 3 is the use of repeated noun phrases between the context and target sentences. Under some conditions, such expressions cause disruption of processing, because they are thought to either violate common usage (e.g., Sanford & Garrod, 1981) or engender competition in integration (Almor, 2000). Additionally, we cannot be certain whether readers interpreted the noun phrases in the context and target sentences as coreferential (though our argument does not require that they are interpreted
in this way). Although this potential complication does not clearly explain why effects were smaller in the target sentences than in the context sentences in Experiment 3, we nevertheless performed a further experiment in which the explicit full-noun-phrase anaphors from Experiment 3 were replaced by pronouns (such as it, or them). If Experiment 4 replicates the findings of Experiment 3, it would show that this form of priming does not require exact repetition of the words used.

Method

Subjects

Thirty-two undergraduate students at the University of California at Davis participated in exchange for course credit. All participants were native English speakers with normal vision and hearing.

Stimuli

The stimuli consisted of the 28 sets from Experiment 2 with the critical-noun phrases in the target sentences replaced by pronouns (as in 4a–d):

(4a) The student started a book in his dorm room. Before he started it, he checked his e-mail (coercing context, coercing target).
(4b) The student read a book in his dorm room. Before he started it, he checked his e-mail (control context, coercing target).
(4c) The student started a book in his dorm room. Before he read it, he checked his e-mail (coercing context, control target).
(4d) The student read a book in his dorm room. Before he read it, he checked his e-mail (control context, control target).

Procedure

The eye-movement monitoring procedure was identical to the previous experiment.

Results and discussion

Table 4 reports mean values for four dependent measures by region and condition for Experiment 4. There was one minor change to the regions. Whereas in the preceding experiment, the second noun region consisted of the determiner and noun following the main verb, in this experiment, the second noun region consisted of the pronoun and the word following plus the comma. We reconfigured the region because pronouns (especially the pronoun it) are frequently skipped. Hence, the encoding fixation for the pronoun would often be the fixation on the word immediately preceding or following the pronoun (Rayner & Pollatsek, 1989). Because the verb region immediately preceded the pronoun, effects there may be influenced by processes involved in interpreting the pronoun. As in the previous experiments, the verb region contained the matrix verb and any auxiliary. The post-noun region consisted of the two words following the noun region.

Before analyzing the data, we removed any fixation times less than 120 ms or greater than 2000 ms. This procedure eliminated 13.1% of the data from Experiment 4.

The data from each scoring region were subjected to 2 (context sentence type: coercing vs. control verb) × 2 (target sentence type: coercing vs. control) repeated-measures ANOVAs.

Three effects were significant in both the by-participants and by-items analysis. First, as in Experiment 3, total reading time on the verb region in the context sentence was greater when the context sentence had a coercing verb than when it had a control verb, \( F(1,31) = 11.2, p < .01, MSe = 1116; \) \( F(2,1,27) = 8.65, p < .01, MSe = 9514 \). Indeed, the average total times on the verb in this experiment, 446 ms for coercing verbs versus 384 ms for control verbs, were quite comparable to the times observed in Experiment 3, 423 ms versus 376 ms (respectively). Second, and again as in Experiment 3, total reading time on the noun region in the context sentence was greater when the context sentence had a coercing verb than when it had a control verb, \( F(1,31) = 6.55, p = .02, MSe = 12,048; F(2,1,27) = 3.65, p = .07, MSe = 16,452 \). The average total time on the noun region was 569 ms with coercing verbs and 512 ms with control verbs, as compared to 586 and 523 ms in Experiment 3. Finally, consistent with Experiment 3, there was no evidence to suggest that readers found the coercing expression difficult to process in the target sentence. The only significant effect (marginal by participants) in the target sentence was that total reading time in the post-noun region was greater when the target sentence contained a control verb than when it contained a coercing verb, \( F(1,31) = 3.84, p = .06, MSe = 15,268; F(2,1,27) = 7.58, p < .01, MSe = 5103 \), which suggests that, for some unknown reason, readers had more difficulty processing control than coercing expressions. Because this effect is isolated and does not occur in the regions where total time effects of coercion are normally detected, it probably does not reflect real differences between conditions. In any case, it is of course consistent with the claim that our contextual manipulations reduce difficulty.

As in the preceding experiment, we conducted further analyses comparing corresponding regions in the context and target sentences, using 2 (sentence: context vs. target sentence) × 2 (context verb: coercing vs. control) ANOVAs. The verb regions produced an interaction of sentence and verb types in the total time data, \( F(1,31) = 16.4, p < .01, MSe = 8799; F(2,1,27) = 10.7, p < .01, MSe = 9102 \). Total reading time for coercing verbs was 62 ms greater than for control verbs in the context sentence, but only 17 ms greater in the target sentence. The noun regions produced a trend toward the same interaction of sentence and verb types,
Table 4
Mean first-pass, regression-path time, first-pass regressions, and total time by scoring region and condition for Experiment 4

<table>
<thead>
<tr>
<th>Condition</th>
<th>First-pass time</th>
<th>First-pass regressions (%)</th>
<th>Regression-path duration</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context sentence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercing context, coercing target</td>
<td>324</td>
<td>8.9</td>
<td>378</td>
<td>432</td>
</tr>
<tr>
<td>Coercing context, control target</td>
<td>344</td>
<td>7.1</td>
<td>394</td>
<td>460</td>
</tr>
<tr>
<td>Control context, coercing target</td>
<td>303</td>
<td>14.7</td>
<td>399</td>
<td>370</td>
</tr>
<tr>
<td>Control context, control target</td>
<td>320</td>
<td>9.8</td>
<td>410</td>
<td>398</td>
</tr>
<tr>
<td>Noun region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercing context, coercing target</td>
<td>433</td>
<td>10.3</td>
<td>521</td>
<td>580</td>
</tr>
<tr>
<td>Coercing context, control target</td>
<td>431</td>
<td>12.9</td>
<td>521</td>
<td>558</td>
</tr>
<tr>
<td>Control context, coercing target</td>
<td>417</td>
<td>8.0</td>
<td>476</td>
<td>521</td>
</tr>
<tr>
<td>Control context, control target</td>
<td>413</td>
<td>11.2</td>
<td>537</td>
<td>517</td>
</tr>
<tr>
<td>Post-noun region</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercing context, coercing target</td>
<td>359</td>
<td>9.4</td>
<td>456</td>
<td>438</td>
</tr>
<tr>
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<td>9.8</td>
<td>453</td>
<td>463</td>
</tr>
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<td>Control context, coercing target</td>
<td>356</td>
<td>12.5</td>
<td>447</td>
<td>449</td>
</tr>
<tr>
<td>Control context, control target</td>
<td>388</td>
<td>5.8</td>
<td>426</td>
<td>457</td>
</tr>
<tr>
<td>Target sentence</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Verb region</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Coercing context, coercing target</td>
<td>318</td>
<td>9.4</td>
<td>374</td>
<td>346</td>
</tr>
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<td>Coercing context, control target</td>
<td>307</td>
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<td>365</td>
<td>327</td>
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<td>388</td>
<td>375</td>
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<tr>
<td>Control context, control target</td>
<td>299</td>
<td>9.4</td>
<td>366</td>
<td>363</td>
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<tr>
<td>Noun region</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>312</td>
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</tr>
<tr>
<td>Control context, coercing target</td>
<td>269</td>
<td>5.4</td>
<td>323</td>
<td>314</td>
</tr>
<tr>
<td>Control context, control target</td>
<td>269</td>
<td>4.5</td>
<td>322</td>
<td>295</td>
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<tr>
<td>Post-noun region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercing context, coercing target</td>
<td>384</td>
<td>5.4</td>
<td>419</td>
<td>428</td>
</tr>
<tr>
<td>Coercing context, control target</td>
<td>399</td>
<td>7.1</td>
<td>446</td>
<td>482</td>
</tr>
<tr>
<td>Control context, coercing target</td>
<td>385</td>
<td>8.5</td>
<td>442</td>
<td>453</td>
</tr>
<tr>
<td>Control context, control target</td>
<td>401</td>
<td>6.7</td>
<td>464</td>
<td>485</td>
</tr>
</tbody>
</table>

Note. Fixation times are reported in milliseconds.

$F(1, 31) = 3.31, p = .08, MSe = 11.291; F(2, 17) = 2.95, p < .10, MSe = 11.043$, suggesting that there was a greater difference in total reading time between coercing and control expressions in the context sentence than in the target sentence. Total reading time in the coercing noun region was 60 ms greater than the control noun region in the context sentence, but virtually identical in the target sentence (304 ms vs. 307 ms). Finally, although the initial analyses showed a difference between the control and coercing expressions in the post-noun region in the target sentence, the post-noun regions did not produce an interaction of sentence and verb types, both $Fs < 1$. Additionally, the correlational analysis procedure described in the Experiment 1 results section was applied to the data from Experiment 4, again without producing a significant result.

The finding of difficulty in the context sentence when a coercing verb preceded an entity noun is consistent with the results of the first three experiments and with prior studies (McElree et al., 2001; Traxler et al., 2002). As with Experiment 3, there was clear evidence that the corresponding processing cost in the target sentence was attenuated when the context sentence contained the complete event structure (e.g., either read a book or started a book). In this experiment, there was no sign of any difficulty, even on the total time measures in the target sentence. This finding alleviates any concern that the results reported in Experiment 3 might be due to infelicitous NP repetitions.

General discussion

The first two experiments demonstrated that expressions requiring complement coercion were difficult to process whether or not the context introduced the
action implicit in the dominant interpretation of these expressions. This conclusion is supported by total time differences in the verb and noun regions in Experiment 1 and by total time effects in the post-noun region in Experiment 2. We suggest that the pattern of results indicates that inferring or selecting the action inherent in the event sense is not the sole source of the difficulty in coercion. The fact that coercing expressions produced measurable processing costs in Experiment 2 also suggests that it is unlikely that the cost results from readers inferring an inappropriate object.

Before interpreting the results further, we highlight and discuss a few potential concerns. First, because some of the experiments involved items where verbs were longer on average in the coercing conditions than in the control conditions, some part of the main effects might have been due to length effects rather than enriched semantic processing. However, we do not believe that this was the case. First, with the exception of one marginal first-pass effect (18 ms in Experiment 2), there were no other indications that coercing verbs were harder to process than control verbs. Previous studies in which coercing and control verbs were matched for length and frequency have shown that coercing verbs themselves are as easy to process as control verbs (McElree et al., 2001; Pickering et al., in press; Traxler et al., 2002). Second, elevated processing times for coercing expressions occurred in the absence of differences on the verb. Third, differences between coercing and control expressions did not occur in contexts where the event sense was introduced by an unambiguous (control) expression. If the coercion effects were based on artifactual differences between coercing and control verbs, reading times should have been elevated in the coercing expressions, but they were not. Finally, when length differences were accounted for in residual reading time analyses, differences between coercing and control conditions remained.

Second, it is possible that readers may have experienced some difficulty processing the NP regions of the stimuli because they attempted to interpret them anaphorically. That is, when reading the book in the target sentences in Experiments 1 and 2, readers may have attempted to find a referent in their representation of the context. Because the target nouns were not previously introduced, any attempt to treat this expression as an anaphor would fail, potentially leading to increased reading times. However, this hypothesis cannot account for the differences between coercing and control expressions. Crucially, the same definite NPs appeared across conditions, so any increased cost in the coercing expressions due to anaphoric processing should be matched by the same degree of increased cost in the control expressions.

Finally, despite the overall positive evaluation of the stimuli exhibited in the plausibility post-test, some contextual effects may have been obscured as a result of particular features of the stimuli. For example, some items contained violations of temporal iconicity, which have been shown to cause elevated processing times (Mandler, 1986). That is, readers take longer to process texts when the events are mentioned in the text in a different order than they occurred in the real (or imagined) world. It is possible that contextual influences on the coercion process might emerge in a sample of items with improved discourse features.

With these cautions in mind, we suggest that the findings from Experiments 1 and 2 are at odds with approaches that would solely attribute the cost of processing coercing expressions to inferring or selecting the action inherent in the event sense. The only evidence that supports such a claim is the isolated interaction of context (explicit event vs. neutral) and type of expression (coercing vs. control) observed in total time on the noun region in Experiment 2. Were this the only reliable effect in this experiment, it would of course suggest that coercing expressions can be interpreted without substantial cost in contexts where the relevant action in the event sense has been previously specified, and this in turn would suggest that processes involved with inferring or selecting an action for the event sense are uniquely responsible for the coercion effects observed in other studies. However, main effects of coercion were found in several other measures in this experiment as well as in Experiment 1, and this suggests that these alternative accounts are either incorrect or, at a minimum, inadequate. The overall pattern of results clearly establishes that coercing expressions engender additional processing costs even when the context explicitly supplies a highly appropriate and likely action for the coerced sense.

As mentioned previously, this interaction suggests that this type of context can partly facilitate the processing of a subsequent coercing expression, even though it does not entirely eliminate the cost. It may do so by making the required action more accessible when it is not readily apparent, thereby facilitating retrieval processes, or by making the action more salient, thereby reducing competition from alternative senses. We note that this interaction could also result from readers having anticipated the NP in the coercing expression when processing some of the context sentences. For example, when processing the context sentence The contractor had been building..., some readers may have assumed that the contractor was building houses. If this were the case, the reader would have computed the full event sense prior to processing the coercing expression, and this context would be functionally equivalent to the full event sense contexts used in Experiments 3 and 4. The results of Experiments 3 and 4 show that a context with a full event sense eliminates the cost of coercion, so it is possible that a context that enabled readers to anticipate the
NP in the coercing expression on some trials could have attenuated the coercion cost.

Whatever the reason for this isolated interaction, the overall pattern of results from both experiments indicates the cost of processing expressions like \textit{began the book} cannot be reduced to the cost associated with inferring or selecting one of several possible actions for the event sense. Concerning the latter, we note that if contextual information serves to constrain an interpretation, as is often assumed (e.g., Altmann & Steedman, 1988; Binder & Morris, 1995; Hess, Foss, & Carroll, 1995; Pickering & Traxler, 1998, Experiment 3), the context should have made the action salient and eliminated the inherent ambiguity of these expressions and, correspondingly, eliminated the processing costs. Consequently, although expressions like \textit{began the book} are semantically underspecified, we believe that it is highly unlikely that his type of ambiguity is the source of the observed cost in processing these expressions.

Likewise, these experiments also indicate that the source of the observed difficulty does not lie entirely in the difficulty of retrieving or inferring an action implicit in the event sense. If this were the case, making the implicit action salient by explicitly introducing it into the context should have eliminated the cost associated with coercion. There may be expressions requiring coercion in which the recovery of a suitable action does have measurable consequences, perhaps because it may require a relatively slow inferential process. However, in the types of materials examined here and in the studies of McElree et al. (2001), Pickering et al. (in press), and Traxler et al. (2002), which employed verbs like \textit{begin, finish, and enjoy} paired with a complement like \textit{the book}, the implicit actions are typically common ones involving a designated purpose for the entity (\textit{reading the book}) or which express the means by which the entity was created (\textit{building a condominium}). We assume that these properties are retrieved relatively automatically when the noun is encountered.

This assumption is consistent with the formal approach developed by Pustejovsky (1995), in which lexical representations consist of a Qualia Structure that codes common attributes of the entity, such as its constituent parts, telic properties (purpose and function), and agentive properties (mode of creation), among others. The telic or agentive qualia can be readily used to type-shift an NP like \textit{the book} from an entity to an event by providing semantic properties that enable the creation of a predicate like \textit{began to read \{write\} the book}. A primary reason for assuming lexical representations of the sort proposed by Pustejovsky (1995) is that they account for the default interpretations of otherwise underspecified expressions: An expression like \textit{enjoyed reading the book} is apt to be interpreted as either \textit{enjoyed reading the book} or \textit{enjoyed writing the book} unless there is other information to override these defaults. Although the Qualia Structures outlined in Pustejovsky (1995) are too restrictive to give a full account of all possible interpretations of coerced expressions, they do provide a principled explanation for findings from corpus analyses indicating that common activities, like reading or writing a book, are most often left unexpressed in texts (Briscoe et al., 1990; Lapata & Lascarides, 2003).

The fact that coercing expressions generated processing costs in Experiments 1 and 2 when the context introduced an explicit action is surprising given that similar contexts can eliminate the difficulty in processing other expressions. Perhaps most relevant are findings reported by Liversedge et al. (1998) that a context sentence like \textit{The gardener wondered where to plant the shrubs} eliminates the processing difficulty normally associated with a locative by-phrase in a passive sentence like \textit{In fact, the shrubs were planted by the greenhouse...} (see also Liversedge, Pickering, Clayes, & Branigan, 2003). However, the discrepancy between our findings and those of Liversedge et al. is less surprising with reflection on the differences between the two types of structures. The difficulty with locative phrases is attributed to fact that they are adjuncts not arguments (like agentive by-phrases), and so they are not projected from the verb’s lexical representation (Liversedge et al., 1998). When readers encounter the locative adjunct, they presumably engage in additional operations to incorporate the adjunct into a discourse representation. Simply introducing an unspecified locative role in the context (\ldots\textit{wondered where to plant}) apparently circumvents these costly operations. In contrast, however, if what is costly with \textit{began the book} is not integrating the expression into a discourse representation, but rather, as we hypothesize, building a local interpretation for an otherwise underspecified expression, then there is no reason to expect that placing the required action in the discourse would circumvent the need to build an event representation for the verb that incorporates the NP complement. Processing of an action like \textit{reading} may also cause readers to posit an open a discourse role for the theme of the action, but if a theme for the action is posited, that role is apparently not specific enough to facilitate the interpretation of an expression like \textit{began the book}.

Experiments 1 and 2 are consistent with our hypothesis that enriched composition is costly because readers must undertake operations that build a representation for the event sense of the complement, something like \textit{\{began, \{reading the book\}\}}, which incorporates the action into the semantic representation of the VP. Although simply providing the action in the immediate discourse would not be sufficient to circumvent the need to build a specific event representation, these operations may not be necessary if the required event sense for the complement (\S above) is available in the immediate discourse. Support for this claim was found in Experiments
3 and 4, which employed context sentences that either explicitly or implicitly contained the relevant event sense. Experiments 3 and 4 demonstrated that context sentences with coercing expressions were more difficult to process than context sentences with comparable control expressions, consistent with the results of Experiments 1 and 2 and other studies (McElree et al., 2001; Pickering et al., 2002). The clearest evidence for this conclusion is the significantly longer total times in the context sentence at the verb and noun regions in coercing as compared to control expressions. However, in both Experiments 3 and 4, the same effects were strikingly absent in the target sentences. At best, there were only sparse and unreliable indications that coercing expressions were more difficult to process than the control expressions following a context sentence that introduced the full event sense. Hence, if readers experienced any difficulty at all, it was likely only minor and transitory. These experiments provide clear evidence that recent processing of a relevant event sense greatly attenuates the processing difficulty that would otherwise occur with these types of expressions.

Equally important, a significant attenuation of the processing difficulty, and of comparable magnitude, occurred whether the context sentence introduced the relevant event structure explicitly or implicitly through a coercing expression that was repeated in the target sentence. This result strongly implicates event structures as the determining factor. If contextual effects were limited to cases involving repetition, the most parsimonious explanation would be one that appealed to the notion of repetition priming. The data indicate that there were only minor effects of repetition, and that repetition is not a necessary condition for attenuating the processing costs.

That processing costs were attenuated whether or not the target expression used the same verb as the context expression e.g., read or began and whether it used a repeated noun (Experiment 3) or pronoun (Experiment 4) suggests that readers were able to circumvent the costly act of building an event sense for the target expression by linking its interpretation to a relatively abstract event representation in the discourse. That process may be quite similar in nature to the processing of verb anaphors, notably VP ellipsis, which some have argued can be interpreted with a cost-free copying mechanism in which an interpretation of the elided material is simply copied from the discourse representation of its antecedent (Frazier & Clifton, 2001). In cases of coercion, comprehenders may likewise process the complement in the target VP anaphorically, using the event sense in their discourse representation as the antecedent.

Experiments 3 and 4 show that the cost of coercion can be circumvented if a relevant event sense is in the immediate discourse. These experiments do not, of course, specify all the necessary conditions for this to occur. Whether or not a discourse representation can substitute for coercion may depend on such factors as the saliency of the event sense in the discourse structure, as well as the specificity and degree to which the discourse sense matched the required sense. Concerning the latter, for example, we have demonstrated that processing either began the novel or read the novel eliminates the cost of interpreting either began the novel or began it, but we do not know whether finished the novel, began the newspaper, or enjoyed the newspaper would likewise eliminate the cost. Further research is needed to fully specify the conditions under which a discourse representation can substitute for enriched compositional operations.

Finally, it may be informative to contrast processing of coercing expressions with processing of metonymies. In metonymic expressions, a constituent with a simple default interpretation (like Dickens = Charles Dickens the author, as in My great-grandmother met Dickens) is used to represent a more complex meaning (like Dickens = any of a number of books written by Charles Dickens, as in I read a lot of Dickens in college, Dickens is on the top shelf). Recent studies on the processing of such metonymic expressions indicate that they are no more costly to process than equivalent literal expressions (Frisson & Pickering, 1999; cf. Gibbs, 1979). Metonymic expressions are similar to coercing expressions in that both require readers to forego a default interpretation in favor of an alternative. Coercing expressions are different from metonymic expressions in that they evoke substantial processing costs, while metonymic expressions do not. Why this difference? Frisson and Pickering suggest the relevant metonymic senses are part of the lexical representation of words commonly used metonymically and are automatically activated during lexical access. These studies suggest further that the interpretation of metonymic expressions is left underspecified, but that readers can, when necessary, engage in additional processes to select from among multiple related senses. We argued above that the full interpretations of coercing expressions cannot, even in principle, be stored as part of individual words’ lexical representation. Thus, full event senses for coercing expressions cannot be recovered from lexical access routines alone. In order for any interpretation at all to be assigned to a coercing expression, comprehenders must inspect and simultaneously evaluate the component properties of the agent, verb, and object. Further, coercing expressions require comprehenders to generate semantic and syntactic structure not explicitly represented in the text, which is not the case for metonymy.

Conclusions

The reported studies provide further evidence that the interpretation of some seemingly simple expressions
require enriched forms of composition. The unique con-
tribution of this study is to provide evidence suggesting
that composition is costly when readers must build a
sense for an expression that is not overtly expressed in
the sentence and that is not directly coded in the lexical
representation of the constituent in the expression.
Although context can have a profound influence on
different facets of sentence processing, often eliminating
processing difficulties that would otherwise occur, evi-
dence at hand suggests that its impact on coercion is
more limited. Context can ameliorate the cost associ-
ated with coercion if it contains a relevant event sense.
In this way, a discourse representation appears to serve
as an extended lexicon, providing an accessible reposi-
tory for specific senses that may otherwise be costly to
compute.

Appendix A

Stimuli from Experiments 1 and 2: C1, The context sentence mentions an activity related to the interpretation of the event-taking verb in the target sentence. C2, Control context sentence. T1, The target sentence contains an event-taking verb followed by an entity noun. T2, Control target sentence. Where the critical noun in Experiment 2 differed from the critical noun in Experiment 1, the noun from Experiment 2 appears in parentheses. “/” marks indicate where line breaks occurred when the stimuli were presented to readers in the eye-tracking procedure.

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>The contractor had been building in the suburbs.</td>
<td>The contractor had been looking for new jobs.</td>
<td>That spring, he began a condominium (house) next to the shopping center.</td>
<td>That spring, he built a condominium (house) next to the shopping center.</td>
</tr>
<tr>
<td>The student had been wanting to draw all day.</td>
<td>The student had been visiting the gallery all day.</td>
<td>That evening, he managed to start a picture of the winter landscape.</td>
<td>That evening, he managed to draw a picture of the winter landscape.</td>
</tr>
<tr>
<td>The soldier was drinking in a bar next to the base.</td>
<td>The soldier was hanging around outside the base.</td>
<td>In the afternoon, he began a bottle of imported scotch (a beer that was imported from Germany).</td>
<td>In the afternoon, he drank a bottle of imported scotch (a beer that was imported from Germany).</td>
</tr>
<tr>
<td>The quarterback was drinking a lot in celebration of the victory.</td>
<td>The quarterback was celebrating winning the championship game.</td>
<td>Notably, he enjoyed the champagne (alcohol) provided by the sponsor.</td>
<td>Notably, he drank the champagne (alcohol) provided by the sponsor.</td>
</tr>
<tr>
<td>The handyman was building all afternoon.</td>
<td>The handyman was working all afternoon.</td>
<td>Early in the evening, he completed the wall separating the bathroom and kitchen (table for the dining room).</td>
<td>Early in the evening, he built the wall separating the bathroom and kitchen (table for the dining room).</td>
</tr>
<tr>
<td>The mother was reading all morning.</td>
<td>The mother was relaxing all morning.</td>
<td>Just before lunch, she finished a thriller (book) about drug smuggling.</td>
<td>Just before lunch, she read a thriller (book) about drug smuggling.</td>
</tr>
<tr>
<td>The student was reading in his office.</td>
<td>The student was resting in his office.</td>
<td>After a while, he started a book about health care spending (the homework that was due on Monday).</td>
<td>After a while, he read a book about health care spending (the homework that was due on Monday).</td>
</tr>
<tr>
<td>The professor was writing at her desk.</td>
<td>The professor was sitting at her desk.</td>
<td>Before going to lunch, she finished a letter to the dean (a paper about the election).</td>
<td>Before going to lunch, she wrote a letter to the dean (a paper about the election).</td>
</tr>
<tr>
<td>The cadet was flying in a training program.</td>
<td>The cadet was participating in a training program.</td>
<td>By the end, he had mastered the bomber (plane) very well indeed.</td>
<td>By the end, he had flown the bomber (plane) very well indeed.</td>
</tr>
</tbody>
</table>
Appendix A (continued)

C1 The coastguard recruit was sailing at the academy./
C2 The coastguard recruit was training at the academy./
T1 During the course, he mastered the boat used for rescue.
T2 During the course, he sailed the boat used for rescue.

C1 The tycoon was sailing in the Caribbean./
C2 The tycoon was vacationing in the Caribbean./
T1 In fact, he enjoyed the yacht bought for this occasion (ocean the entire time).
T2 In fact, he sailed the yacht bought for this occasion (ocean the entire time).

C1 The trainee was flying at the testing base./
C2 The trainee was attending the testing base./
T1 After lots of practice, he enjoyed the plane and didn’t want to stop.
T2 After lots of practice, he flew the plane and didn’t want to stop.

C1 The schoolboy was reading a lot that semester./
C2 The schoolboy had worked a lot that semester./
T1 For his course, he began the novel about the industrial revolution (text about the industrial revolution).
T2 For his course, he read the novel about the industrial revolution (text about the industrial revolution).

C1 The author was writing at the research institute./
C2 The author was staying at the research institute./
T1 Before leaving for Thanksgiving, he started the article (thesis) on global/warming.
T2 Before leaving for Thanksgiving, he wrote the article (thesis) on global/warming.

C1 The novelist wrote every morning in his conservatory./
C2 The novelist sat every morning in his conservatory./
T1 That particular day, he began the chapter about the main villain (novel about the historical figure).
T2 That particular day, he wrote the chapter about the main villain (novel about the historical figure).

C1 The artist was drawing in her studio all morning./
C2 The artist was busy in her studio all morning./
T1 By lunchtime, she had completed the portrait for the customer.
T2 By lunchtime, she had drawn the portrait for the customer.

C1 The workmen were building for the contractor./
C2 The workmen were working for the contractor./
T1 Eventually, they finished the roof of (frame for) the mall.
T2 Eventually, they built the roof of (frame for) the mall.

C1 The dieter had been eating too much all week./
C2 The dieter had been worrying too much all week./
T1 On Saturday, she resisted the chocolate (cakes) from Belgium.
T2 On Saturday, she ate the chocolate (cakes) from Belgium.

C1 The banquet-goers had been eating from the buffet./
C2 The banquet-goers had been examining the buffet./
T1 Eventually, they tried the venison smothered in mushrooms (shrimp smothered in butter).
T2 Eventually, they ate the venison smothered in mushrooms (shrimp smothered in butter).

C1 The barley was drinking all afternoon./
C2 The barley was in the bar all afternoon./
T1 By early evening, he was trying the whiskey imported from Ireland (vodka imported from Poland).
T2 By early evening, he was drinking the whiskey imported from Ireland (vodka imported from Poland).

C1 The party-goer had been drinking too much that evening./
C2 The party-goer had been really living it up that evening./
T1 At midnight, she resisted the cocktail made by the hostess (wine offered by the hostess).
T2 At midnight, she drank the cocktail made by the hostess (wine offered by the hostess).

C1 The sailor was eating in the galley by the engine room./
C2 The sailor was sitting in the galley by the engine room./
T1 Right away, he started the salad (sandwich) that was uniformly despised.
T2 Right away, he ate the salad (sandwich) that was uniformly despised.

(continued on next page)
C1 The landscape artist was drawing in the dwindling daylight.
C2 The landscape artist had waited for the dwindling daylight.
T1 In sort time, he finished the seashore covered in kelp (horizon lit by the setting sun).
T2 In sort time, he drew the seashore covered in kelp (horizon lit by the setting sun).

C1 The poet had written in different verse styles.
C2 The poet had appreciated different verse styles.
T1 Eventually, he mastered the sonnet (haiku) after several years.
T2 Eventually, he wrote the sonnet (haiku) after several years.

C1 The diner was eating constantly throughout the evening.
C2 The diner was very happy for the whole of the evening.
T1 In particular, he enjoyed the casserole (food) made of lamb and potatoes.
T2 In particular, he ate the casserole (food) made of lamb and potatoes.

C1 The yachtsman was sailing all summer long.
C2 The yachtsman was vacationing all summer long.
T1 Towards the end, he finally tried the catamaran (speedboat) built in the Canada.
T2 Towards the end, he finally sailed the catamaran (speedboat) built in the Canada.

C1 The schoolboy was reading all weekend.
C2 The schoolboy was relaxing all weekend.
T1 By Sunday, he had completed the comic-book (story) filled with superheroes.
T2 By Sunday, he had read the comic-book (story) filled with superheroes.

C1 The pop star was smoking all night.
C2 The pop star was rather overindulgent.
T1 Finally, he resisted the cigar from Havana, Cuba (cigarettes from France).
T2 Finally, he smoked the cigar from Havana, Cuba (cigarettes from France).

Stimuli from Experiment 3: C1, The context sentence contains an event-taking verb followed by an entity noun. C2, Control context sentence. T1, The target sentence contains an event-taking verb followed by an entity noun. T2, Control target sentence. “/” marks indicate where line breaks occurred when the stimuli were presented to readers in the eye-tracking procedure.
Appendix A (continued)

C1 The student started a book in his dorm room.
C2 The student read a book in his dorm room.
T1 Before he started the book about the opium trade, he checked his e-mail.
T2 Before he read the book about the opium trade, he checked his e-mail.

C1 The professor finished a letter in her office.
C2 The professor wrote a letter in her office.
T1 After she finished the letter to the dean, she took a friend to lunch.
T2 After she wrote the letter to the dean, she took a friend to lunch.

C1 The cadet mastered the bomber early in his training program.
C2 The cadet flew the bomber early in his training program.
T1 Once he had mastered the bomber, he changed over to much smaller aircraft.
T2 Once he had flown the bomber, he changed over to much smaller aircraft.

C1 The coastguard recruit mastered the boat with the rescue equipment.
C2 The coastguard recruit sailed the boat with the rescue equipment.
T1 After he mastered the boat, he was sent to sea in a much larger craft.
T2 After he sailed the boat, he was sent to sea in a much larger craft.

C1 The tycoon enjoyed the yacht with the bright yellow sails.
C2 The tycoon sailed the yacht with the bright yellow sails.
T1 In fact, he enjoyed the yacht much more than any of his power boats.
T2 In fact, he sailed the yacht much more than any of his power boats.

C1 The trainee enjoyed the plane that he bought from an old stunt pilot.
C2 The trainee flew the plane that he bought from an old stunt pilot.
T1 After lots of practice, he enjoyed the plane much more than he expected to.
T2 After lots of practice, he flew the plane much more than he expected to.

C1 The author started an article at the research institute.
C2 The author wrote an article at the research institute.
T1 Once he had started the article on global warming, he learned that his funding had been cut off.
T2 Once he had written the article on global warming, he learned that his funding had been cut off.

C1 The schoolboy began the novel about the mafia family.
C2 The schoolboy read the novel about the mafia family.
T1 Once he began the novel, he forgot all about doing his homework.
T2 Once he read the novel, he forgot all about doing his homework.

C1 The novelist began the chapter about the main villain in her apartment.
C2 The novelist wrote the chapter about the main villain in her apartment.
T1 Although she began the chapter well before lunch, it took her a long time to get going.
T2 Although she wrote the chapter well before lunch, it took her a long time to get going.

C1 The artist completed the portrait for the picky customer in her studio.
C2 The artist drew the portrait for the picky customer in her studio.
T1 By lunchtime, she had completed the portrait and a life-sized sketch.
T2 By lunchtime, she had drawn the portrait and a life-sized sketch.

C1 The workmen finished the roof of the mall.
C2 The workmen built the roof of the mall.
T1 Before they finished the roof, water had been leaking on the newly installed tile floor.
T2 Before they built the roof, water had been leaking on the newly installed tile floor.

C1 The dieter resisted the chocolates on Saturday.
C2 The dieter ate the chocolates on Saturday.
T1 On Sunday, she resisted the chocolates all day long and tried to otherwise stick to her diet.
T2 On Sunday, she ate the chocolates all day long but tried to otherwise stick to her diet.

C1 The wedding guests tried the salmon smothered in cream sauce.
C2 The wedding guests ate the salmon smothered in cream sauce.
T1 Although they tried the salmon, they only went back for seconds of the roast beef.
T2 Although they ate the salmon, they only went back for seconds of the roast beef.

(continued on next page)
References


